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Feasibility study for maximizing common parts strategy between MAN India and MAN Germany

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Non-Disclosure Agreement

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STATUARY DECLARATION

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Acknowledgement

This master thesis has been carried out at the organization MAN Truck & Bus, Germany during the summer semester of 2016, and it has been composed as a part of the master's program Production Science & Management. The thesis was led under the supervision of Prof. Dr. Christian Ramsauer, Mr. Christoph Sams at Technical University of Graz and my mentor Mr. Jens Hartmann at MAN Truck & Bus.

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In the end, I wish to thank my family and friends who have believed in me and made my journey a joyful experience.

Abstract

In today's competitive environment companies need to be price competitive and provide customers the products they demand. To achieve the ultimate goal of being successful in the market, companies need to align their product strategies with business strategies. For selection of right product strategy, it's necessary to analyse company's current market position by studying its strengths and weaknesses in relation to competitors.

This thesis was realized as an analytical study at the department of Product Management and Strategy of MAN Truck & Bus, Germany; one of the world's leading manufacturer of heavy commercial vehicles. The aim of this thesis is to find out potential of cost saving to bring MAN India in profitable business. A concept of takeover of aggregates with potential of savings by MAN India from widespread range of products and aggregates from MAN Germany is presented in this thesis.

This study focusses on comparing and analysing the material cost and overhead cost of aggregates made by MAN India and MAN Germany. A technical feasibility study of the aggregates was done to check possibility of replacement of the existing aggregates of MAN India by aggregates from MAN Germany. The author has briefly investigated the impact of aggregate takeover by perspective of different functions of the company such as Design, Purchasing, After sales, Marketing and Product Management. Landed cost estimation and effect of the aggregate takeover on the customers' total cost of ownership was evaluated. In the final section of the thesis estimation of potential saving due to proposed concept is presented.

Conclusions derived from this thesis show that there are some aggregates made cheaper in Germany than in India due to effect of economy of scale. Rear axles, one of the aggregates which are made cheaper in Germany, will cost the same for MAN India even if they are imported from Germany. In the final section of the thesis it is found that these axles will not only cost the same but also will give some additional value to customers enhancing the total cost of ownership.

Kurzfassung

Im heutigen Wettbewerbsumfeld müssen Unternehmen den Kunden die gewünschten Produkte zu global wettbewerbsfähigen Preisen liefern. Um auf dem Markt erfolgreich zu sein, müssen sie ihre Produktstrategien an die gewählten Geschäftsstrategien anpassen. Für die Auswahl der richtigen Produktstrategie ist es notwendig, die aktuelle Marktposition des eigenen Unternehmens zu analysieren, indem die Stärken und Schwächen in Bezug auf den Wettbewerb untersucht werden.

Die vorliegende Arbeit wurde als analytische Studie an der Abteilung Produktmanagement und Strategie von MAN Truck & Bus, Deutschland, realisiert, einem der weltweit führenden Hersteller von schweren Nutzfahrzeugen. Das Ziel der Arbeit ist es, Potenziale der Kosteneinsparung zu finden, um das Geschäft von MAN Indien profitabler zu gestalten. Dabei wird ein Konzept zur Übernahme von einzelnen Aggregaten aus den weit verbreiteten Baureihen von MAN Deutschland durch MAN Indien vorgestellt.

Nach Aufbereitung der theoretischen Grundlagen befassen sich die praktischen Kapitel der Arbeit mit der Analyse und dem Vergleich der Material- und Gemeinkosten der Aggregate von MAN Indien und MAN Deutschland. Des Weiteren wird eine technische Machbarkeitsstudie durchgeführt, um die Möglichkeit des Ersatzes der bestehenden Aggregate von MAN Indien durch Aggregate von MAN Deutschland zu prüfen. Der Autor untersucht zudem die Auswirkungen der Aggregate-Übernahme unter Berücksichtigung verschiedener Bereiche des Unternehmens wie Design, Einkauf, After-Sales, Marketing und Produktmanagement.

Die aus der Arbeit abgeleiteten Schlussfolgerungen zeigen, dass in Deutschland, aufgrund der Skaleneffekte, einige Aggregate kostengünstiger hergestellt werden können als in Indien. Die Hinterachse beispielsweise kann somit, trotz Transport und Importkosten zu insgesamt gleich hohen Kosten aus Deutschland beschafft werden. Im letzten Abschnitt der Arbeit wird festgestellt, dass diese Achsen nicht nur die gleichen Kosten haben, sondern auch einen zusätzlichen Mehrwert für die Kunden hinsichtlich der Lebenszykluskosten haben.

Table of Contents

1 Introduction

MAN Truck & Bus is one of the leading brands in the commercial vehicle industry all over the world. Due to its global reputation, MAN desires to make its roots strong in Indian market. MAN Trucks India (MTI) is recently becoming the most noticed and studied case from Indian commercial vehicle (CV) market.[1]

1.1 About MAN India

MTI's operation includes number of factors such as- MAN Truck & Bus, operation in India, history with Force Motors, language, culture as well as old leadership and working style in India.

MAN was already well known at the start of year 2000, soon after this MAN decided to go global and make its presence in the global market. Towards the efforts of going global MAN established joint venture (JV) with Indian partner Force Motors in India.[2]

The main aim of the joint venture was to take the advantage of technical expertise and MAN brand value benefits, whereas Force Motors will contribute with its local market knowledge and the network in India. With this motive MAN planned to spread its business in Indian soil. The main aim of the joint venture can be seen in the Table 1:

Joint Venture concept	
MAN	**Force Motors**
Technological Expertise	Local Market Knowledge
Global Brand Value	Network
Expansion in Indian Market	Expansion of Business

Table 1: Joint venture concept[3]

With this joint venture MAN commenced their operation in India in the year of 2006. In 2012 MAN Force Trucks Private Limited (MFTPL) was taken over by MAN Trucks & Bus AG, Germany and 100% subsidiary under the name MAN Trucks India Pvt. Ltd. was formed. The headquarters was housed in Pune while the production facility was

[1] Cf. Chandel, Atul (2014) , p.3
[2] Cf. MAN internal data
[3] Cf. MAN Trucks India, Corporate Portrait Year 2016 (2016), p.5

placed in Pithampur at the same location of the joint venture period of the company. Initial journey of the company can be seen in the timeline below.[4]

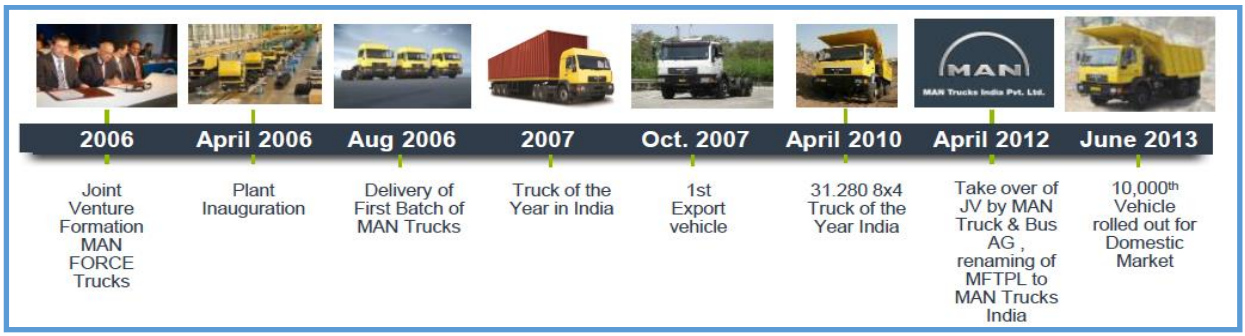

Figure 1: Journey of MAN Trucks India[5]

1.2 Current situation and problem definition

MAN group has entered the Indian market to expand its horizons over the Indian seas and capture one of the most promising markets of BRIC (Brazil, Russia, India & China) countries. In spite of being a strong global brand MAN hardly managed to have successful operation in India. In the presence of over a decade now MAN is still struggling to have profitable business in India. MAN's problem today is how to improve business unit in India and to bring it in profitable operation and target the mass market which all other Original Equipment Manufacturers (OEMs) are pouring their money and efforts in. [6]

The main observed hurdle is the difference in tool kits (baukasten) of Indian CLA (Cargo Line Asia) & German TG (Trucknology Generation) product range. Due to these differences it has become very difficult to take over, reuse and transfer the baukasten within MAN's subsidiaries. As CLA products are derivatives of few old obsolete TG products and further modified as per Indian market requirements, they are not aligned with TG products. Therefore it is also very difficult to track these baukasten at MAN Truck & Bus, Germany (MTB). So it is highly possible that MAN as a group is spending money to develop similar baukasten at different locations. Also it is difficult to deny the fact that possibly MTI is not taking the advantage of know-how, expertise and existing baukasten of MTB products and vice versa.[7]

Hence to understand the potential of improvements, firstly it's necessary to understand the concept of product management, modular product architecture, CLA & TG products

[4] Cf. MAN Trucks India, Corporate Portrait Year 2016 (2016), p.5, Own illustration
[5] http://www.mantrucksindia.com/company/mti-at-glance/, date of access: 20.04.2016
[6] Cf. Chandel, Atul (2014) , p.5, Own illustration
[7] Own illustration

in aspect of structure, Bill of Material (BoM) & price. Understanding these factors will surely help to answer the following research questions.

1.3 Thesis objectives and research leading questions

The Objective of this thesis is to investigate weather MAN is following the right product strategy for Indian market. This thesis also aims to find out some solutions to achieve profitability and harmony between MTI & MTB.

Hence to understand the potential of improvements, firstly it's necessary to understand the concept of product management, modular product architecture, CLA & TG products in aspect of structure, BoM & price. Understanding these factors will surely help to answer the following research questions:

Research Question 1:- *What are the potential solutions in aspect of product management to bring MAN Trucks India in profitable business operation?*

Research Question 2:- *Are there some aggregates made cheaper by MAN Truck & Bus, Germany which can be taken over by MAN Trucks India?*

Research Question 3:- *Will it be beneficial from TCO perspective to take over aggregates from MAN Truck & Bus, Germany?*

1.4 Reference framework

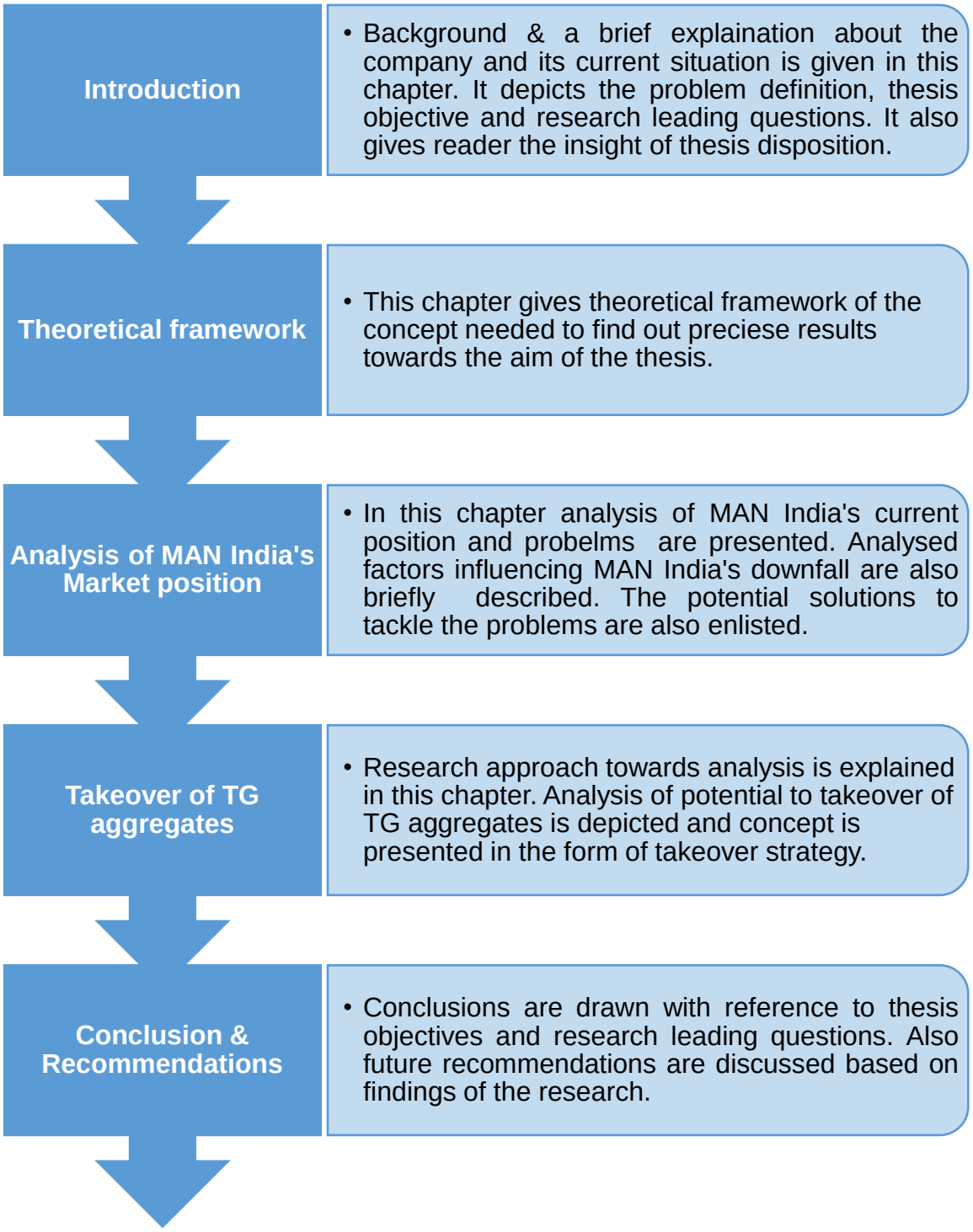

Figure 2: Reference framework[8]

[8] Own illustration

2 Theoretical framework

This chapter presents the theoretical framework of the thesis. Theoretical background for the research of the purpose *"Feasibility study for maximizing common parts strategy between MAN India and MAN Germany"* is discussed in this chapter. It forms groundwork of the theories which are relevant to have a clear academic understanding to answer the research question. This section also gives an overview of the academic concepts like product management, variant management, 4P's of marketing and total cost of ownership which are needed to find a potential solution for existing problems.

2.1 Product management

"The product management is the holistic business management of the product from the time it is conceived as an idea to the time it is discontinued and withdrawn from the market."[9]

The fulcrum point of a successful business is product management. The role of product management is commonly not understood well in the organizations. Hence to understand the exact role of product management it is very necessary to understand the terms product and management.

2.1.1 Product

"A term used to describe all good, services and knowledge sold. Products are bundle of attributes (features, functions, benefits and uses) and can either be tangible as in the case of physical goods; intangible as in the case of those associated with service benefits; or can be a combination of the two."[10]

In nowadays business product is not a standalone entity, it is generally a sub-part of the other product or member of a product line. This can be offered as a package to the customers to meet the specific customer needs. These product lines are integral part of the broader product portfolio which is shared by a single firm, business units or different divisions of a larger company. Further categorization of the product into product elements, components or modules can be done. These products can be built upon a

[9] Steven Haines (2008), p.12
[10] Dr. Cooper (2007), p.32

common product platform or architecture.[11] Figure 3 gives and overview of this hierarchy.

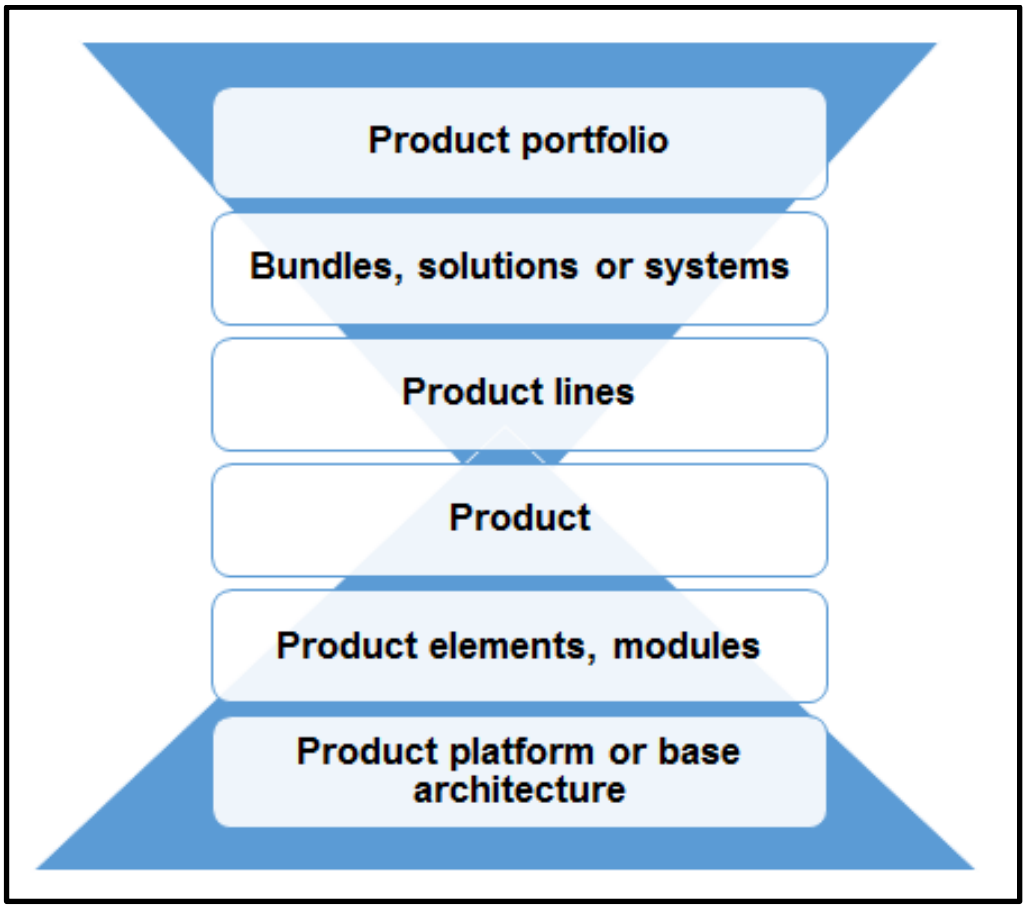

Figure 3: Typical hierarchy of products & services[12]

In business sense product is anything that can be sold, tangible or intangible. There are different ways to sell the product. Products can be directly sold to the customers or to other businesses. In other case some companies sell products to other companies which further sell it to the customers. The best example of such business is automotive parts manufacturers. Automotive part manufacturer supply parts to the automotive company which sells further to dealers and finally dealer sell products to the end customers.[13]

Product Lines

Nowadays companies group their products into a certain product line. These product lines address particular customer groups or the particular customer demand. Generally products in these product lines share many common parts. Figure 4 Figure 4: Hierarchy

[11] Dr. Cooper (2007), p.32
[12] Cf. Steven Haines (2008), p.13
[13] Ibidem

of product lineshow how the product lines are generally managed nowadays in the companies.

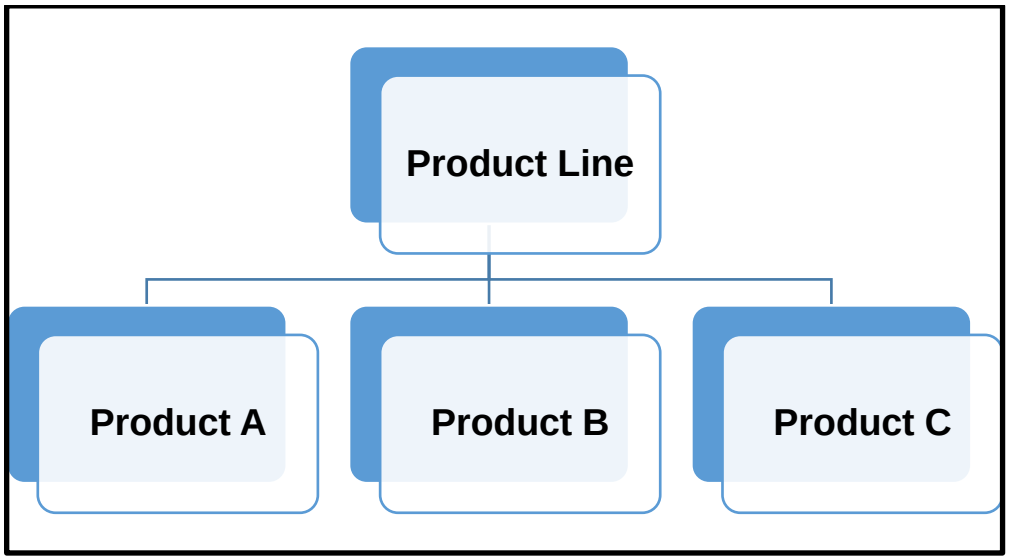

Figure 4: Hierarchy of product line[14]

As shown in the figure above, companies generally organize similar products under a product line. These products are generally aimed towards similar market or are made through similar process. A typical example of product line is BMW's product line. Figure 5 shows the hierarchy of BMW's product line

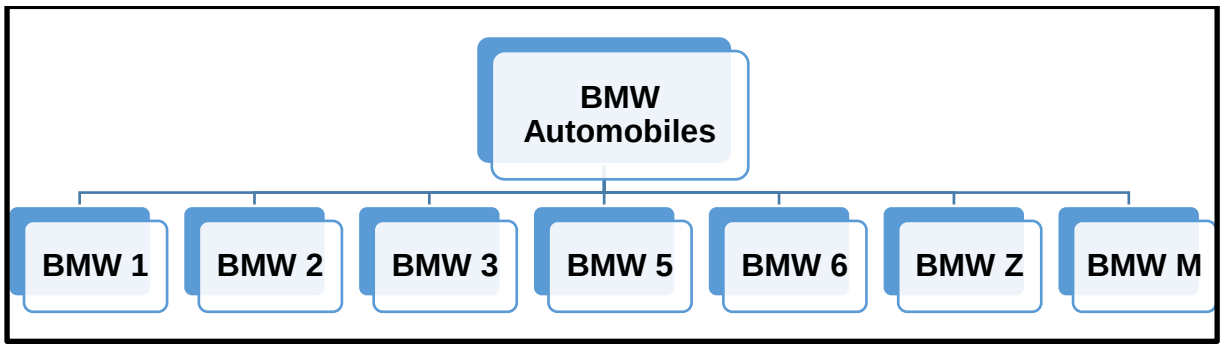

Figure 5: BMW Automobile product line[15]

For a huge company like BMW, a product line is a small product portfolio. BMW group has several product lines like Mini brand, Rolls-Royce brand and BMW automobile brand. Figure 5 shows the different products under BMW Automobile Division. Managing products under a specific product line enables manufacturers to focus specific customer demand and maintain brand value.

[14] Cf. Steven Haines (2008), p.14
[15] Ibidem

Product portfolio

Product portfolio is a combination of different products, product line or other grouping within a business unit. Product portfolio can consist of products which are ready to be offered to the market or product which are under development phase which will soon ready for the market. Product portfolio can contain different product which are at different phase of their product lifecycle. Small companies may have a single product, single service or a single product line as the whole product portfolio. On the other hand, some other companies can have hundreds of products under offered product portfolio. [16] A visual example of typical product portfolio is illustrated in Figure 6

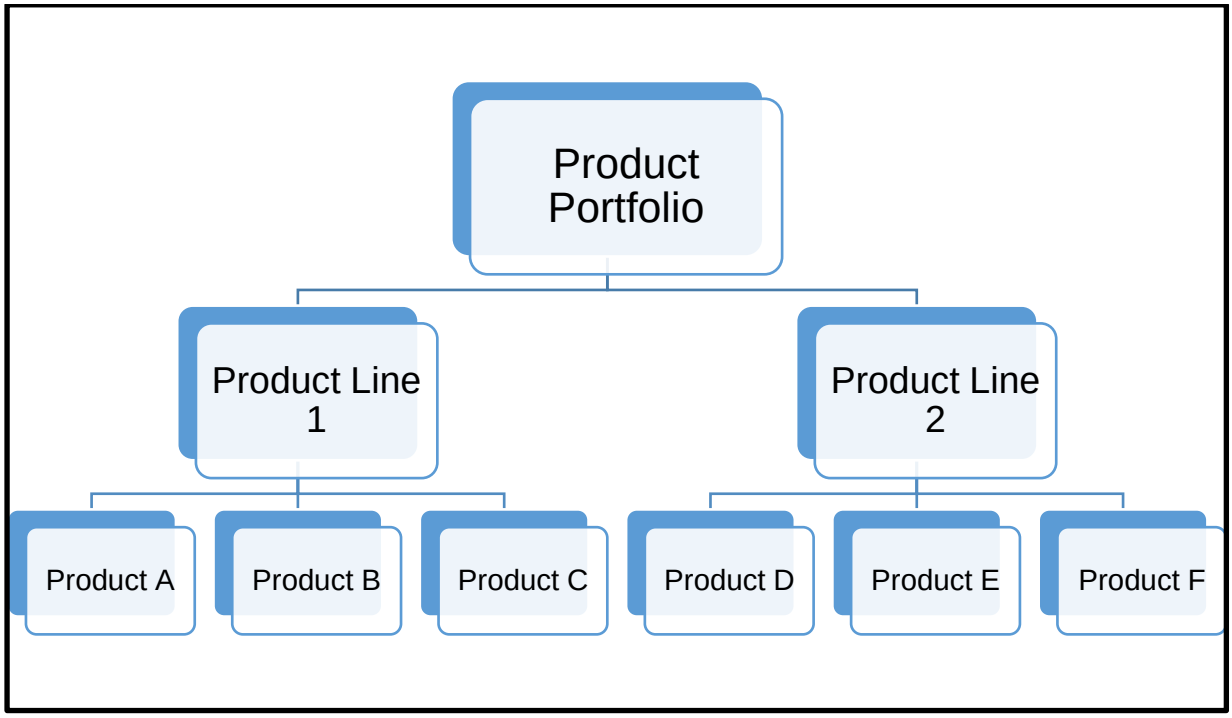

Figure 6: General product portfolio structure[17]

The product portfolio in most companies comprises of several product lines or products. Common approaches to organize the product portfolio include the following: [18]

- *Market on which products focus:* In this approach product portfolios are categories based on the market which they will focus on.

- *Types of products produced:* In this approach products are categorized in special product line depending on their different type and difference as compared to the other products.

[16] Cf. Steven Haines (2008), p. 9
[17] Ibidem
[18] Ibidem

- *Broad functional themes:* In this approach the companies categorise their product depending on their functionality. For example hardware, software and services.

Companies select specific approach to manage their portfolios depending on their products and preference. In some cases same product can also lie in two different product lines. By the basic principal of product portfolio management, this shouldn't be the case, but sometimes it practically makes more sense to have same product offered under two different product lines. Further companies should continuously manage and optimise their portfolios to be competitive and be profitable. [19]

Figure 7 shows the BMW's automobile lines product portfolio. As mentioned before, BMW owns different brands such as Mini and Rolls-Royce. Figure depicts the portfolio of the offered products line under BMW Automobile Division.

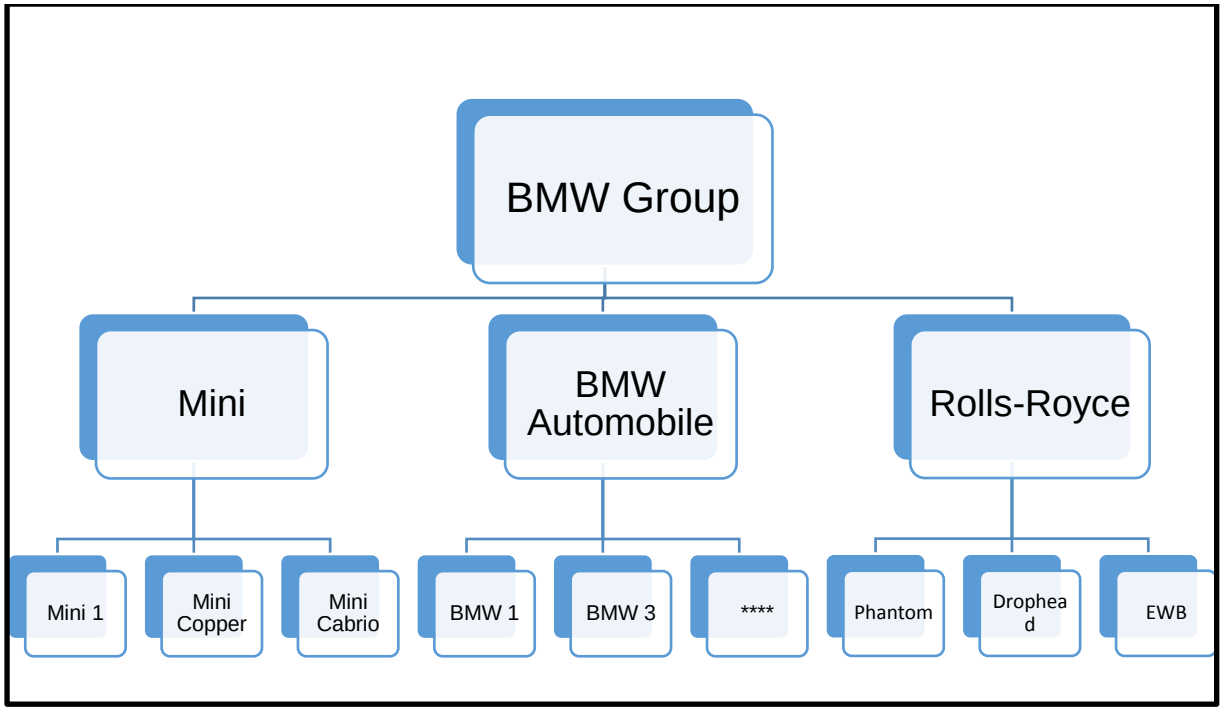

Figure 7: BMW Group automobile portfolio[20]

Solutions, Bundles and Systems

Related secondary products or services are generally grouped into solutions bundles or systems. Solutions are quiet complicated as they offer a solution to a complex problem and often require specific customization to address particular needs or requirements.

[19] Cf. Steven Haines (2008), p. 10
[20] Cf. BMW Group (2016)

Firm that aims to offer solutions should have an organizational structure which supports solution-based marketing, sales and delivery. Such companies need to have their representatives very close to market so that they are in close contact with customers and understand their needs. This enables companies to understand precise customer demands and address them quickly. [21]

In principle, "*every product should be a solution to some problem*."[22] If it's considered that every product is a solution to some problem then ideally every company is doing solution business. But it's not the case as some companies provide the products which do not provide solution from start to finish. Grouping of such products is called bundling. In business to business (B2B) settings, if buyers can easily replace individual component then it's a bundle and not solution. Bundles do not contribute much to the product profit. Hence organizations should avoid allocating overheads to bundles.[23] A conceptual illustration of a solution in B2B setting is depicted in Figure 8

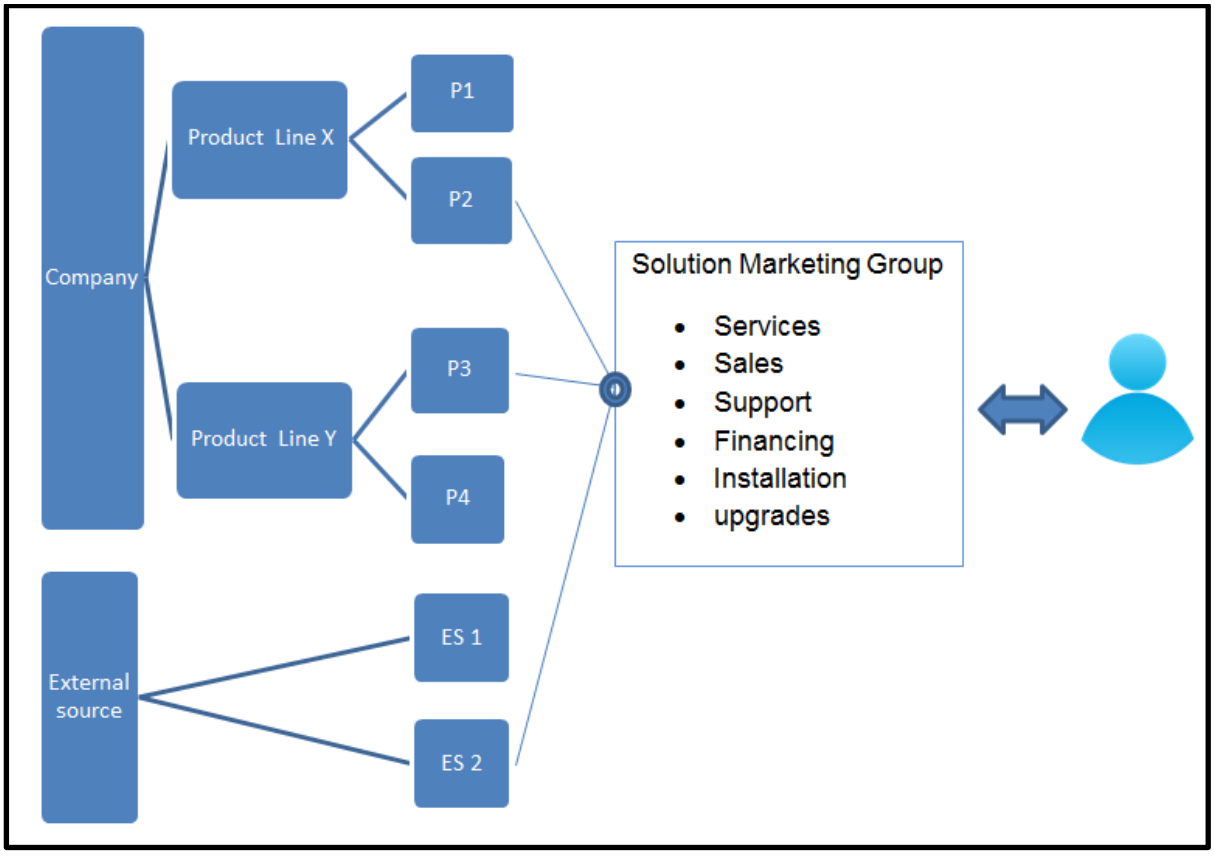

Figure 8: How solutions are structured[24]

Along with the produced products companies use some external services or some of the components from external source and offer a complete solution to the customers.

[21] Cf. Steven Haines (2008), p. 10
[22] Steven Haines (2008), p.11
[23] Cf. Steven Haines (2008), p. 11
[24] Cf. Steven Haines (2008), p. 12

Companies take help from other sources because they either do not have resources for it or do not have expertise in certain area.[25]

Platforms

Platforms define the base architecture on which products are built. This enables companies to achieve maximum degree of standardization across the portfolio. Due to standardization in product architecture, economy of scale affect and flexibility in product design can be realised. It helps companies to meet the customer demands more precisely and yet be profitable. [26]

"Product platforms must be managed. If a platform is not rejuvenated, its derivative products will become dated and will fail customers in terms of function and value. If a company's platforms are renewed periodically, redesigned to incorporate new functions, components, and materials, the product family will remain robust through successive generations. Robust product platforms do not happen by accident. They are the result of a unique methodology and of strategies for designing, developing, and revitalizing them over time."[27]

In recent past, automotive manufacturers have focused a lot on platform concept due to competitive market environment, design flexibility, or required economy of scale effect. Nowadays companies share many components or modules across the platform. On the other hand, companies which are formed by mergers and acquisition find it really difficult to rationalize their product into a uniform platform due to the huge difference in the products. In such cases platforms can become so difficult that it can end up being more expensive to set up a platform than its benefits to the organization. Figure 9 shows the visual representation of the platform concept.[28]

[25] Cf. Steven Haines (2008), p. 12
[26] Cf. Steven Haines (2008), p. 14
[27] Lehnerd, Meyer (2011), p.19
[28] Ibidem

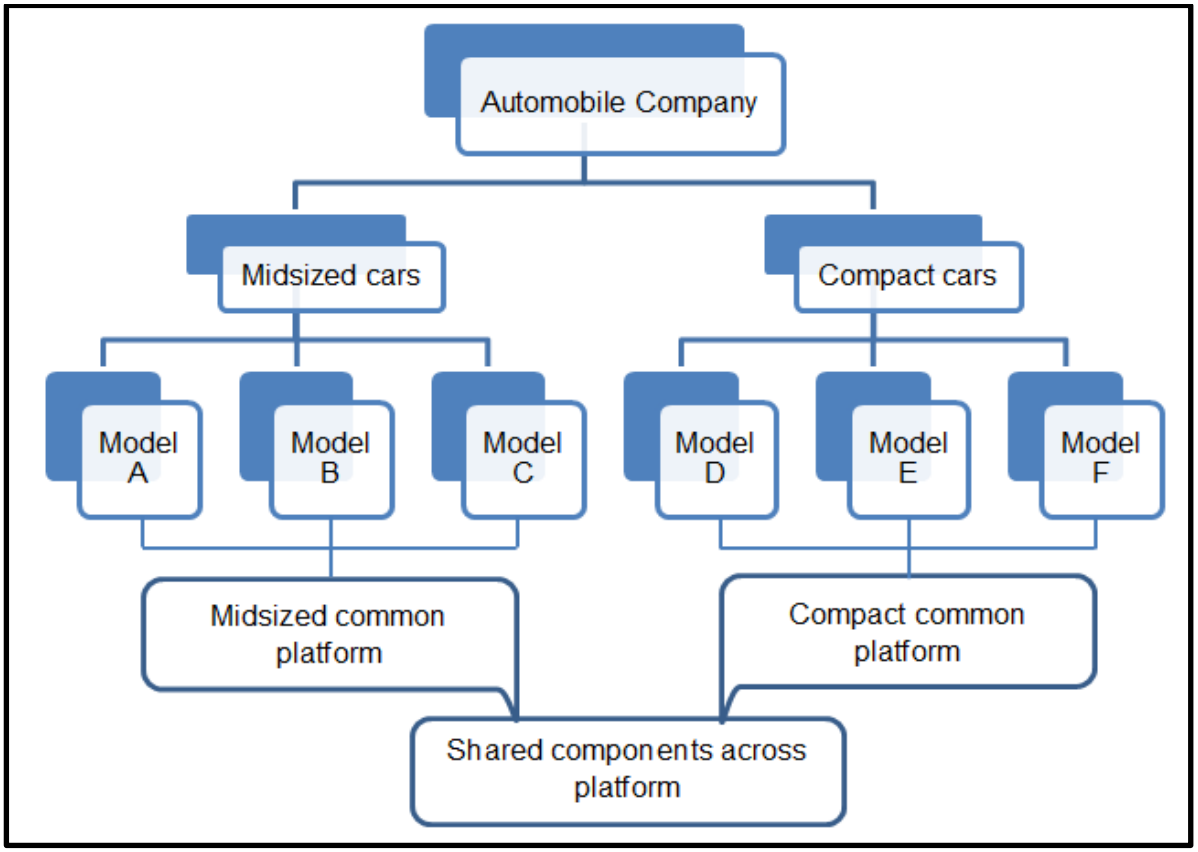

Figure 9: Platform structure within product portfolio[29]

2.1.2 Management

The second important part of product management is technique of management itself. There are several definitions of management available.

"Management (to manage) is to forecast and to plan, to organise, to command, to co-ordinate and to control."[30] The activity of management generally includes the usual cycles of business elements:[31]

- Setting goals
- Directing humans and financial resources
- Assessing outcomes
- Reassessing and/or resetting goals

[29] Cf. Steven Haines (2008), p. 15
[30] Prasad, Gulshan (2011), p.21
[31] Cf. Steven Haines (2008), p. 16

To understand the art of product management, it is necessary to understand the tasks in product management. Typical tasks performed in product management function are as below:[32]

- **Integrating and synchronizing:** It consists of integrating and synchronizing the outputs and performance of different functions in the organization.

- **Leading and influencing:** It is very different than managing as managing means explicit authority over personnel and leading means to convince member to follow one's vision.

- **Cross-functional teaming:** In any project or task only product management cannot perform all tasks. Expertise of people in special field is needed. Hence there is a need of a cross functional team where everyone will contribute and perform in specific task to achieve a common goal.

- **Solving problems and making decisions:** Solving problems which occur over the lifecycle of a product is very crucial to meet initially set goals. In virtue of achieving those goals making right decisions is also integral part.

- **Financial planning and analysis:** Any kind of investment done in a product by a company is expected to give profits to the company. Hence planning and analysis of financials involved is necessity in product management function.

- **Assessing the industry and competition:** To be competitive and remain profitable it is very important to analyse the current market, behaviour of the industry and position of the competitors. A close look on the competitor's activities and advancements made gives a guiding path to companies to plan and organize their products and make right decisions required.

- **Segmenting markets, identifying target customers, and uncovering customer needs:** Segmenting markets activity need involvement of cross-functional team along with product management function. Often help from external research firms or consultants is also taken for this activity. In depth study of target customer groups help to position the product in the market and focus on customer needs after thorough study.

[32] Cf. Steven Haines (2008), p. 16

- **Forecasting:** The activity of forecasting includes tasks like forecasting volumes, market share and revenue. This task is often solely owned by product management function from start to finish.

- **Formulating product and marketing strategies:** With the help from a cross-functional team, product managers set a vision for the product and design the path to future. Product strategies are developed in product management function. The most crucial task here is to align the product strategy with that of organization's strategy. Alignment of product strategy with organizational strategy is the key to successful business operation.

- **Leveraging the Product Management Life Cycle Model:** Product strategy should be designed in such a way that it is not only aligned with organization strategy but also supports the product's development, launch, and management across its market life cycle. Product management provides the strategic management plan of the products. It is done by manipulating different levers such as marketing mix, launch of new products or replacement of an existing product. Product management function also influence heavily on product strategy, product launch, business case, marketing plan and the product requirements. Figure 10 shows a typical product management lifecycle model.

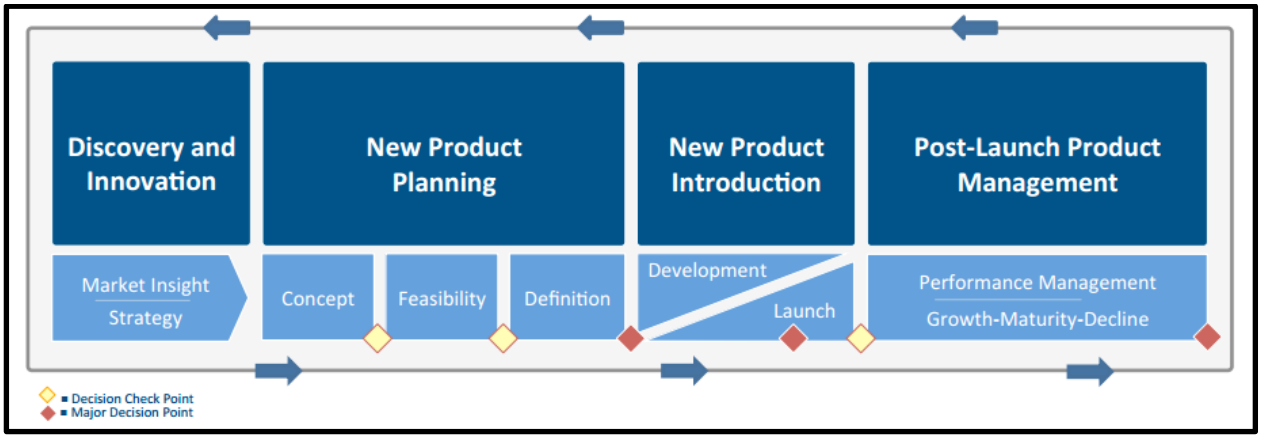

Figure 10: Product management lifecycle model[33]

Neatly organized product management transforms a good idea into successful and profitable business. Product management lifecycle model helps to achieve organized product management. This model is divided into four phases over the lifecycle. These four phases include:[34]

[33] Cf. Stark, J. (2004), p.33
[34] Cf. Steven Haines (2008), p.16

- **Discovery and innovation:** In this phase new ideas are captured upon, insight planning and strategies are formulated. A in depth study of new entrants to the market, unexpressed challenges face by customers, industry trends and competitor activities is done to come up with new ideas. Outputs of the discovery and innovation phase are used as an input to the strategy formation.

- **New product planning:** In this phase the major decisions regarding product are made. A cross-functional team works together to ensure that proper investment decisions are made. New product planning does not imply that planning of only new product is done in this phase. Planning of existing products also comes in this phase as the existing products are enhanced for some new features or benefits. This phase is further divided into three sub phases. Concept phase includes idea generation and shortlisting of the ideas. In feasibility phase there ideas are further planned with greater details. In the last phase of definition products are designed and specified so that they are ready for production.

- **New product introduction:** This is the execution phase of the total product management lifecycle model. This phase is subdivided into two phases namely development and launch. In the development phase product is being developed in a normal product development process. Development phase starts once the project is sanctioned and budget for it is released. Meanwhile a cross-functional team prepares the launch of the product so that it is available in the market for the customers to buy. Launch phase is integral part of the new product introduction phase as it starts in the early period of this phase when the product is being developed. This activity is often carried out by marketing team. It gives an organized sequence of the activities necessary to bring product to the market.

- **Post launch product management:** The role of product management doesn’t stop after the launch of the product. Product management continues to manage the product even after launch to the market. After launch product is being optimised for the performance and to meet the firm’s strategies and to better fit it into the product line.

The four phases of the model are not distinct in lifecycle of the product. Every phase is interrelated to the other phase and some phases are completely dependent on the previous phase. Though this model provides a guideline for product management but it isn’t sufficient throughout. The product management process is very dynamic as many factor like market position, customer demand, technology advancement and competitor strategies constantly change over the time. Tackling all the dynamic situations and

problems yet keeping the ultimate goal in mind is the real key to a successful product management.[35]

2.2 Variant management

In today's competitive environment, it's very crucial for organizations to focus on their customers' demands and to deliver those demands precisely in their products. Customised products generally generate extra costs. It is very important to find the perfect fit of standard and customised components to meet the customer requirements and optimised cost of the products.[36]

To get the most benefit from product variety, product portfolios need to be managed on different levels with different approaches. Variety and complexity management are the key success factors for companies.[37] Basic hypothesis of variant management indicates that it can be achieved by aiming the product portfolio variety. As variants provide unique value to the customers, increase in variants initially results in strong benefit to the companies.[38] This additional value can help companies to increase the sales price of the product or offer a new product range to customers. However, further increase in variety decreases the marginal profit.[39] The costs for providing multiple variant, complexity costs, increase exponentially with increasing variants.[40] These facts are the ground for variant management. It leads to two major tasks in variant management which are shown in Figure 11: [41]

- *Determine appropriate level of variety:* The motive of this task is to identify the level of variety in product portfolio which will result in maximum corporate benefit to the company. All the boundary conditions are supposed to be given in this stage. Only the decision about variety needs to be made here.

- *Master variety:* It is assumed in this task that level of variety is given. Variety is mastered by taking right decisions about product design, integration, organisation and manpower allocation.

[35] Cf. Steven Haines (2008), p.16
[36] Cf. https://blogs.oracle.com/PLM_Cafe/en/entry/variant_management_which_approach_fits, date of access: 12.10.2016
[37] Cf. Bjorn Avak (2007), p. 21
[38] Cf. P.J. Rathnow (1993), p. 13
[39] Cf. P.J. Rathnow (1993), p. 19
[40] Cf. G. Stalk, T.M. Hout (1990), p. 48
[41] Cf. Bjorn Avak (2007), p. 21

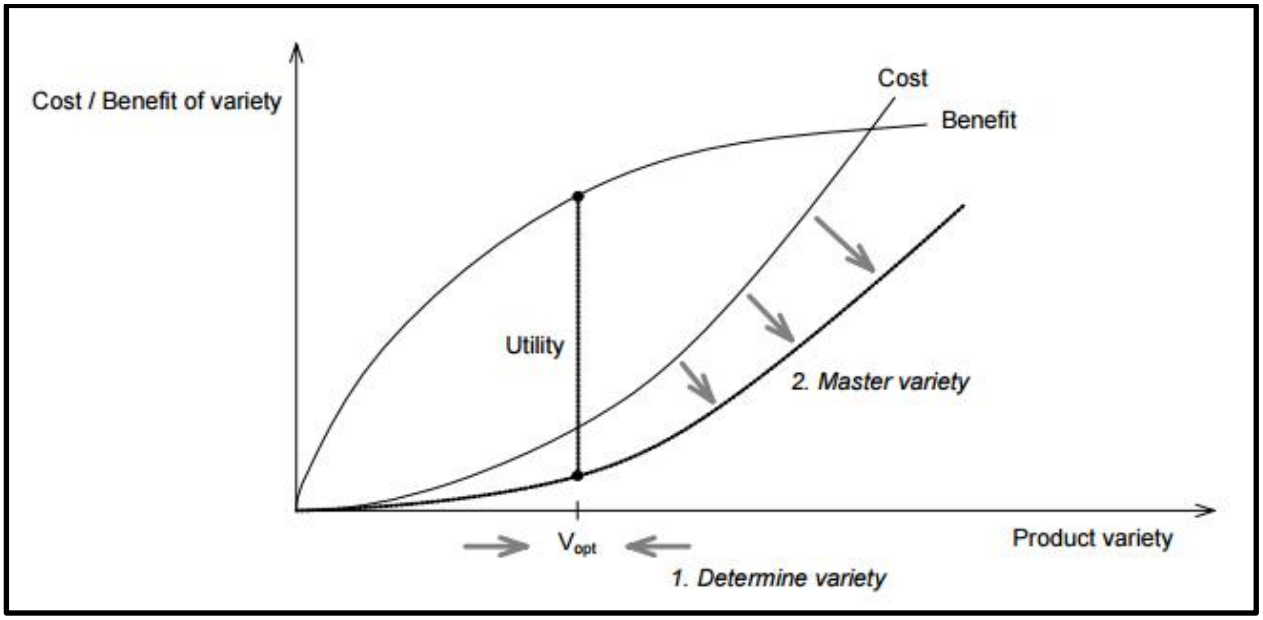

Figure 11: Cost-benefit function in variant management[42]

As observed in Figure 11, after a certain level costs increase exponentially with increase in variants. Therefore it is very crucial to determine the exact amount of variety which can be offered while keeping the benefit of the company in mind. In the subsequent sections, different approaches to variant management are outlined.

2.3 Different approaches to variant management

In this section of the chapter different approaches used to manage variants are outlined. To determine the perfect combination of variety and corporate benefit, variants can be managed with three different approaches. These approaches include variant generation, variant prevention, variant reduction and variant control. These approaches can be applied in different stages of the product life cycle. Figure 12 shows in which phases of the product life cycle these approaches can be applied.

[42] P.J. Rathnow (1993), p. 44

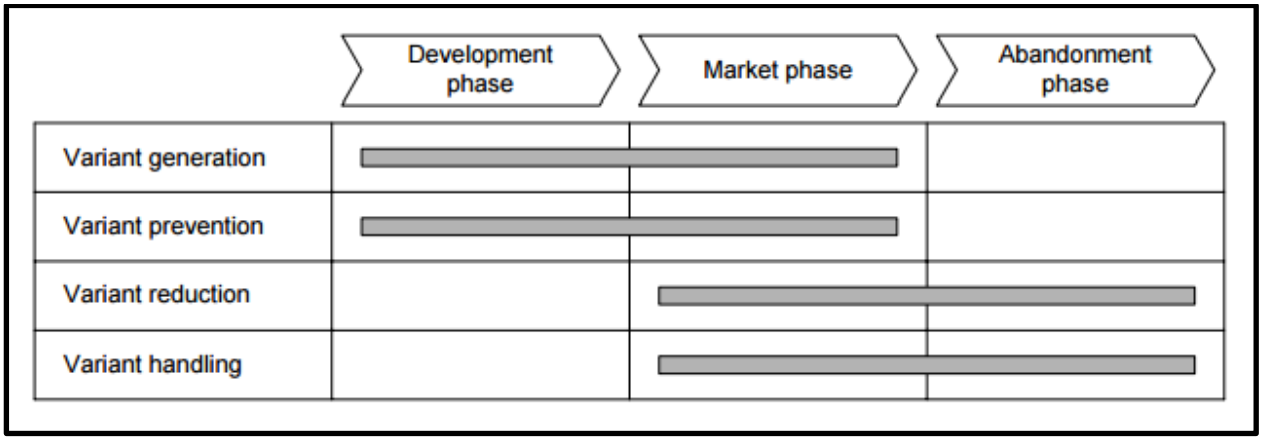

Figure 12: Approaches to variant management in product life cycle[43]

In development phase required variants are planned to meet sales forecast. In this phase focus is on variant generation and prevention. In market phase extra variants are generated to meet the changing market demand or to cope up with changing legislative requirements. Also market phase includes reduction of non-profitable variants. At the end of product life, in abandonment phase variants are reduced and required variants are better handled.[44] As variant generation is the approach used at early stage of product development, hence only relevant approaches are discussed in following sections.

2.3.1 Variant prevention

In this section approach of variant prevention is described. This generally relates to the development phase of the lifecycle. It suggests preventing generation of unnecessary variants while designing a product. It also suggests, wherever possible, using existing components with some rework to meet the new product requirement. Variant prevention is the basic and very effective way of managing the complexity of variants. [45]

One way to prevent variants is by designing product families. In product families products can be categorised on the basis of series. Within a series, products are of same functional specification but are systematically graded based on size. These products differ only in performance, weight and external dimensions.[46] Similar concept of product families can be applied to components as well. Product families are generally made based on the principal of modular products. Modular products are made from different modules. These modules can be parts, subassemblies or assemblies in a product. These modules are generally reusable and can be used in different variety of

[43] Cf. J. Heina (1999), p. 42
[44] Ibidem
[45] Ibidem
[46] Cf. Ehrenspiel K. (1995), p. 617

products. The main aim of the modular product structure is to maintain widespread product portfolio while reducing the required components or subassemblies to make it.[47]

Due to frequent use of same modules for different products, time to market and product development time is reduced considerably. But it must be remembered that too frequent use of modules makes customers think that there is no innovation in this product. By use of modular structure different customer requirements can be addressed still maintaining the economy of scale.[48]

2.3.2 Variant reduction

Variant reduction is generally aimed to reduce internal complexity and reducing overhead costs. In most cases reduction in number of variants results in improvement of company's profit. Cost saving due to variant reduction generally results in very little cost saving as the number of variant will again increase to cope up with changing demands. [49]

Variant reduction can be achieved on two levels. One level focuses on reduction of part variants and other focuses on reduction of product variants. The way to reducing product variant is by thoroughly analysing the sales figures of company and eliminating the products which are in demand in the market[50]. Disadvantage of this method is that further possible combinations of variants which could use the eliminated variant are neglected. [51]

2.3.3 Variant control

Unlike the other two approaches of variant management, this approach suggests controlling variants instead of preventing or reducing. It suggests offering products cost effectively by taking appropriate corrective measures without affecting the offered product range. Though variants should be reduced according to first two approaches, variant control approach suggests controlling it due to increasing demand of variations.[52] Increased number of variants often brings internal complexity and it should be controlled by the companies. This is generally addressed by outsourcing some of the components or the services in the company. Variant problem also can be solved by

[47] Cf. Ehrenspiel K. (1995), p. 626
[48] Cf. J. Heina (1999), p. 48
[49] Cf. J. Heina (1999), p. 51
[50] Cf. H. Schlegel (1978), p. 72
[51] Ibidem
[52] Cf. J. Heina (1999), p. 53

bringing flexibility in manufacturing. This will result in managing complexity and reducing time to market.

Outsourcing of services or some of the components reduces the internal complexity and leads to improved cost structure. By outsourcing complex components companies can still maintain the variety in the final product. However it should be noted that the complexity is shifted to supplier end. If the suppliers are not able to manage the complexity of the components efficiently, they will often compensate the complexity by high component prices. Therefore in make-or-buy decision of company not only short term cost saving are considered but also complexity at supplier end and transaction cost involved are considered.[53]

2.4 Marketing mix

The concept of marketing mix emerges from the single P (product) of microeconomic theory.[54] Marketing mix is generally referred to 4P's of marketing.[55] These are the medium to implement marketing planning and strategy into actual business.[56] It is not a theory but just a method or tool what marketing managers use while taking decisions about how to offer products to meet the market demands.[57] This tool can be used either to set up a strategy or to analyse the existing business in terms of marketing mix. It helps decision taking managers to make both short term and long term strategies.[58] Marketing managers need to take decision and focus on specific market demands keeping in mind the market they are focusing on. It is very influential in making the right decisions to meet specific customer demands.

Marketing mix is a very effective concept because it helps to simplify marketing and distinguish it from other organizational tasks. Marketing mix can help companies to completely turn around the business.[59] However marketing mix is criticised by many researcher claiming that additional dimensions or P's need to be added to it.[60] In the subsequent chapter traditional 4P's of marketing are discussed in detail.

[53] Cf. J. Heina (1999), p. 53
[54] Cf. Chong K. W. (2003), p.67
[55] Cf. Kotler P. (1984), p.89
[56] Cf. Bennet A. R. (1997), p. 151
[57] Cf. Goi C. L. (2009), p. 2
[58] Cf. Palmer A. (2004), p32
[59] Cf. Grönroos, C. (1994), p. 4-20
[60] Cf. Moller K. (2006), p. 439-450

2.4.1 4P's of marketing

Four P's of marketing is the framework to improve the elements of the marketing mix. It is a method how company offers the product or service into the market. It helps companies to assess the marketing strategy in terms of product, price, place and promotion[61] to meet specific customer requirements. It is basically a set of decisions and preferences companies agrees upon for bringing product to the market. [62]

Marketing mix, often referred as 4P's of marketing, is the combination of variables which company can control to influence the consumers behaviour. Marketing decisions are categorised as shown in Table 2

Product	Price	Promotion	Place
Design	Wholesale	Strategies	Special offers
Technology	Internet	Skimming	Endorsements
Usefulness	Direct sales	Penetration	Advertising
Value	Peer to peer	Psychological	User trials
Convenience	Multi-channel	Cost-plus	Direct mailing
Quality		Loss leader	Leaflets/posters
Packaging			Free gifts
Branding			Competitions
Warranties			Joint ventures

Table 2: Elements of 4P's of marketing[63]

The factors that influence development of strong customer relationship in market vary from time to time.[64] Hence companies need to organize how to position your product in the market to meet customer demands. Four crucial elements of marketing mix, 4P's of marketing are shown in Figure 13.

[61] Cf. Rhonda, A. (2000), p. 47
[62] Cf. McCarthy, J. E. (1964)
[63] Cf. Singh M. (2012), p.40
[64] Cf. Anderson A. (1998), pp. 125-127

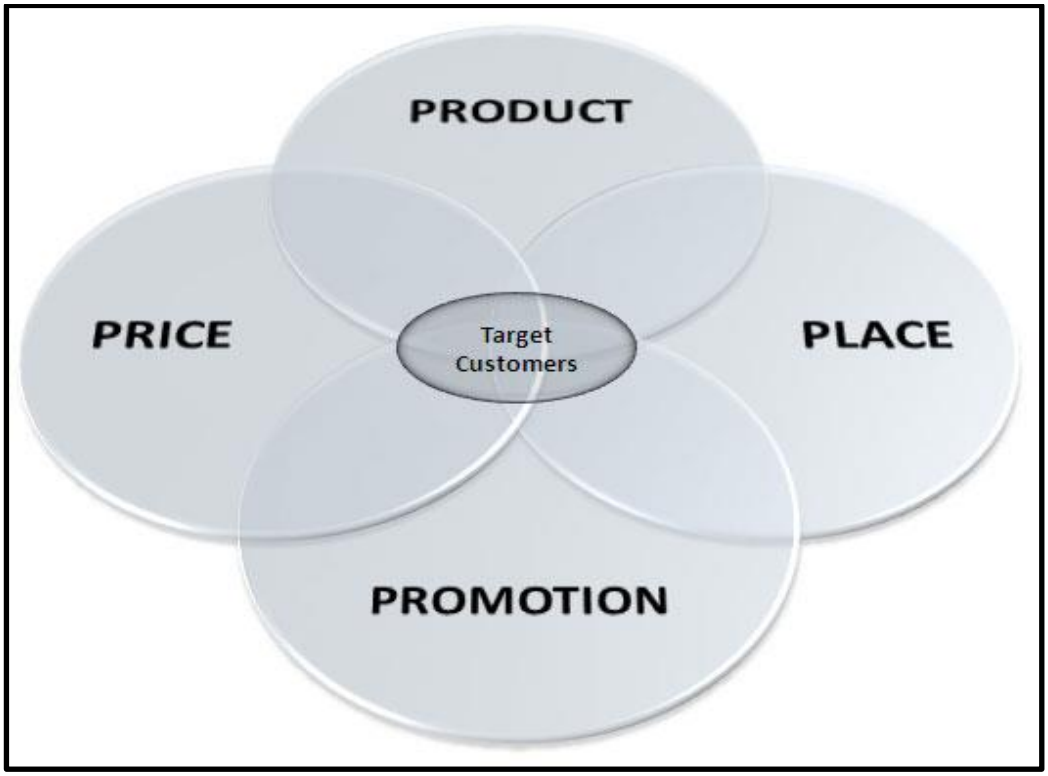

Figure 13: 4P's of marketing[65]

- **Product** The right product in right target market
- **Price** The right product at right price
- **Place** The right product offered at right price in the right place to be purchased by customers
- **Promotion** To inform the customers about the right product at right price available in right place

Product

Anything that can be offered to the market which can meet someone's requirement is called as product.[66] In production industry products can be raw material completed goods or any services. In different industries products can be referred to different entities. Products are the tangible goods and services are the intangible.[67]

There can be many aspects of products to which customers are attracted. Some customers may be interested in the way it is packaged or its appearance. Features,

[65] Singh M. (2012), p.41
[66] Cf. Kotler, et al. (2006), p.7
[67] Cf. Singh M. (2012), p.41

quality, options, warranty and services are some other attributes. Hence companies need to pay close attention to exactly what are they offering as a package. The right product needs to be placed in the right target group. A luxury product needs to be offered to people who already have everything and create such an image in the market. On the other hand for a price conscious target customer a basic product should be offered. [68] Companies need to know their competitors and customers to offer products which meet the customer demand to avoid mistakes. If a company is planning to launch a new product, it needs to think weather a product matches company's strength and weakness or not. For instance if companies expertise it to provide good aftersales facility then it should be included with the product as a package. The customer demands and product need to be taken care throughout the life cycle of the product.[69] Figure 14 shows different stages of the product lifecycle.

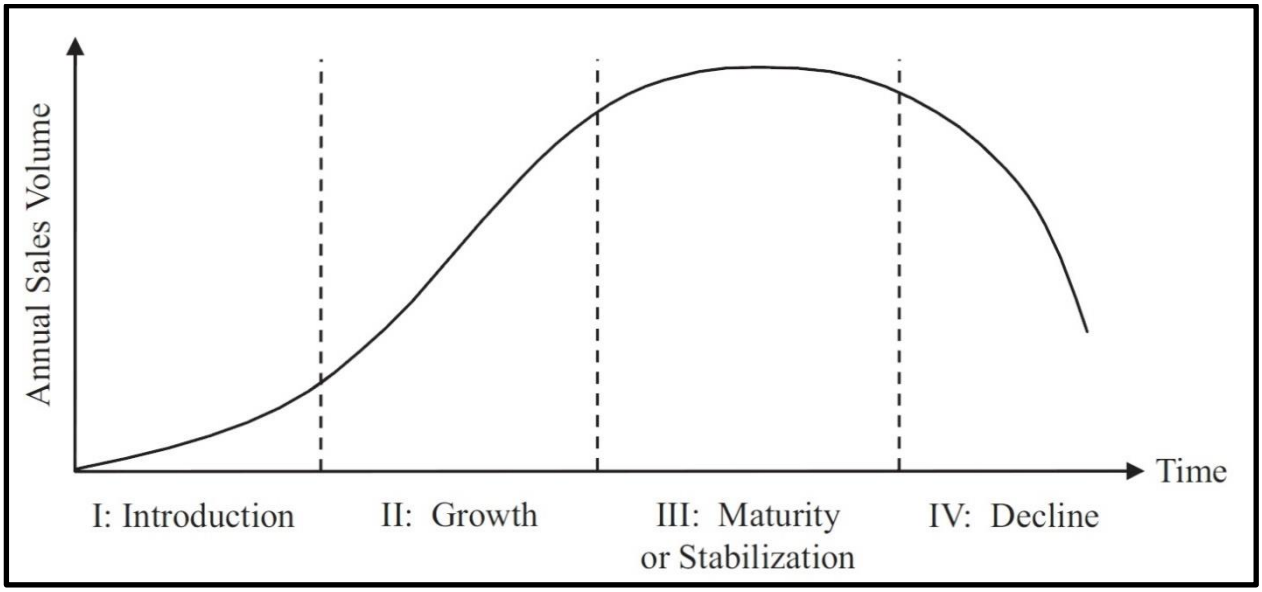

Figure 14: Product life cycle[70]

Product lifecycle is the graph of annual sales volume against time. It shows the different stages of product in life cycle after introduction to the market.

[68] Cf. Ehmke, Fulton and Lusk (2010), p.45
[69] Ibidem
[70] Cf. http://images.google.de/imgres?imgurl=https%3A%2F%2Fupload.wikimedia.org%2Fwikipedia%2Fcommons%2Fd%2Fd5%2FProduct_life-cycle_curve.jpg&imgrefurl=https%3A%2F%2Fen.wikipedia.org%2Fwiki%2FProduct_life-cycle_management_(marketing)&h=667&w=1448&tbnid=RIemEpI8iYn4IM%3A&docid=OaXwab3KOOhN7M&ei=N6wIWImeLMvTgAaSh72oAw&tbm=isch&iact=rc&uact=3&dur=342&page=0&start=0&ndsp=15&ved=0ahUKEwjJldWupenPAhXLKcAKHZJDDzUQMwgdKAEwAQ&bih=638&biw=1366 , date of access: 20.10.2016

Price

Price is the amount that customers pay to get the offered service or product.[71] Price of any product or service is dependent on many factors and is dynamic. While deciding price of the product or service all the expenses related in marketing and all other functions of the company need to be considered. Expenses related to promotion activity, sales and distribution are important factors in deciding the product price. If some or all the variables change then naturally price of the product also changes. [72]

Deciding on right price of the product is very crucial and it defines the success of the product in the market. Low price products are often associated with low quality and high price products are often doubted for its value for money. The high price of the product will not let the product to be successful in the market. Pricing of the product should be decided in such a way that it covers all occurred cost in manufacturing and also the profit margin.[73] Pricing strategy for every company and product varies depending on its customer demand, competitive environment and product. Some of the pricing strategies used by companies nowadays are mentioned below: [74]

- **Value-based:** Pricing is done based on the perception of the customer irrespective of the cost of company.

- **Cost plus:** Pricing is done with assessment of fixed costs, variable costs and profit margin to the company.

- **Competitive:** Price is defined based on the price of products offered by competitors in market.

- **Going-rate:** Companies don't have control over the pricing and they offer the product at the price what is going-rate in the market.

- **Discount:** Companies generally offer some extend of discount of the initially offered price.

- **Loss-leader:** In this strategy companies sell some products at price lower than production cost so that customers buy some other products along with offered cheap products.

[71] Cf. Borden, Marshall (1959), p.11
[72] Ibidem
[73] Cf. Ehmke, Fulton and Lusk (2010), p3
[74] Ibidem

- **Psychological:** To offer price that simply appears better. e,g, 2.99 instead of 3.00.

- **Skimming:** Reducing the price of product after market saturation. These products are generally offered at very high price initially.

Place

Place in the marketing mix generally refers to distribution networks, storage, transportation and inventory. Method of distribution highly depends on what kind of product an organization is making. In automotive field companies who make assemblies or subassemblies can either sell it directly to customers or sell it to OEMs (Original equipment manufacturers).[75]

Place refers to exactly where the product is available for customers to buy. Ease of access and location of availability influences the success of any business. The role of marketing is not only to make products available to the customers but also to think about proximity, specific demand at specific place and meeting those demands by studying the customers.[76] Most of the physical products need a store to sell but nowadays services like customer care or a website can also be placed in marketing channel.

Depending on what strategy company opts for distribution, there can be different ways of distribution. Some of the ways of distribution are discussed in brief below:[77]

- **Direct sales:** In this method manufacturer decides to sell product on their own. It can be through different means like door-to-door, on-site or e-commerce. It helps companies to be in close relation with customers and understand them better.

- **Reseller sales:** Unlike in direct sales, companies decide to sell products visa retailers, wholesalers or dealers. This enables companies to reach more customers. In this method of distribution its crucial to maintain the brand value of the company and it may be affected due to involvement of third part in distribution network.

Along with method of distribution, extent of market coverage also needs to be considered. Extent of coverage defines the proportion till which company wants to

[75] Cf. Needham, D. (1996), p.45
[76] Cf. Kerin, Hartley & Rudelius (2001), p.66
[77] Ibidem

reach the market. There several types of market coverage extents followed by companies nowadays.[78]

- **Intensive distribution** method covers as wide as possible extent of product placement. Generally companies offer product nationwide or even internationally in some cases

- **Selective distribution** restricts the distribution of product. Premium products are offered at certain selective retailers. It helps companies to be in close relation with customers.

- **Exclusive distribution** constraints the distribution of the product to a particular seller solely. It often helps companies to maintain the image of prestigious product.

Promotion

Promotion is the way of letting customers know about your products and influence their interest. It is one of the power attributes of marketing.[79] Marketing managers decide on how to send their budget on different activities. Activities in promotion include customer relation, publicity, exhibition etc. Promotion helps companies and its sales force to reach customers in better way and encourage them into buying the product.

One of the key elements of promotion is advertising. It helps companies to create a certain image of a product in the market. In today's competitive environment, advertising helps companies to maintain dynamism of the industry. Promotion is a very helpful tool to decide the positioning of the product in certain market. It often demands lots of expenditure and hence should be counted as cost of the product while deciding on the pricing of the product. [80]

Companies should convey a clear message through the advertising if they want to be successful. Advertisement should contain a clear message about how the product works, what are its benefits and how it satisfies their needs. It should be clearly stating the target customers. Promotion can be done by different means such as mentioned below:[81]

[78] Cf. Kerin, Hartley & Rudelius (2001), p.67
[79] Cf. Culliton J. W. (1948)
[80] Cf. Singh M. (2012), p.42
[81] Cf. Ehmke, Fulton and Lusk (2010), p5

- **Radio** is a cheaper way to reach target customer by giving your message to customers via audio advertisements.

- **Print** is a traditional method of promotion by reaching target customers with the help of newspapers, magazines, flyers etc.

- **Television** helps to reach wide range of audience with one effort targeting different target groups of customers. It is generally an expensive method.

- **Electronic** means of advertising include website and reaching target customers through internet.

- **Generic** promotion is that method when the advertisement is about the company itself in general and not any specific product.

- **Word of mouth** publicity is generally done by existing satisfied customers sharing their experiences to friends and acquaintances.

2.4.2 Boston matrix

In strategy planning process an important task of management is to provide market intelligence. This knowledge enables companies to assess the internal competences and help to develop the right strategy for the company and implement it. Companies can react to changing demands and dynamic market with ease if they know their internal capabilities well. Boston Matrix is a marketing tool used by companies to analyse offered product portfolio. [82]

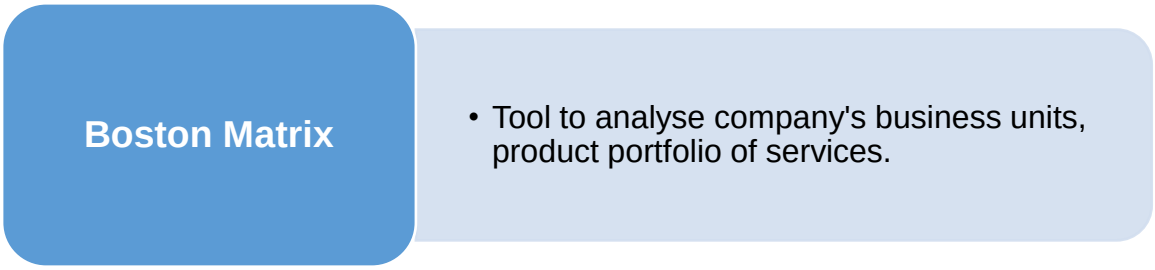

Figure 15: Functions of Boston Matrix[83]

Boston matrix is used as a tool to analyse company's product portfolio with respect to its market position. It also helps to understand how to allocate internal resources to

[82] Cf. http://www.free-management-ebooks.com/faqst/boston-01.htm , date of access: 21.10.2016
[83] Ibidem

products depending on their market position. This tool is useful for different function of the company such as marketing, product management, portfolio analysis and strategic management. This tool helps to understand the amount of efforts required for certain products and the revenue those products are generating. It enables companies to take decision as which products to be maintained, which products to be pushed into market and which products need to be stopped. Boston Matrix is also known by different names which are listed below:[84]

- B-Box
- BCG Analysis
- Portfolio Diagram
- Boston Box
- BCG-Matrix
- Boston Consulting Group Analysis

The matrix shown in Figure 16 is a graph plotted with market share on X axis and market growth rate being on Y axis Boston Consulting Group Analysis. The graph is divided into four equal quadrants which enable companies to categorise their products or services. Each product is then carefully placed on graph depending on its market share and market growth rate for that segment or specific product. [85]

[84] Cf. http://www.free-management-ebooks.com/faqst/boston-01.htm , date of access: 21.10.2016
[85] Ibidem

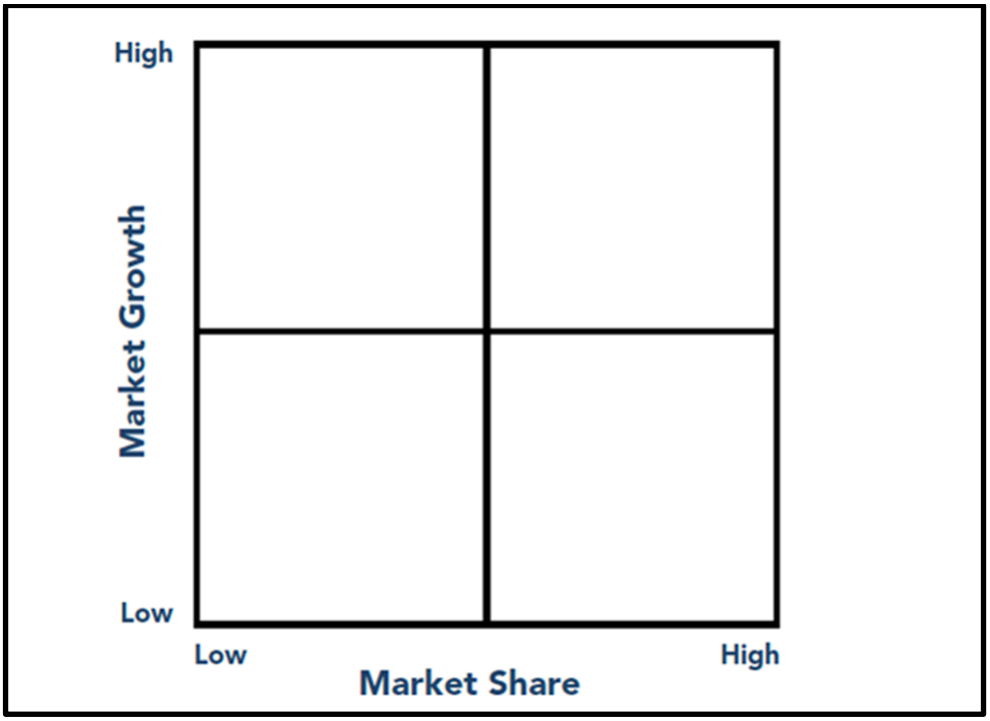

Figure 16: Boston Matrix[86]

The matrix helps to scrutinize organization's potential. It gives a method to organization's resource allocation and budget distribution with motive of increasing profit margin in the future. It also helps to manage portfolio to achieve maximum growth and offering the right product in right time. In this matrix market share and market growth rate attributes are taken into consideration. Depending on these attributes organizational priorities are defined. In order to understand this prioritization, it is important to understand two attributes; market share and market growth rate. [87]

[86] Cf. http://www.free-management-ebooks.com/faqst/boston-01.htm , date of access: 21.10.2016
[87] Ibidem

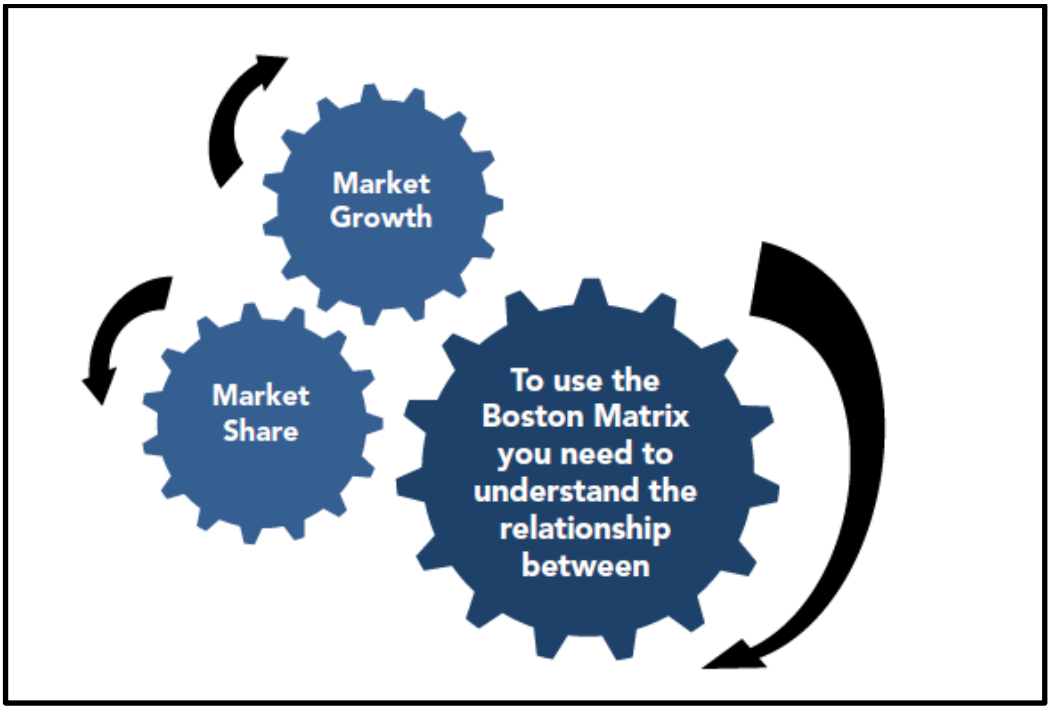

Figure 17: Interrelation of market share and market growth rate[88]

Market share

It is the proportion of either sales volume or revenue that organization holds of the whole market.[89] The organizations with higher market share control and influence the market and pricing. In this matrix one assumption is made that profit increases with increase in market share. This assumption is not always true and hence a limitation of this method. It is also assumed in Boston Matrix that organizations with high market share of certain product are highly profited from that product and have achieved economy of scale.

A typical way to express market share is to indicate market share relative to company's strongest competitor. It indicates how dominant position company holds for a certain position in the market. High market share not necessarily mean high profit because some loss-leader product can have high market share but they don't give profit. In this case profit is generated by other associated product with loss-leader.[90]

Market growth

It is the percentage growth achieved as compared to trailing year. It is used to understand how attractive product is to existing customers and potential new

[88] Cf. http://www.free-management-ebooks.com/faqst/boston-01.htm , date of access: 21.10.2016
[89] Cf. Cadle, Paul & Turner (2010), p.22
[90] Ibidem

customers. Generally high growth markets easily increase profits even if market share remains the same. On the other hand in low growth markets companies need to put in special efforts just to maintain constant market share. In this area strong activities from the competitors are hurdles for the growth and to maintain current position.[91]

Classification of products on Boston Matrix

As described earlier, two axes of Boston Matrix are market share and market growth rate. These axes are further divided into high and low. It from four equal quadrants on Boston matrix and these quadrants are the category of products which helps companies to position their product on the matrix and analyse them. These categories of the products are as mentioned below:[92]

- **Stars:** Products with high market share and high growth rate. Generally are the new products in the company.

- **Question marks:** Products with low market share but high potential growth. Can become dominant product in the market.

- **Cash cows:** Market leaders but low potential of growth of market. Generate high revenue.

- **Dogs:** Product with low market share and low market growth. Generally products at the end of Lifecycle.

[91] Cf. Cadle, Paul & Turner (2010), p.24
[92] Ibidem

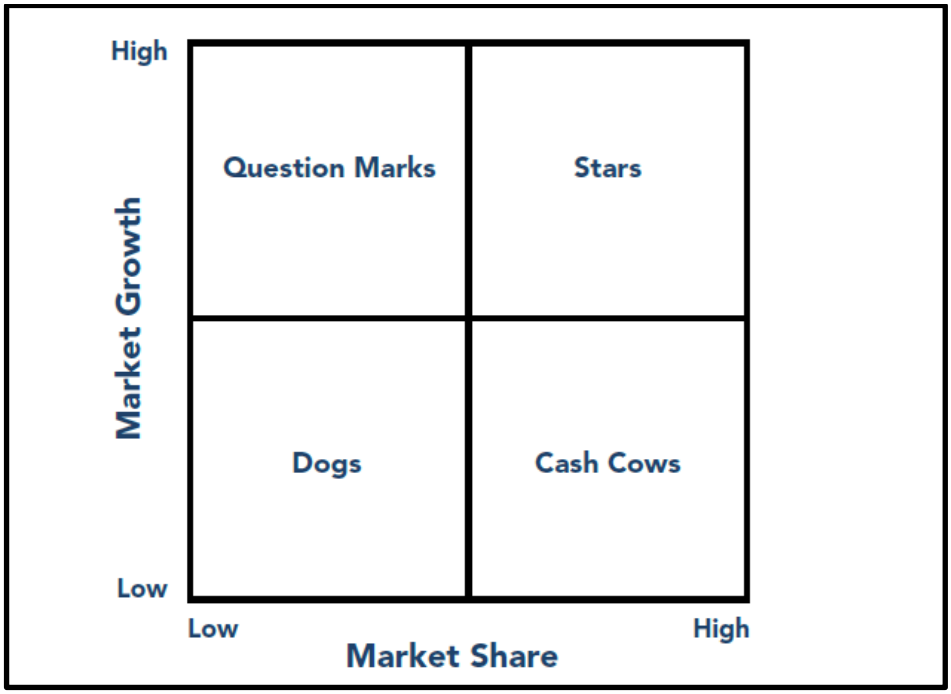

Figure 18: Classification of products on Boston Matrix[93]

Stars

Products with considerable market share of a high growth market. These generally generate more revenue than the amount of investment required. Hence companies are often interested in retaining or growing these products' market share.[94]

Figure 19: Characteristics of Stars[95]

High growth markets generally observe rapidly increasing new customers and high profit to the organizations. It attracts new competitors to enter the market. Companies operating such market should keep in mind that high profit is often associated with product development and marketing costs. At the maturity phase of fast growing market stars generally become Cash Cows and those product that have not been able to capture market share switch to Dogs category. [96]

[93] http://www.free-management-ebooks.com/faqst/boston-01.htm , date of access: 21.10.2016
[94] Cf Kotler, Keller, Brandy, Goodman & Hansen (2009), p.39
[95] Cf. Cadle, Paul & Turner (2010), p.23
[96] Ibidem

Question Marks

This category of the product has low market share in fast growing market. This category is also called as “Problem Child” or “Wildcat”. This category may generate revenue to some extent but not enough to maintain rapid growth. Question Marks can easily become consumer of cash and not able to maintain its market share.

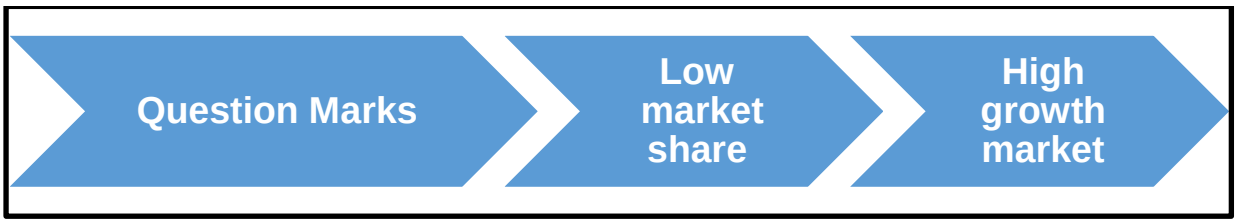

Figure 20: Characteristics of Question Marks[97]

It is very crucial for companies to spot these Question Marks as they have potential to gain market share and become Cash Cows. It needs to be carefully analysed if Question Marks are worth further investment to make them cash cows or not because in fast growing market existing product can be replaced by new product or new technology. Question Marks demand huge investments in order to become Stars or cash Cows. And if they fail to achieve sufficient market share they become Dogs as the market declines. Therefore amount of investment to be done on Question Marks needs to be carefully analysed. For this kind of analysis more sophisticated method than Boston Matrix is needed. [98]

Cash Cows

Cash Cows are the products which are successful in mature market and generate most of the company’s revenue. They have high market share in a mature market of slow growth. These are generally the market leaders and revenue generated from these products can be invested in growing market.[99]

Figure 21: Characteristics of Cash Cows[100]

[97] Cf. Cadle, Paul & Turner (2010), p.23
[98] Ibidem
[99] Cf. Cadle, Paul & Turner (2010), p.24
[100] Ibidem

Revenue generated from these products is often higher than the amount of investment needed to produce them. Hence the surplus amount can be invested in fast growing market to gain sustainable market share. It is assumed in Boston Matrix that the initial investment done for Cash Cows is already recovered several times and there is very little demand for marketing expenses. This assumption is often not true as companies need to invest continuously to maintain brand value and customer loyalty. As these products are in the mature phase which has slow growth rate, there is least threat about new competitors to enter the market. [101]

Dogs

Dogs are the products in the shrinking market with low market share. The revenue generated by Dogs is just enough to break even and maintain low market share. Dogs are often seen as drain to organization's resources as these resources could be better utilised to focus on products with high market share or fast growing markets.

Figure 22: Characteristics of Dogs

Organizations tend to reduce number of Dogs in offered product portfolio as they consume resource. Often products in this category are at the end of their lifecycle and companies need to take the right decision whether to further invest on them or not. Any additional investments done on redevelopment of product are likely to not recover due to slow growing market. Hence companies are reluctant towards any further investments on Dogs.

Dogs can be beneficial to organization in particular cases. Some mature markets are so huge that even a small market share can generate huge revenue. And Dogs are sometimes maintained to offer a wide range of product portfolio and maintain brand value. [102]

A balance product portfolio

A balanced product portfolio should tend to avoiding Dogs and have the right combination of Cash Cows, Stars and Question Marks. It helps organizations to take

[101] Cf. Cadle, Paul & Turner (2010), p.24
[102] Ibidem

advantage of current situation and future opportunities to grow. A Cash Cow can generate revenue which can be used to invest on Question Marks to make them future Stars. And todays Stars ensure the future success of the company. Therefore it is crucial to find a balanced product portfolio for organizational success. [103]

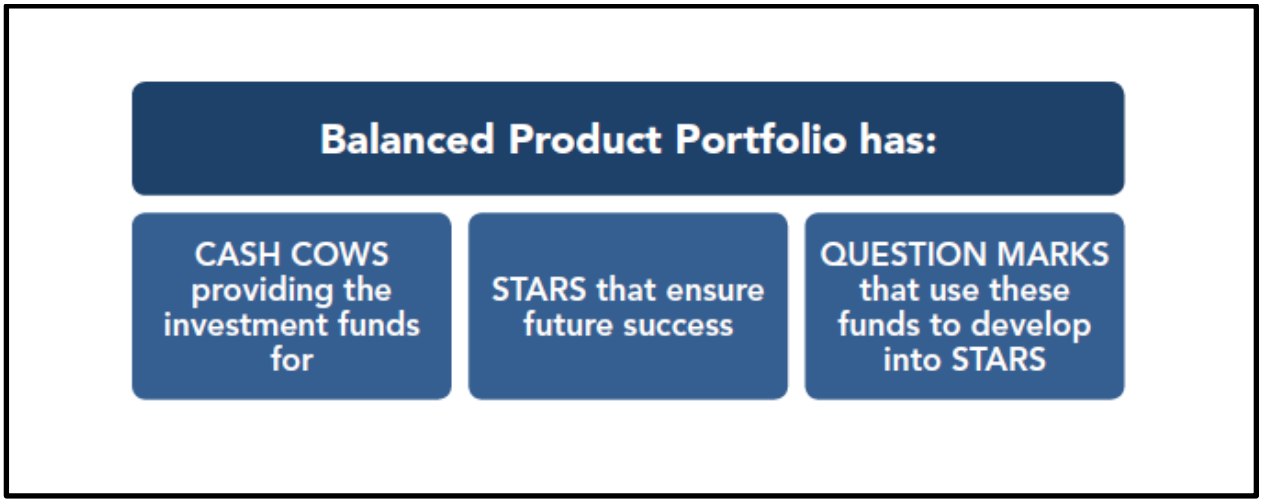

Figure 23: A balance product portfolio[104]

2.5 Total cost of ownership

Total cost of ownership (TCO) is a financial projection aimed to help the owners to identify the direct and indirect cost of the product or a system over its lifetime. It is the sum of purchase price and all the other costs that occur minus the income earned by that system. Initial purchase price is not all what owners spend on a product. It is generally only 30-50 percent of the total cost of ownership. [105]

Capital goods like cars, trucks, manufacturing machineries, furniture, computers and fixtures are often benefited by TCO analysis. [106] TCO also can be used in below mentioned cases in a business: [107]

- In a business case to assess the costs, benefits and risks associated with the investment.

- When assessing different business models, maintenance options or solutions on a comparable cost basis.

[103] Ibidem
[104] Ibidem
[105] Cf. Ellram, L.M.(1996)
[106] Cf. Burt, Dobler and Starling (2003), p.160
[107] Cf. Ministry of Business, Innovation & Employment , New Zealand Government (2013)

- to understand the different cost drivers in the life of a procurement

- by a supplier when bidding for a contract to demonstrate the total benefits and value being offered – especially where the initial purchase price is higher than competitors, but the total cost of ownership is lower

- in selecting the best supplier by assessing the comparative whole-of-life costs of competing bids

- in managing the contract to track actual expenses and income against budget

- as part of a benefits realisation exercise

Two different types of costs considered under TCO are:[108]

- **Direct costs:** Direct costs are attributed to the product directly. Purchase price of any product is a direct cost.

- **Indirect costs:** Indirect costs are not attributed to the product directly. Additional cost that owners incur while the use of product or a service are indirect costs. Indirect costs are further divided into two types:[109]

    - Fixed costs: Rent, insurance, salaries etc.
    - Variable costs: Fuel, energy, downtime etc.

2.5.1 Components of total costs

These components give another way of categorising the total costs. These components of the total costs are as mentioned below:

Acquisition costs

These are the initial costs of the products, services or material. These are short term costs but create sudden outflow of the cash. These costs are generally one-time costs associated with the product. Acquisition costs consist of the direct price paid for buying a product or service. Purchase price generally contribute as major contributor of the

[108] Cf. Ministry of Business, Innovation & Employment , New Zealand Government (2013), p.3
[109] Ibidem

total costs. Sometimes purchase price also includes the costs owners incur to get products, installation, training and testing.[110]

Operating costs

These costs are generally underestimated at the start by owners. These are the expenses needed for the operation of a product, machinery or services. It also includes the resources used for the operation. [111]

2.5.2 Typical total cost of ownership of a truck

Initial decision of whether to buy a truck or not is very much dependent on price of the truck. But purchase price is not the only costs associated with owning a truck. To have a successful and profitable business by owning a truck is very much dependant on how owners analyse the total cost of ownership over the long run. TCO is method to calculate the cost of operating a truck. It considers not only the purchase price of the truck but also all the costs associated with operation of the truck. This method gives a closer estimate of how much the running costs of the truck are. This analysis considers all costs from purchase of the truck till disposal. [112]

The efficiency of a transportation business very much depends on how owners optimise their operations. Optimising the running costs can show great results in profitability enhancement. Nowadays many truck manufacturers are making efforts in educating their customer about TCO optimisation. In calculation of TCO, different costs are considered that are parts of two main categories of costs explained in the previous section viz. acquisition costs and operating costs. These typical costs considered for TCO calculations are:[113]

- **Acquisition costs:** These are the costs associated with price of the product. These costs contribute to major part of the TCO. These are one time investments made for a product. Nowadays many truck manufacturers are offering a leasing of truck instead of purchase. Hence Acquisition costs can be for below mentioned two components:[114]

  - Buying
  - Leasing

[110] Cf. Ministry of Business, Innovation & Employment , New Zealand Government (2013), p.3
[111] Cf Gupta, Sharma and Ahuja (2009), p.316
[112] http://www.truck.man.eu/de/en/long-haul-transport/total-cost-of-ownership-_tco_-optimizer/TCO-Optimizer.html, date of access: 01.11.2016
[113] Ibidem
[114] Cf. Paquette, L. (2004), p.29

- **Fuel:** These costs contribute to one of the major elements of the TCO. The expenses done on fuel consumed for the operation of the truck are considered here. As fuel prices may vary depending on market, fuel costs can also vary in long term operation of the truck.

- **Human resources:** This element mainly consists of the salaries of the truck drivers. It also included additional overhead required for the operation of the truck.

- **Maintenance and repair:** For continuous and efficient operation of truck, regular maintenance and repair needs to be done. These costs are the element of variable costs the owners incur.

- **Tires:** Tires are one of the expenses that occur for consumable items. After certain time period in the operation of the truck, tires need to be changed. Tire repair and replacement costs contribute a considerable amount to the total costs and hence need to be considered in the analysis.

- **Taxes and insurance:** Different types of taxes need to be paid for owning a truck and these expenses are generally overlooked by the fleet owners. Hence the total cost planning is often misjudged. Regular insurance costs also occur in operation of a truck. These insurance costs come under indirect fixed costs category.

- **Toll:** During the operation in the total lifetime of a truck, truck should ideally spend most of the time on road. For operating truck on the road, owners need to pay different toll charges. These costs also need to be considered in the TCO analysis.

- **Management:** Truck owners generally own the truck in different fleet sizes. To manage these fleet owners need to hire some person who will take care of all the administrative issues of fleets. The expenses that owners incur for personnel and the office for administration come under this category.

Nowadays truck manufacturers offer TCO analysis solutions to their customers to educate their customers on how they can improve the efficiency of their fleets by optimizing the TCO. This practice has become an integral part of the marketing activities in the companies. It helps fleet owners to analyse and improve the TCO to get

the maximum benefits of their products. A typical solution offered by truck manufacturers consider the below elements of TCO.[115]

Different parameters considered in TCO calculation tool offered by MAN Germany are depicted in Figure 24.

[115] Cf. https://my.man-mn.com/tcowebapp/index.html#/truck , date of access: 14.11.2016

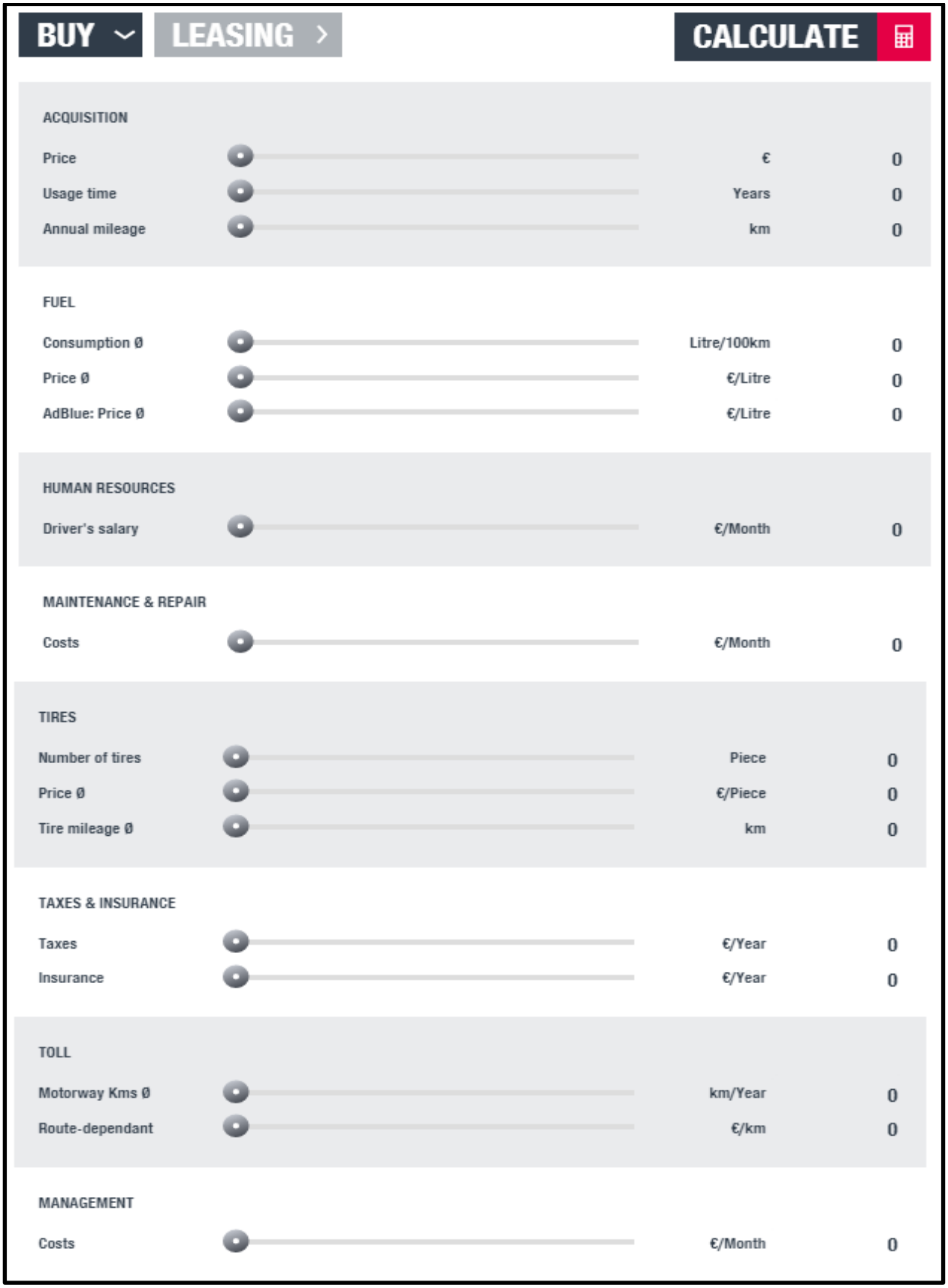

Figure 24: MAN TCO calculator[116]

[116] https://my.man-mn.com/tcowebapp/index.html#/truck , date of access: 14.11.2016

This TCO calculator gives an overview of the total cost of ownership. It helps existing or potential fleet owners to analyse what expenses are needed to own a truck fleet. A typical TCO distribution graph indicates all the considered elements of costs that contribute to total cost. Figure 25 depicts a typical TCO of a truck.

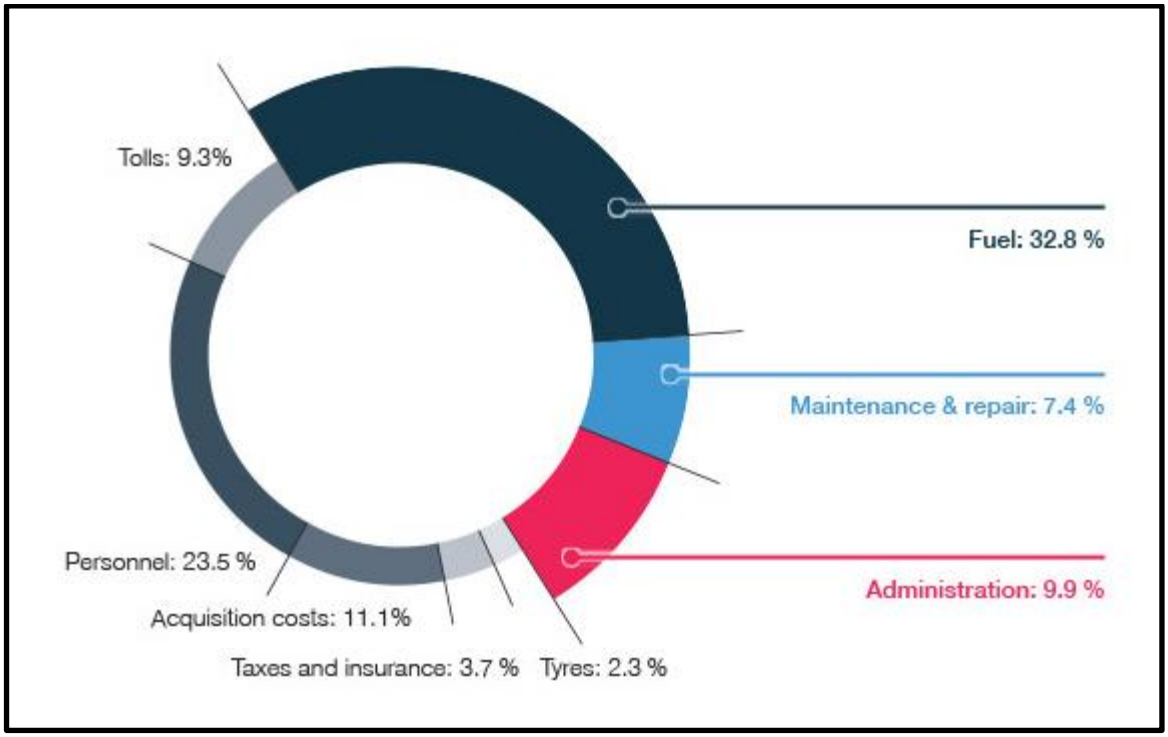

Figure 25: Typical TCO of a truck[117]

[117] http://man.etpl.ch/truck/global/en/services-and-parts/maintenance-and-parts/service-contracts/tco-services/TCO-services.html , date of access: 14.11.2016

3 Analysis of MAN India's market position

In order to find some potential solutions to improve the current situation of MAN India, it is very important to understand where MAN India stands in competitive Indian market. The problems faced by company and its consequences and the factors influencing MAN's downfall in Indian market needs to be analysed to come up with realistic and feasible solutions to come over the current situation of the company. Hence this chapter presents analysis of all above mentioned aspects.

3.1 Current position and problems

Though MAN was able to leave its footprints in the global market, they were unable to do so in India. Initially products were launched in collaboration with Force Motors, but soon company saw a threat towards the authenticity of the product in the eyes of customers. The status of the products as premium products would be lost. After the separation from Force, MAN has seen constant drop in annual sales although they introduced a tractor head in the top tractor segment followed by the introduction of tipper segment.

By then MAN was still working with no concrete mind set and had not analysed their stand in the Indian market. In the same period entry of BharatBenz into Indian market made it more troublesome. BharatBenz entered Indian market after MAN but managed to show better sales figures than MAN. Company couldn't read between the line of what BharatBenz did right and what MAN did wrong. MAN aimed on Heavy Commercial Vehicles (HCV) whereas BharatBenz had wide spread product portfolio from light to heavy duty vehicles. Key difference between approaches to Indian market by two companies was that MAN targeted niche market while BharatBenz focused on mass market. Though both brands were financially strong and of equal reputation, BharatBenz left strong footprints in Indian soil in shorter period that MAN had managed in past years.

Some of the most severe problems like reduction in sales volume, weak market share and portfolio gaps compared to competitors are depicted in the graphs below:

3.1.1 Reduction in sales volume

The graph below shows the annual sales figures of MTI from the start of its function in India. MTI showed a steady growth in initial period of 6 years. When the year 2012 dawned where MAN decided to take over the joint venture completely, MTI started

seeing a constant drop in sales volume. Drop in sales volume over the past years is threatening to the existence of the company.

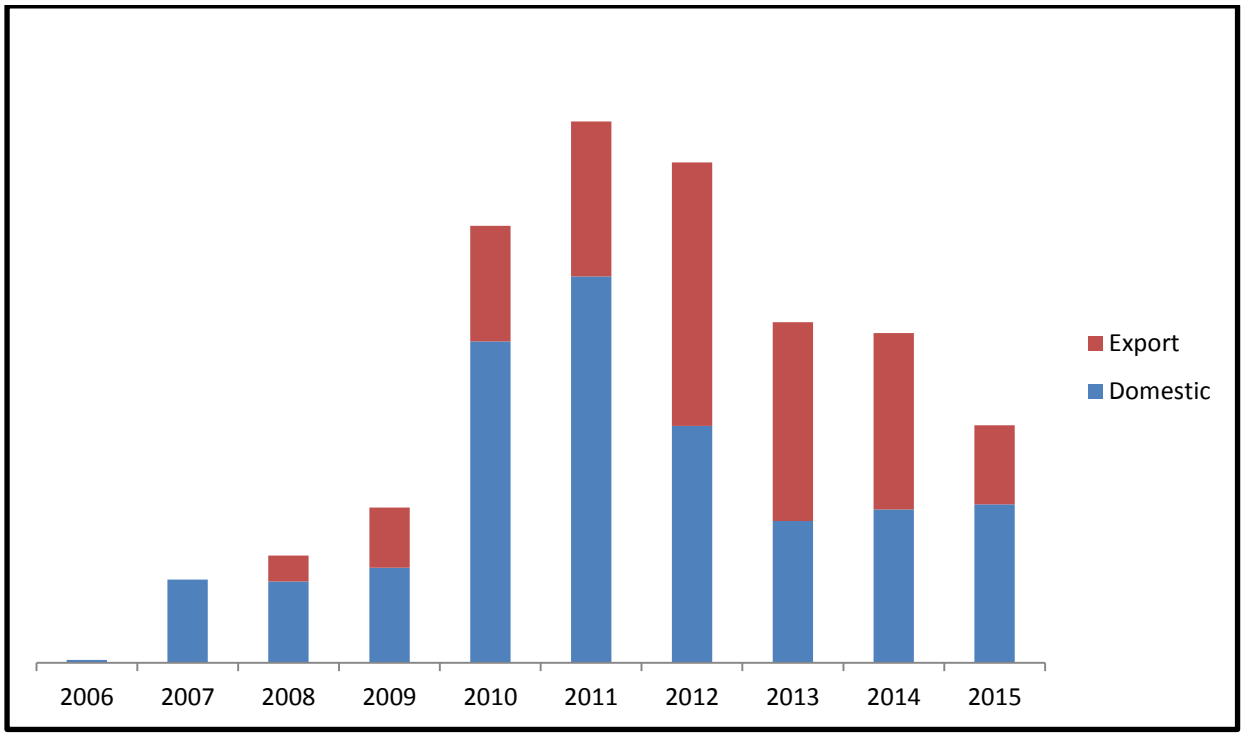

Figure 26: Annual sales figure of MTI (number of units)[118]

3.1.2 Weak market share

Due to very low sales volume and strong competition from local competitors like TATA Motors and Ashok Leyland MAN struggled to have a very weak market share. In some segments of vehicles MAN has negligible or no market share. Depending on application MAN India's portfolio is categorized into three segments. Comparative analysis of MAN India's market share into these segments was done from available data. Figure 27 show the MAN India's market share in Rigid Segment.

[118] Own illustration, based on MAN internal data.

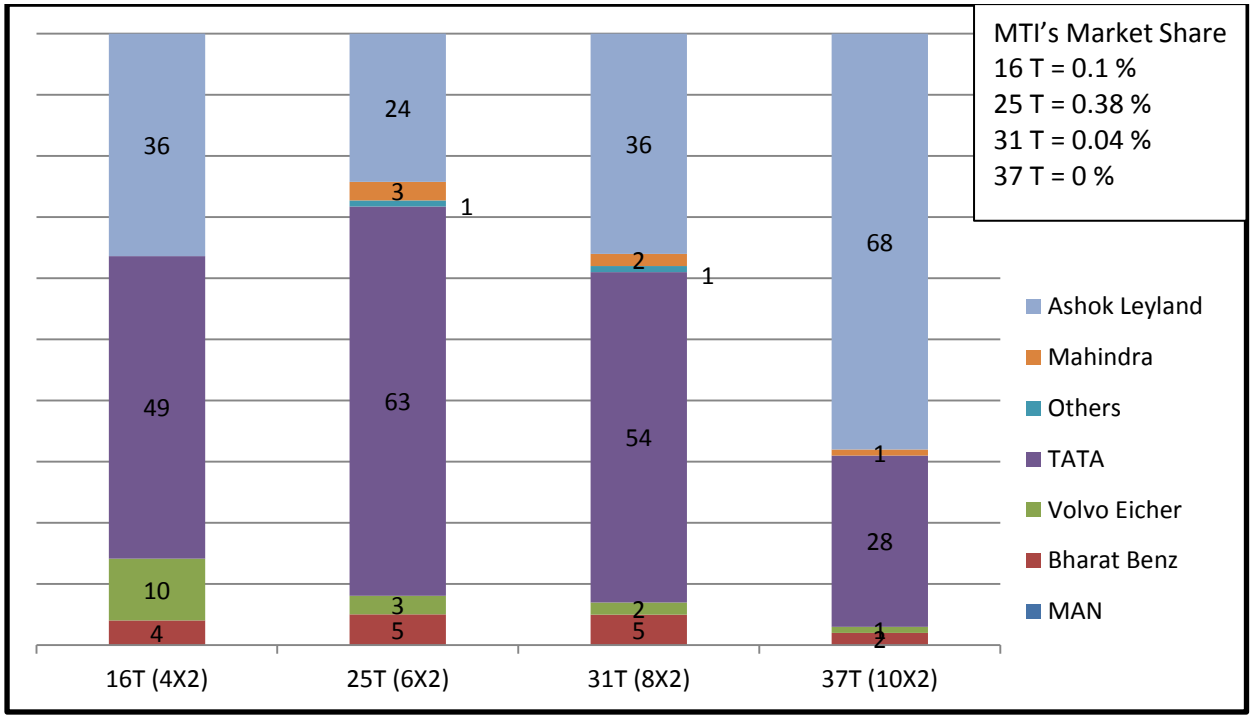

Figure 27: Rigid Segment market share[119]

In Rigid Segment MAN India's market share in all four tonnage capacities is negligible. In this segment TATA Motors and Ashok Leyland are the market leaders with majority of share. This market has huge potential due to rural and infrastructure undertakings by Government of India. Still MAN has not managed to capture good market share in this segment.

Second segment is Tipper Segment in which all the market players generally offer trucks with the capacity of 16 tonne and 25 tonne. Out of these two product ranges MAN has a small market share of 2.7 percent in 25 tonne segment. Market share position of other players and MAN can be seen in Figure 28. In both ranges of product TATA holds more than half of market share. 16 tonne segment is dominated by only three market payers: TATA, Ashok Leyland and Volvo Eicher. MAN and BharatBenz have almost negligible market share in 16 tonne segment. As small capacity trucks are in high demand in India Mahindra has taken some aggressive steps to increase market share in this segment. Whereas 25 tonne Tipper Segment is half covered by TATA and rest 50 percent is well distributed amongst all other market players.

[119] Own illustration, based on MAN internal data.

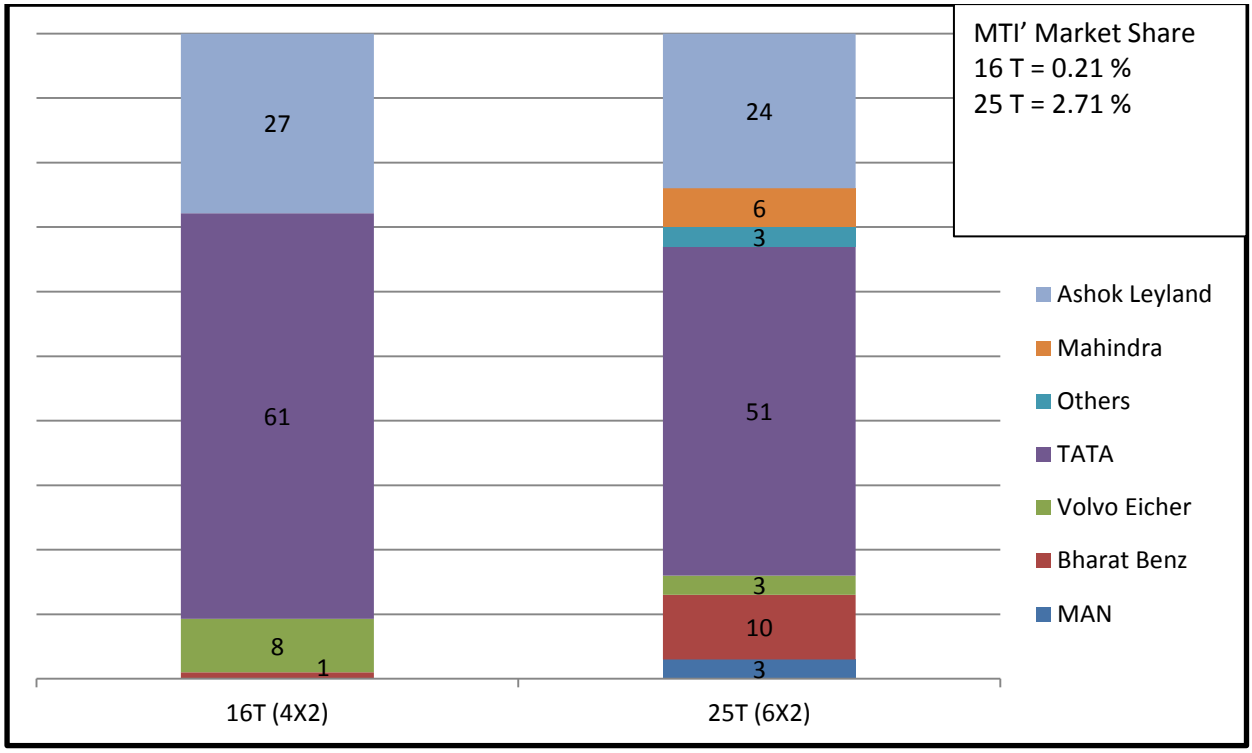

Figure 28: Tipper Segment market share[120]

Third segment is Tractor Segment where MAN has managed to gain considerable amount of market share in 49 tonne capacity vehicle. Even in this segment TATA is the market leader followed by Ashok Leyland. In 40 tonne vehicles TATA has monopoly with market share of almost 75 percent. Due to these well-established price competitive market players it has become very hard for MAN to grow in India market. Mahindra on the other hand is steadily growing its market share in this segment. International manufactures like BharatBenz and Volvo also have very little share in this segment.

Tractor Segment of 40 tonne has very high growth but MAN has very little market share in it. Surprisingly BharatBenz has decent market share of 5 percent in 40 tonne vehicle segment in only few years of operation in India. On the other hand the intermediate capacity vehicle of 35 tonne is not offered by MAN.

[120] Own illustration, based on MAN internal data.

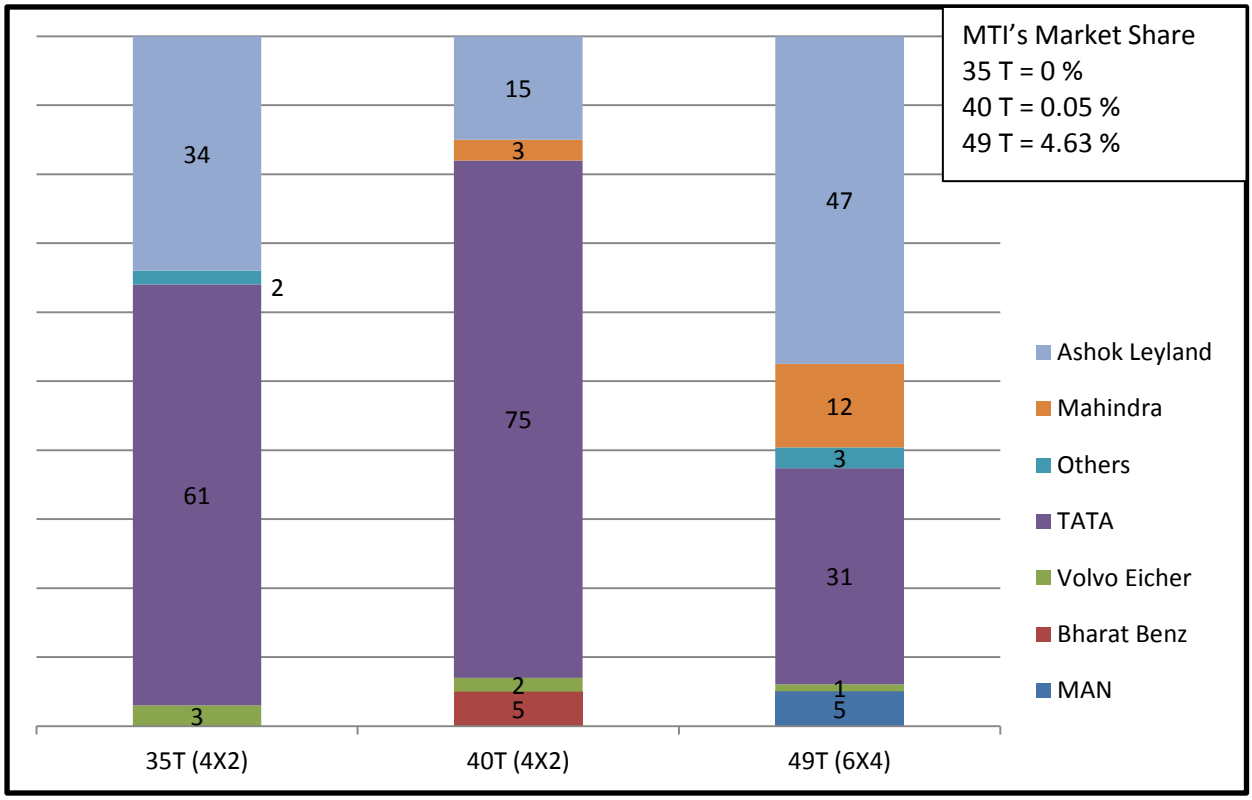

Figure 29: Tractor Segment market share[121]

3.1.3 Portfolio gaps compared to competitors

Due to continuous downfall of MAN India it has become very difficult for further investments in new upcoming projects. Competitors are ahead in time and are ready with latest technology and new legislative regulations efective in India in next years. Euro IV regulations are mandatory in India from 2017 and MAN India is not prepared for a product with these requirements. Hence it has created a portfolio gap compared to competitors. It has become a threat for MAN India's sales volume in coming years.

Euro IV emission standard are compulsory for entire India from 01.04.2017 onwards. Currently MAN has engines with Euro IV emission norm only in high capacity above 300 HP. Hence there will be a considerable gap in offered product portfolio after Euro IV compulsion as no engine with Euro IV is available in low power segment. Table 3 shows the portfolio gaps MAN might face in coming year as compared to competitors.

[121] Own illustration, based on MAN internal data.

Quarter 2 /2016	Quarter 3 /2016	Quarter 4 /2016	Quarter 1 /2017	Quarter 2 /2017	Quarter 3 /2017	Quarter 4 /2017
Euro III				**Euro IV**		
280 HP engine				300 HP engine		
230 HP engine				**Portfolio gap**		
220 HP engine						

Table 3: Emission norms and potential portfolio gaps[122]

3.2 Boston Matrix analysis

With available data of sales volume and segment-wise growth rate of Indian market Boston Matrix analysis of MAN India was done. As described in the theoretical framework, relative market share of the products being X axis and growth rate being on Y axis, graph was plotted. Positioning of products on Boston Matrix was done. Every vehicle segment depending on tonnage capacity was treated as one entry on Boston Matrix and scatter points were positioned on the matrix depending on market share and growth rate. As it can be clearly seen from the Figure 30, most of the product ranges are either Question Marks or Dogs. This clearly justifies the non-profitable business of MAN India. Many products are in the category of Question Marks which indicate that those products have high growth rate but MAN India has very low market share. Corrective actions and right strategic decisions are needed to bring these Question Marks into Stars or Cash Cow category. The categories into which products were sorted are listed below.

- 16 tonnes (16t)
- 16 tonnes tipper (16t tipper)
- 25 tonnes (25t)
- 25 tonnes tipper (25t tipper)
- 31 tonnes (31t)

[122] Cf. MAN Truck & Bus AG. (2016), p.59, Own illustration

- 40 tonnes Haulage (40t)
- 49 tonnes (49t)

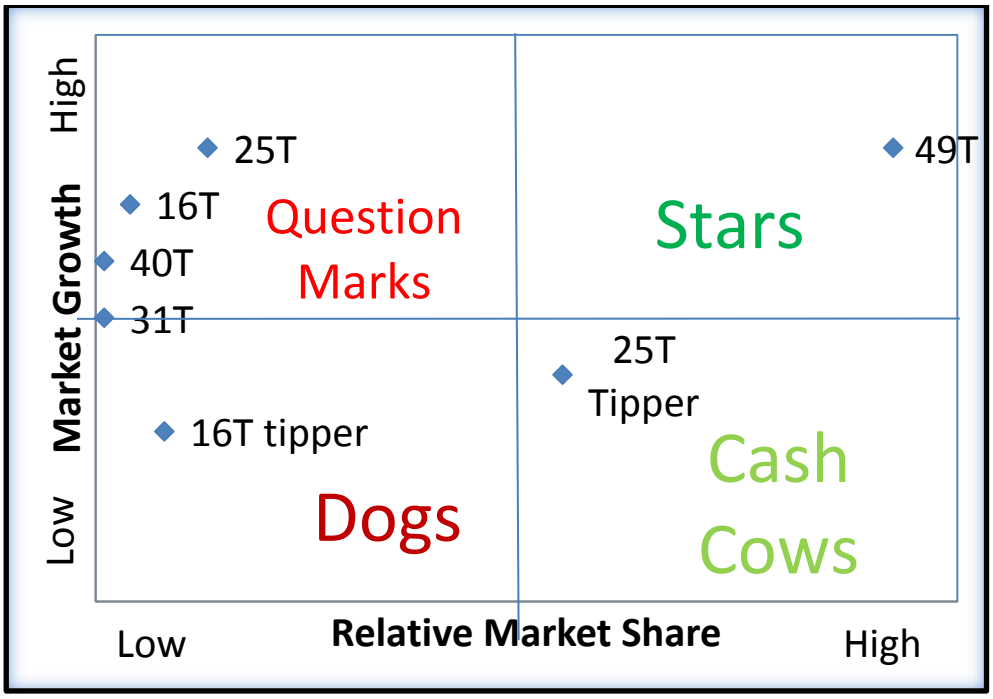

Figure 30: Boston Matrix analysis of MAN India's product portfolio[123]

3.3 Factors influencing downfall of MAN India

Out of the multiple reasons for the downfall of MAN's products in the Indian market, few are listed below which include Product & Pricing, Positioning and Promotion methods.

3.3.1 Product and price

Company's initial vision towards the sales plan was 65% tractor heads and 35% tippers to be sold in the Indian market. These products were priced at ₹ 2.4 million which is about 35000 euros. Though Indian market is really price sensitive, Indian customers digested the high prices of offered trucks owing to MAN's global brand reputation. Moreover MAN promised its customers reduction in price after products are localized with certain span of time. Secondly there remained the problem that as MAN had no cooperation with Force motors, product support and after sales support was removed. Additionally the service network was very weak and this triggered the huge decline of haulage market resulting in customer rejection.

[123] Own illustration, based on MAN internal data.

On these grounds, MAN's target market focus diverted to tippers with 280Hp engine 25 tonne load capacity addressing mining sector. But there was strong competition in this segment from Actros & Volvo which provided same vehicle configuration at fewer prices. As the Indian market was growing, new market players like BharatBenz and Tata entered the market with more efficient product range and prices as well. It moulded customers' minds that their requirements and expectations were not matched by MAN India, portraying MAN India as an unsatisfying service, and customers started to withdraw their interest in the company.

3.3.2 Position

In view of position, MAN's failure can be blamed on agreements depending on undertaking the mining projects, irrigation work, metal transportation, road construction, soil transportation for tractor segment. At first customers digested the high price of MAN products but in tipper segment, they needed higher powered engines than MAN had to offer by then.

To meet these tipper segment requirements MAN planned the 16 tonne tipper with 220Hp engine and 6 speed gearbox. But these tippers were equipped with 6 speed overdriven gearbox, which was not the best fit for the tipper application. Overdriven gearboxes are meant for high speed and long run application whereas tipper demands for high traction hence direct driven gearbox would have been best fit. Due to hasty selection of gearbox for this tipper application, there existed a chronic problem in the market of often gearbox failures. This surely further hammered the image of MAN in India.

3.3.3 Promotion

In the era of JV, MAN Force conducted many awareness campaigns and road shows throughout India. Distinct prominence was given to marketing and to create huge brand awareness of the company. This helped JV to succeed in selling 8,500 vehicles in India. However after separation of JV, no prominent efforts were observed in creating brand image or awareness in the minds of its customers. The confidence of dealers that MAN would be able to stand tall was shattered, resulting in many dealers quitting from MAN.

3.3.4 Survival of the fittest

After the entry of BharatBenz and recovery of HCV market in year of 2012, Indian truck makers have geared up for protecting their market share and have taken measures

towards it. All manufacturers are imposing aggressive strategy by investing huge sums in new product development and planning to penetrate market with wide range of new attractive products. Even before the product range by BharatBenz was launched, Tata, India's leading truck manufacturer came up with Prima LX range of HCV directly targeting BharatBenz's products and enjoyed the privilege of being first to the market.

Indian HCV market saw acceleration from almost all HCV manufacturers. According to "*The Economic Times",* Tata had planned to invest ₹ 1500-2000 Cr, Volvo Eicher Commercial vehicles ₹ 800-1000 Cr, Asia Motor Works ₹ 300-500 Cr, whereas Mahindra Truck & Bus ₹ 100-250 Cr and all investment will be address to new product development and research & development.

Aggressive strategies in recent past by Indian HCV makers		
	New product launches	Investment (mn Euro)
Tata	50	215 - 285
Ashok Leyland	25	115
Volvo Eicher CV	10-12	115-142
AMW	10-12	42-70
Mahindra Truck & Bus	6-7	14-35
BharatBenz	17	300

Table 4: Aggressive strategies in recent past by Indian HCV makers[124]

Additionally companies are emphasising on ground level activities. Ashok Leyland aims to have service support within range of 75 km focusing on all major highways in India. Also other activities like driver training and working in close collaboration with Dhabas (Highway side restaurant where generally truck drivers stop for food and sometimes overnight stay in long journey) were carried out.

Companies are also focusing on brand awareness and advertising. Players like Tata, AMW, Ashok Leyland, and Mahindra entered television advertising. Mahendra Singh Dhoni, Indian cricket team captain and youth icon, endorses Ashok Leyland. Tata Prima is the main sponsor of wrestling television show "Ring ka King".

[124]Cf.http://articles.economictimes.indiatimes.com/2012-06-1/news/32352375_1_truck-makers-generation-trucks-truckmakers, Date of access: 21.04.2016

Where others are giving it a big push, MAN is still offering almost the same product range. And currently fears of having product portfolio gap compared to competitors after the compulsion of Euro-IV regulation in India. Though few efforts were taken by MAN as well, MAN India had very little to impress the market in this race of competitive business.

3.3.5 Mismatched product architecture

Products at MTI are the downgraded derivatives of obsolete product range from MTB. The CLA product range is built with heavy chassis and the smaller D08 (Variant name of MAN engine) engine with cabin of TGS product series of MAN Germany. This combination makes it completely different product architecture with no alignment to MAN product portfolio offered by MTB. Furthermore this new product range has undergone many changes as per the Indian market requirements & development by MTI, which has made it even more difficult to reuse and transfer the toolkits between MTI & MTB. Therefore this downgraded derivative, CLA product range, has become unique toolkit combination which is not comparable to toolkits and modules followed at MTB. Due to all these scenarios it has become very difficult for MTB to monitor and govern the project and processes at MTI.

3.3.6 Communication and working hours

Though MTI is 100% subsidiary of MTB, it is still working as an individual island. Like standard practice in the industry, MTI is not very well aligned with MAN's headquarters at Munich. Differences in documentation methods, structure of BoM and many other processes make it difficult for engineering (R&D) team to take advantage of expertise & know-how from MTB's engineering team. MAN is losing the basic intension of going to a low cost country, which is penetration in the market with local facilities and technical expertise from the headquarters.

Difference between working hours of the two locations was one of the main hurdles. MTB was closed on weekend like standard practice in the industry whereas MFTPL had weekly off on Thursday. There was no communication between MFTPL & MTB for three days in a week. Moreover to add on there was the problem of 3-4 hours of time difference. Pithampur is the production house of company while MTI's headquarters is based in Pune.

3.4 Potential solutions

India is the market with the highest potential to grow for any automotive manufacturer. With the current GDP growth rate of 7.6 % in 2015-2016 and 7.2 % in 2014-2015[125], India is the fastest growing economy in the world. Indian economy is also called as the safe haven for long term growth.[126] Hence it is very important for MAN to focus on its Indian business unit and to take efforts to bring it in profitable business in order to make a global impact in Asia in long term. Below are three different potential solutions which might help to improve the current situation of MAN India.[127] Figure 31 gives reader an overview about the studied potential solutions.

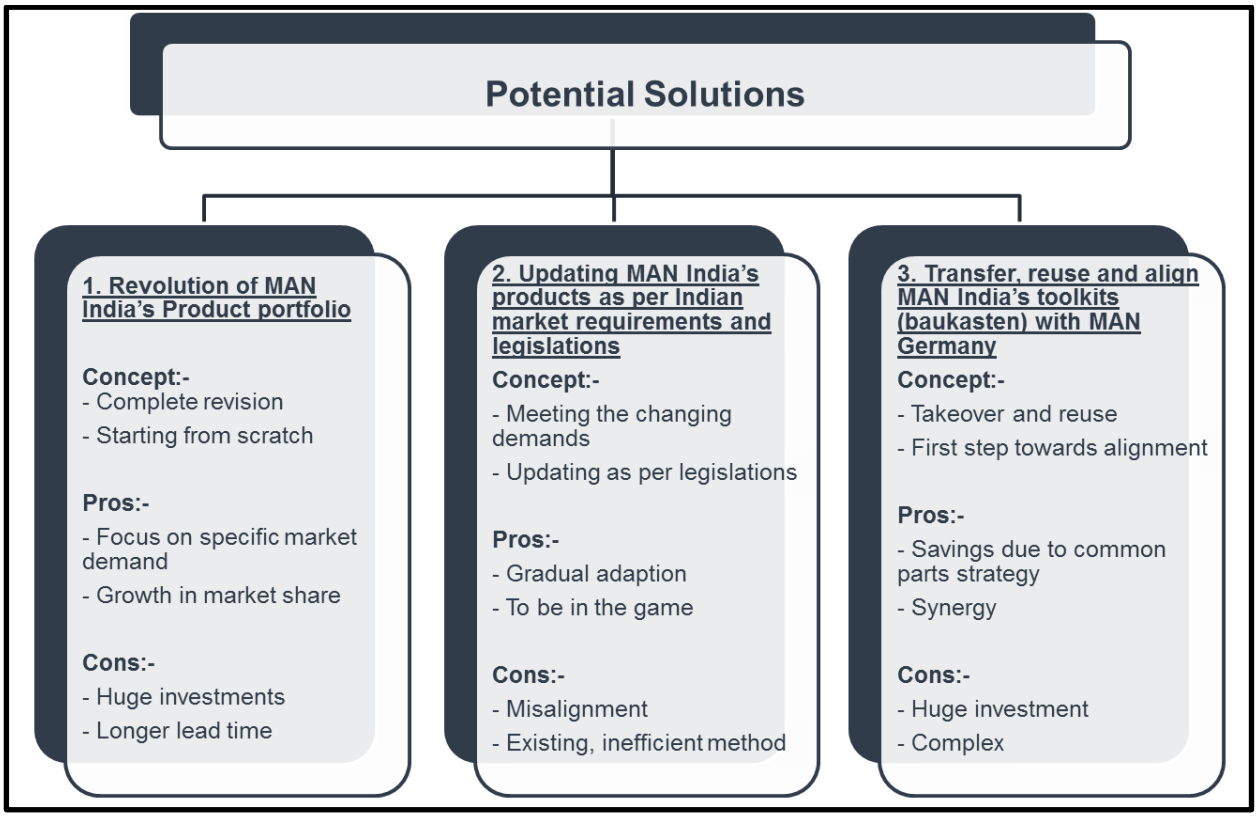

Figure 31: Potential solutions to overcome current problems[128]

3.4.1 Revolution of MAN India's product portfolio

MAN India's products (CLA) were designed to meet the Indian market's specific requirements. These products were configured by selecting the aggregates from different products and some of the obsolete products as well. Aggregates from the

[125] Cf. KPMG (2016), p.1
[126] Ibidem
[127] Own illustration, based on MAN internal data.
[128] Own illustration

European products were selected, downgraded and configured for Indian market. CLA products are the downgraded derivatives of several products from MAN global portfolio.[129]

The potential solution to overcome the existing problems of MAN India can be turning around the business of MAN India by complete revolution of its portfolio. This potential solution suggests to start from scratch and to develop new product range for Indian market, taking into account the current market demands and legislative requirements. This can help MTI to focus on the specific requirements of the market and designing the products to meet those demands precisely. Designing products for specific demands will help in avoiding the overdesign of the product and leading higher customer satisfaction with optimised cost.

This solution can be really effective but also will demand for lot of efforts in engineering and huge sum of investments. It will be a huge challenge for engineering team to understand current market requirements and design products based on that from scratch. This complex method will eventually result in long lead time to market. Till the end of 2015 MAN India has invested cumulatively EUR 335 million.[130] Hence board has taken decision not to follow this method.[131]

3.4.2 Updating MAN India's products as per Indian market requirements and legislations

This potential solution suggests to continuously update MAN India's products. These continuous updates can be due to changing market demands, legislative requirements, product enhancement or cost optimization. These updates are required to meet continuously changing demands and achieve customer satisfaction. Updating products continuously to meet the legislative regulations and changes is mandatory for any automotive manufacturer. These are also very important to be in the game in competitive market like India. This solution will help MAN India not to lose the existing market share.

The existing products are made with aggregates from several European products. Therefore updating these aggregates as per Indian market requirements will lead to misalignment in product architecture between MAN India & MAN Germany, which makes it further difficult to reuse, transfer and align aggregates within organizational

[129] Cf. Interview with Mr. Jens Hartmann, Multi Project Leader, MAN Truck & Bus Germany, date 15.04.2016
[130] Cf. MAN Truck & Bus AG (2016), p.3
[131] Ibidem

subsidiaries. This method is currently followed by MAN India and hasn't turned out to be the effective one. Hence MAN India has seen constant reduction in sales volume since 2012.[132] In year 2015 export sales was -70 % of the target sales volume.[133] Hence concrete actions are needed to stop the downward trend.

3.4.3 Transfer, reuse and align MAN India's aggregates with MAN Germany

This solution suggests reusing the aggregates within organizational subsidiaries to achieve the maximum common parts. The final goal of this approach will be to have modular product architecture which will help subsidiaries to transfer and reuse the individual components, aggregates and products in the future. The step wise approach to achieve these synergies is depicted in the Figure 32:

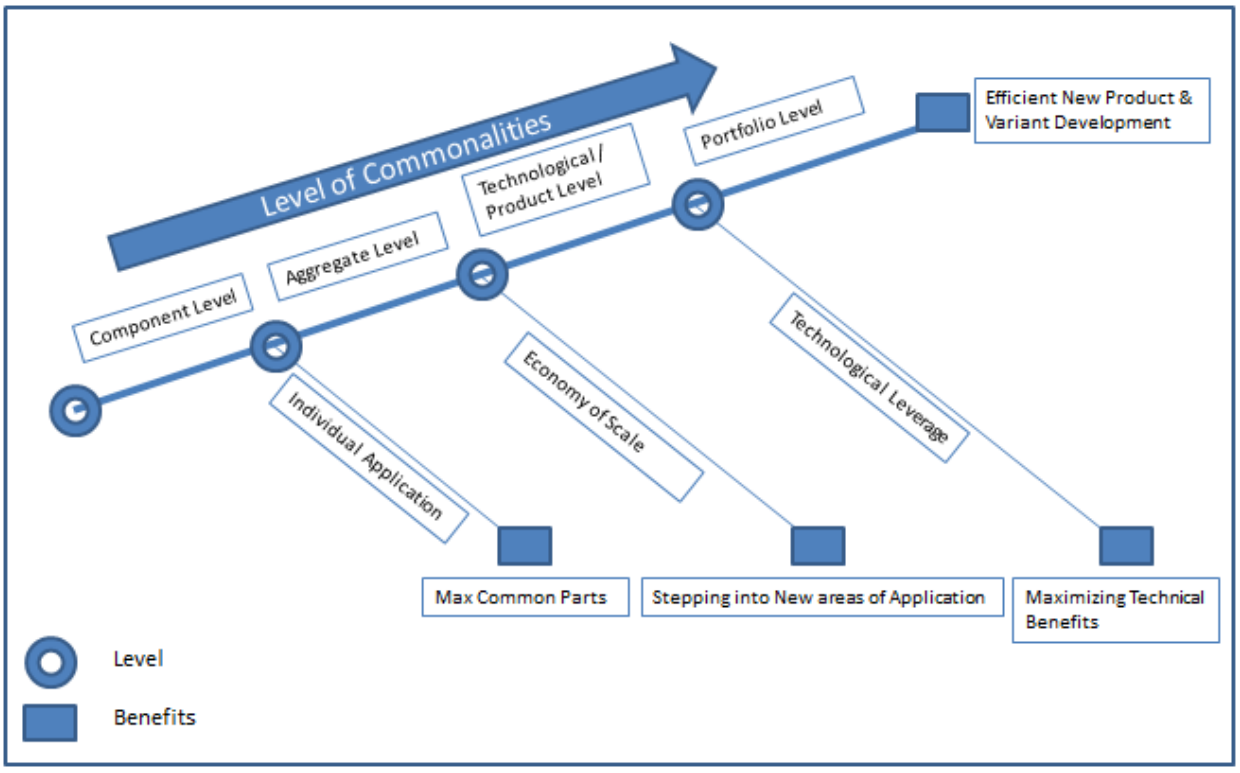

Figure 32 Approach towards commonalities[134]

Finding the possibilities to have maximum common parts and aggregates will be the first step towards the main goal of achieving similarities between product structure of MAN India and MAN Germany's product range. The approach includes four different levels of commonalities i.e. component level, aggregate level, product level & portfolio level. This thesis focuses on aggregate level commonalities, which will provide the

[132] Cf. MAN Truck & Bus AG. (2016), p.21
[133] Ibidem
[134] Own illustration, based on MAN internal data.

strong ground for further research with the goal of achieving modular product architecture.

Having maximum aggregate level commonality will help subsidiaries to take advantage of economy of scale due to similar product structure and combined volume of different subsidiaries. Through investigation of possibility to takeover any existing components from MAN Germany's existing aggregates by MAN India is done in the following chapter. First part of the subsequent chapter deals with reference truck selection, material cost comparison of aggregates of selected reference trucks and identifying the aggregates with potential of saving. And second part of the chapter explains the feasibility of aggregate takeover.

4 Takeover of aggregates by MAN Trucks India

As discussed in the earlier chapter, out of three studied potential solutions, this solutions is found to be the most suitable and with potential of improvements. The detailed analysis of this potential solution is illustrated in this chapter. This chapter depicts the method of selection of reference trucks, selection of aggregates with potential of savings and finally the inspection of feasibility to takeover aggregates for MAN India products from MAN Germany. This chapter gives reader an overview of the step wise methodology followed to check the feasibility of takeover.

4.1 Method

Research methodology used in this thesis is presented in this section of the chapter. A brief discussion on research process, research strategy and research design is presented to give reader an overview how research is structured in this thesis.

4.1.1 Research process

The research process begins with the knowledge from previous research at MAN Germany. Previous research was conducted to have a tool for cost comparison of MAN India and MAN Germany's products. With this knowledge, detailed study to understand the feasibility of takeover of the aggregates is conducted. The study consists of five parts:

- Selection of reference trucks
- Bill of material level material cost comparison of MAN India and MAN Germany products
- Identification and selection of aggregate with potential of savings
- Variant requirement and load capacity check
- Investigation of aggregate takeover feasibility

Though MAN India is a 100 % subsidiary of MAN Germany, product architecture of both companies' is not completely similar. Still there are similarities as the MAN India products are derivatives from MAN Germany's products. So takeover of the aggregates is logically possible but it still has to be analysed thoroughly. This thesis presents

technological, cost and customer benefit analysis of the concept to take over the aggregates from Germany for MAN India products.

4.1.2 Research strategy

The main aim of the thesis is to gain understanding and meet the purpose of the thesis, “Investigation of aggregate takeover feasibility”. This is achieved by answering the formulated research questions in order to understand replicability of the aggregates, material cost differences, technological benefits and customer benefits.

The research in this thesis is based on quantitative research approach. A quantitative approach is the approach used to construct the research. According to Sue Greener, *“Quantitative approach to research is likely to be associated with a deductive approach to testing theory, often using number or fact and therefore a positivist or natural science model, and an objectivist view of the objects studied.”*[135]

4.1.3 Research Design

Trailing section depicts the selection of appropriate method of research for this thesis. This section focuses on the design and structure of the research process. It shows how the research process is developed to acquire the precise data to tackle with individual sections of the research.

The data pool needed for selection of reference truck was acquired from MAN documentation system used at MAN Germany and SAP system used at MAN India. Also sales figures of MAN India for last years were used as the reference data for selection of the reference truck. Collected data was analysed and reference truck was selected on the basis of best-selling range and vehicle axle configuration.

The data required for BoM level material and other cost comparison was acquired from the previous research conducted at MAN Germany. The aim of that research was to conduct a comparative analysis of the MAN India and MAN Germany’s products. The tool developed for BoM comparison in previous research was used to analyse and compare material cost and other cost of the selected reference truck.

Another pool of data used for the variant and load capacity comparison of the axles was obtained by vigorous discussion and interviews with employees from MAN India as well as MAN Germany. Actual data of the vehicle axle configuration was collected from the

[135] Sue Greener, (2008), p. 17

engineering teams of the both companies. This data was used to compare and analyse the replicability of the German axles in the Indian CLA (Cargo Line Asia) products.

Another set of information used for the concept section of the thesis was collected from the concerned departments in the organization. The data like after sales recommendations, customer TCO, landed cost of imported item was used to develop a concept of import of the German axles for CLA products in India.

The concept was investigated for three different aspect i.e. technological, cost and customer value. This observational study was meant to investigate the feasibility of aggregate takeover. The outline of this topic can be seen in the Table 5.

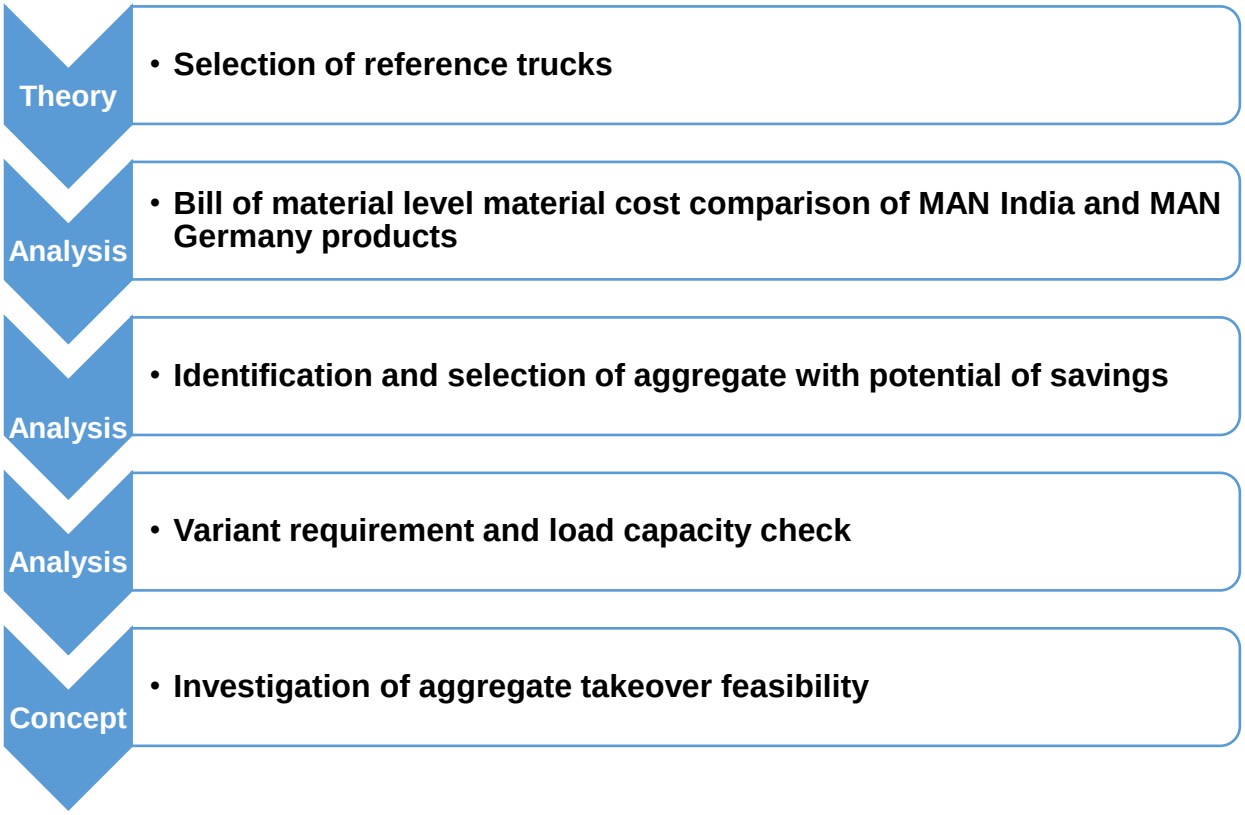

Table 5 Work process stages of the thesis[136]

4.2 Approach for selection of reference truck models

In this chapter different approaches used to select reference trucks from MAN India and MAN Germany are illustrated. The basis used for selection is also discussed in following sections for both reference trucks. This was a very crucial step as further research will be completely dependent on it.

[136] Own illustration based on MAN internal data

4.2.1 Approach for selection of MAN India reference truck

The approach used for selection of reference trucks is presented in this subchapter. The approach of selecting the reference trucks is based on the previous research done at MAN Germany. This thesis is strongly based on the knowledge and finding of the mentioned previous research. Further comparative analysis and feasibility check of aggregate takeover is done for these selected reference trucks.

This approach is based on best-selling product range of MAN India. In this approach the sales figures of MAN India for last ten years were analysed and the best-selling models were deduced. The intention behind using this approach was to target the research to the best-selling product range and getting the maximum benefit from the generated concept.

This approach depicts the selection process of the reference truck based on best-selling models from MAN India's product range. The sales figures of MAN India were analysed and categorised into three categories as low, medium and high selling trucks. Table 6 illustrates the analysis and categories of selling ranges.

Product	Tonnage	Engine in HP	Selling Range
Rigid	25T	180	Low Selling Range
		220	
	31T	220	
		280	
Tractor	40T	220	Medium Selling Range
		280	
	49T	220	
		280	
Tipper Construction	16T	180	High Selling Range
		220	
	25T	220	
		280	
	31T	220	
		280	
Tipper Mining	16T	220	High Selling Range
	25T	280	
	31T	280	
Tipper-Chassis	16T	220	Low Selling Range
	25T	220	
		280	
	31T	280	
RMC	25T	280	Low Selling Range
	31T	280	
Special Application	16T	220	Low Selling Range
		280	
	25T	220	
		280	
	31T	280	
Bus Chassis	16T	220	Low Selling Range

Table 6 MAN India truck selling range[137]

From the analysis of the sales figures of MAN India for last years, high selling range of vehicles was identified. Construction tipper and mining tipper seem to have made huge impact on Indian market. These two product ranges are surely the best performing

[137] Cf. MAN Internal data, sales figures of India

products for MAN India. Hence 31 and 25 tonne tippers with 280 HP engine was selected as the reference truck for the further investigation in this thesis.

MAN CLA 25.280 6×4 Box Body Construction Tipper[138]

MAN CLA 31.280 8×4 Box Body Construction Tipper[139]

As both the reference vehicles share similar vehicle and axle configuration, hence the further investigation will apply for both the reference trucks and all other products sharing similar vehicle configuration.

4.2.2 Approach for selection of MAN Germany reference truck

Reference truck selection of German truck was influenced by the selected reference trucks from India. As there is technology difference in today's German trucks and Indian trucks, the reference truck from Germany was created virtually in the SAP system which meets the same axle configuration and technology with Indian reference trucks. The entire vehicle BoM of these virtual trucks was generated in the system including all cost details for easy comparison. This virtual vehicle and the BoM was used for cost comparison in the further investigation in this thesis.

4.3 Bill of material level material cost comparison of MAN India and MAN Germany products

After selection of reference trucks, BoMs of the two vehicles were collected and analysed with the help of the cost comparison tool developed in the previous research

[138] http://www.mantrucksindia.com/products-service/products/man-trucks/man-tipper-range/overview/ Date of access: 24.05.2016

[139] Ibidem

at MAN Germany. In this tool BoM of CLA products and TG products were made comparable despite of having much dissimilarity. It enables user to input BoM from MAN India and MAN Germany and then it computes all the costs involved on component assembly level. Table 7 shows overall comparison of the costs on the following cost levels.

- Material cost
- Production cost
- Other cost (without production and material cost)
- Scenario of localization

Cost comparison tool												
		Material Cost				Other Cost		Total Production Cost			Scenario of localization in India	
Contruction code	Assy	Material Cost TG (Euro)	Material Cost CLA (INR)	Material Cost CLA (Euro)	Difference %	% of other cost for CLA (Assumption)	CLA Other Cost	Total Cost TG (Euro)	Total cost CLA (Euro)	Difference %	TG Mat. Cost + CLA Overheads	Difference % (TG Mat. Cost + CLA Overheads) - (Total cost CLA Present)
0	Engine	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
1	Engine Housing	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
2	Crank gear	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
3	Cylinder head	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
4	Engine timing	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
5	Engine lubrication	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
6	Cooling system	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
8	Exhaust and intake manifold and air filter	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
9	Boosting and flushing	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
10	Fuel system	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
14		xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx

Table 7: Cost comparison tool[140]

After comparison of the BoMs of two selected reference trucks in this tool, the difference in material cost was studies and analysed. Though India being a low cost country, there were few components had more material cost in India than in Germany. This is due to the effect of economy of scale effect. Although MAN Germany makes premium products for European market, it is able to have lower material cost than in India due to the high volume production. Table 8 below shows the analysis and observations of material and overhead cost differences between two selected reference trucks.

[140] Cf. Singh, U. (2016), p.88

	Material Cost			
Assy	Material Cost TG (Euro)	Material Cost CLA (INR)	Material Cost CLA (Euro)	Difference %
Engine	XXXX	XXXX	XXXX	21.58%
Cooling system	XXXX	XXXX	XXXX	45.62%
Fuel system	XXXX	XXXX	XXXX	41.88%
Exhaust system	XXXX	XXXX	XXXX	90.67%
Lighting, signals, switches, electronical lines, electronical control units	XXXX	XXXX	XXXX	-7.73%
Gearbox	XXXX	XXXX	XXXX	27.36%
Rear axle, trailing axle, axle drive (front/rear axle)	XXXX	XXXX	XXXX	-17.04%
Propeller shaft and bearing	XXXX	XXXX	XXXX	-16.57%
Chassis	XXXX	XXXX	XXXX	58.74%
Axle location, suspension, shock absorber, equipment	XXXX	XXXX	XXXX	15.48%
Non driven front axle	XXXX	XXXX	XXXX	4.28%
Wheels and tyres	XXXX	XXXX	XXXX	-1.33%
Steering	XXXX	XXXX	XXXX	77.93%
Cab	XXXX	XXXX	XXXX	15.37%
Screws, nuts, accessories	XXXX	XXXX	XXXX	60.02%

Table 8: Material cost difference[141]

After comparing the material costs of components from MAN India and MAN Germany products, it was observed that there were several components having lower material cost in Germany than in India.

Note: Precise values of all the parameters mentioned in the table above are available but those are not presented due to classified reasons.

With the help of the same tool, difference in overhead cost was also studied. Table 9 shows the difference between overhead costs of two truck components.

[141] Cf. Singh, U. (2016), p.92

		Overhead costs		
Contruction code	Assy	Overhead cost CLA (€)	Overhead cost TG (€)	Difference(€)
0	Engine	XXXX	XXXX	1574.39
6	Cooling system	XXXX	XXXX	49.81
10	Fuel system	XXXX	XXXX	59.36
15	Exhaust system	XXXX	XXXX	171.13
25	Lighting, signals, switches, electronical lines, electronical control units	XXXX	XXXX	122.78
30	Gearbox	XXXX	XXXX	271.37
35	Rear axle, trailing axle, axle drive (front/rear axle)	XXXX	XXXX	1490.60
39	Propeller shaft and bearing	XXXX	XXXX	45.37
40	Chassis	XXXX	XXXX	540.90
43	Axle location, suspension, shock absorber, equipment	XXXX	XXXX	308.32
44	Non driven front axle	XXXX	XXXX	462.87
45	Wheels and tyres	XXXX	XXXX	215.39
46	Steering	XXXX	XXXX	169.37
60	Cab	XXXX	XXXX	1339.73
90	Screws, nuts, accessories	XXXX	XXXX	1.52

Table 9: Overhead cost difference

These results of the comparison of BoMs form a strong ground for further progress and investigation in this thesis. The table above shows the different overhead costs incurred as per the specific assembly or the components of the vehicle. These results are used in the subsequent chapter for selection of the aggregates with highest potential of savings.

4.4 Identification and selection of aggregates with potential of saving

This section of the chapter gives an overview about the selection of the aggregate for further investigation in the thesis. The results of the cost comparison were analysed and the aggregates with high material cost value and high difference in material cost value were selected for the further study. Some of the major aggregates with high saving potential were observed to be rear axle, propeller shaft & bearing and lighting harness. Table 10 shows the selected aggregates with high potential of saving and which are worth for the further study.

Aggregate	Material cost TG (€)	Material cost CLA (€)	Material cost difference
Exhaust system	xxxx	xxxx	**90.67 %**
Lighting & electronics	xxxx	xxxx	**-7.73 %**
Rear axle	xxxx	xxxx	**-17.04 %**
Propeller shaft & bearings	xxxx	xxxx	**-16.57 %**
Chassis	xxxx	xxxx	**58.74 %**
Wheels & tires	xxxx	xxxx	**-1.33 %**
Steering	xxxx	xxxx	**77.93 %**

Table 10: Selected aggregates with potential of saving

Table 10 indicates the aggregates with high potential of saving and marginal difference in material costs. The negative values of material cost difference indicate that these aggregates have lower material cost in Germany than in India. Therefore these aggregates will be the area of focus for further study in this thesis.

After analysing these aggregates with potential of saving, it was evident that rear axles have the high value of material cost and have the highest difference in material cost. Hence rear axle was selected as the aggregate of focus to check the feasibility of takeover by MAN India for Indian CLA products. Hereafter in this chapter all investigation and feasibility checks are presented related to the rear axle.

4.5 Variant requirement and load capacity check

This section of the chapter depicts the further investigation of the selected aggregate in terms of variant requirement, load capacity and some other important parameters for axle use. Feasibility check of the considered parameters is very crucial to takeover aggregates for use in Indian CLA products.

Axle is the straight shaft on which wheels and tires are mounted in a vehicle. Some of the functions of the axle are load bearing, supporting weight of the vehicle and being part of the suspension system. Other key functions of the axle also include driving the

wheels maintaining the relative position of wheels and steering. Axles have multiple uses in commercial vehicles, including;[142]

- Driving
- Braking
- Steering & alignment

There are two main categories of axles, driven axles and non-driven axles. Driven axles are the rear axles which are powered and can move the vehicle. Non-driven axles are the axles which are not powered and cannot move the vehicle.[143] This thesis focuses only on the driven rear axles. Figure 33 shows a typical rear axles used by MAN.

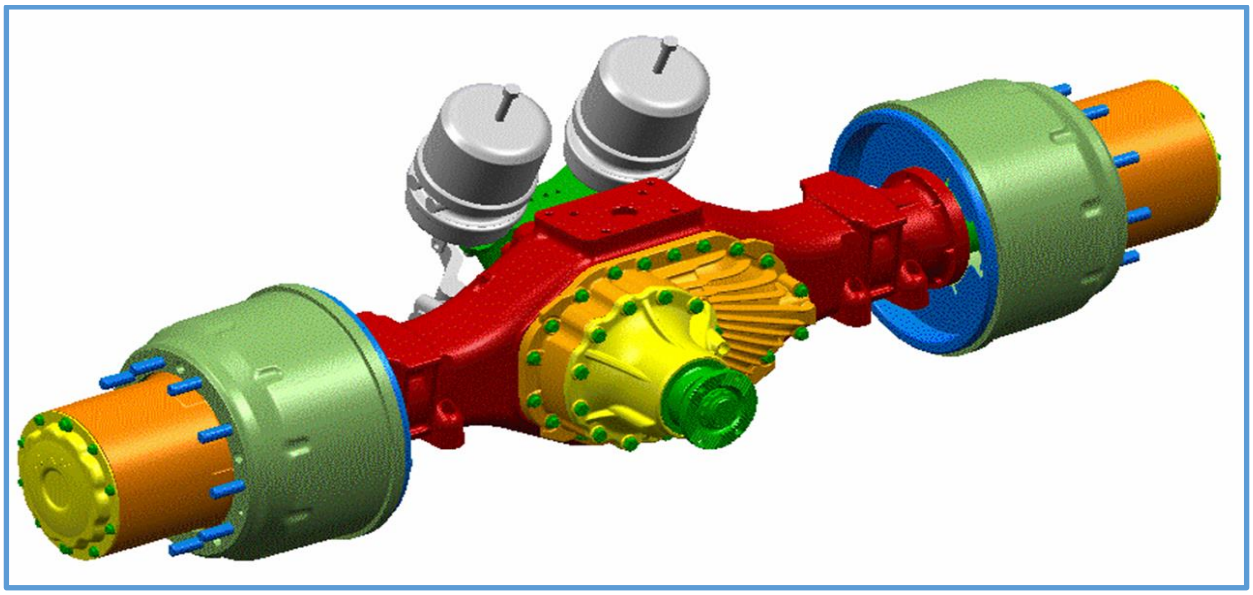

Figure 33: Typical MAN rear axle[144]

Axle is a very important aggregate in the vehicle as it influences the transmitted power, load capacity, fuel consumption and overall vehicle performance. In order to replace these axles into MAN India's CLA product range, following parameters are crucial to check in terms of feasibility:

- Load capacity
- Axle ratio
- Crown Wheel pinion

[142] Cf. Duffy and Wright, (2015), p. 730
[143] Ibidem
[144] MAN Internal data

- Connecting flanges
- Lubrication oil
- Vehicle performance

Axles were shortlisted from wide spread axle portfolio of MAN Germany on the basis of load capacity. The shortlisted axles from MAN Germany and similar axles from MAN India were compared in terms of parameters mentioned above. There is wide range of axle ratios available at MAN Germany. This range covers many axle ratios available at MAN India. Connecting flange specifications are exactly the same for both product ranges.[145] Even the lubrication oil specification is same at MAN India and MAN Germany.[146]

After thorough analysis of axle compatibility, it was evident that these are principally replaceable. Nevertheless vehicle performance calculations need to be done to understand the actual behaviour of vehicle after adapting these new axles from MAN Germany. Table 11 shows the analysis of axles in terms of compatibility for replacement.

Axle parameters	Status
Load capacity	Feasible
Axle ratio	Feasible
CrownWheel pinion	Feasible
Flanges	Feasible
Lubrication oil	Feasible
Vehicle performance	Further detailed calculations need to be done

Table 11: Variant requirement and load capacity analysis

[145] Information provided by Mahesh Patil (Personal communication, June 14, 2016)
[146] Information provided by Debajyoti Adhikari (Personal communication, August 18, 2016)

4.6 Investigation of aggregate takeover feasibility

This chapter depicts the investigation conducted to check feasibility of aggregate takeover by MAN India. The investigation was conducted mainly in two categories viz. in terms of cost and customer value. Customer value was further categorised in two different parts viz. lubrication oil and weight. Influence of weight was investigated further in terms of fuel and payload. Figure 34 gives an overview of the different investigations parameters used in this chapter.

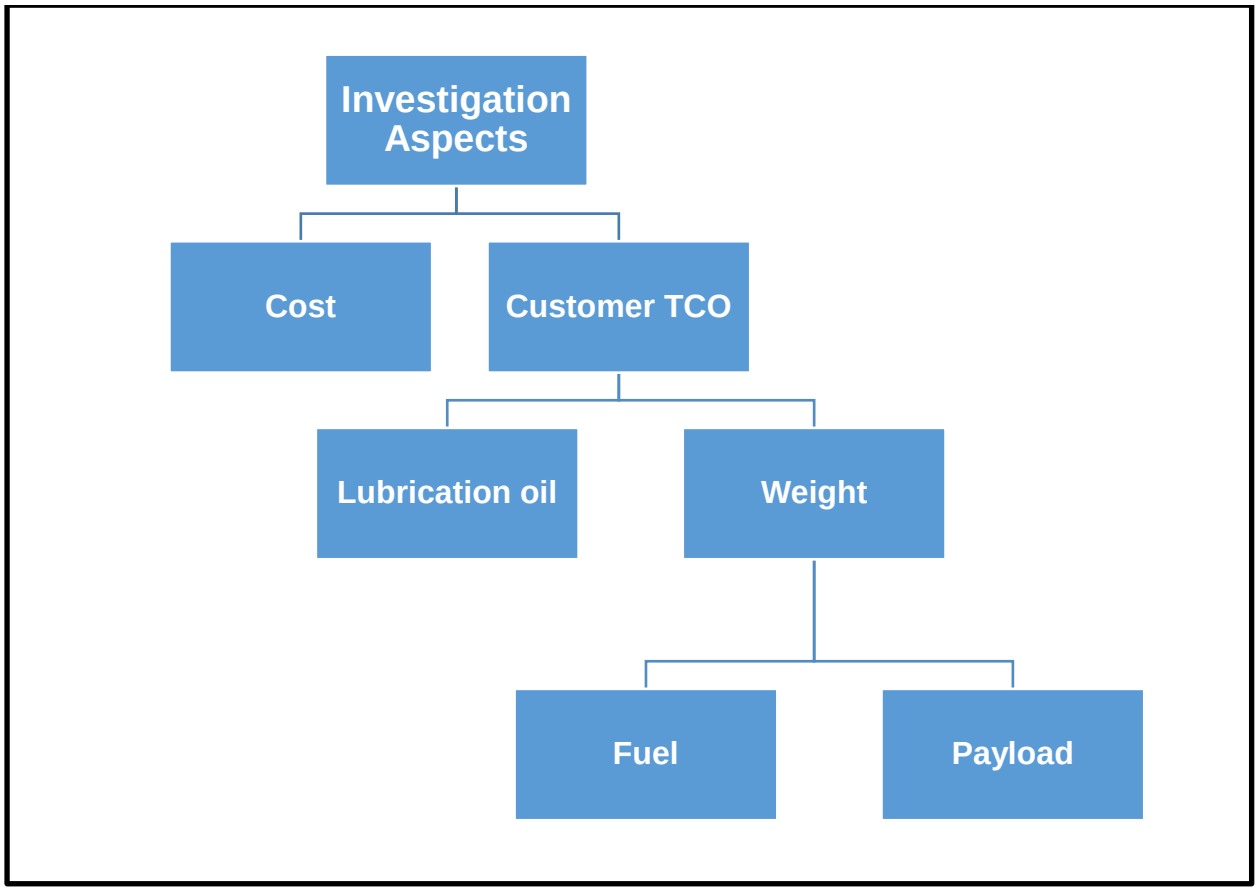

Figure 34: Different aspects of feasibility investigation[147]

The effect of change in weight can result in change in fuel consumption or extra payload available for customer. Both impacts can't be realized together in a vehicle. Either effect on fuel consumption or change in payload can be realized. Feasibility of takeover was inspected in terms of all the parameters mentioned in the Figure 34.

[147] Own illustration

4.6.1 Material cost

After BoM level cost comparison of two chosen reference trucks in section 5.3, it is known that there is a marginal difference in material cost of the axles from MAN India and MAN Germany. The main motive of the thesis is to check the feasibility of aggregate takeover. Due to observed marginal difference in material cost axles can be a very suitable aggregate to investigate further. India being a low cost country, there are also marginal differences in overhead cost of MAN India and MAN Germany. Table 12 shows the difference in material cost and overhead cost for the axles in TG and CLA product range. Negative difference means that material cost is higher for CLA products than TG products.

	TG	CLA	Difference (%)
Material cost of axles (€)	XXXX	XXXX	-17
Overhead cost for axles (€)	XXXX	XXXX	70

Table 12: Material cost and overhead cost difference between TG & CLA products

For takeover of axles MAN India will have to import these axles from MAN Germany which will demand for extra cost associated with import duties and transport charges. If MAN India import these axles from MAN Germany and use it in CLA product range of MAN India with Indian overhead costs then it might lead to some cost saving. To check the potential of saving landed cost of the mentioned axles need to be calculated.

4.6.2 Landed cost

While importing or buying any items from third party, there are always some additional costs associated with it. For analysis of any project or any assignment these costs need to considered well in advance. These costs are often called as landed cost of the product.

A landed cost is the overall product price after it reaches the buyer's door. The landed cost generally consists of original product price, customs, duties, transportation, insurance and packaging.[148] It covers all the costs incurred in getting purchased items

[148] Cf. Delaney, L. (2013), p.67

to buyer's premises. These costs are very crucial in understanding the true value of the imported items.[149]

In past MAN India has imported many aggregates from Germany. Hence the information of all the costs associated with import was available at MAN Germany. With the help of past experience landed cost calculation for axles was done. These calculations include different parameters such as ex-factory cost, packing, freight, insurance and customs duties. Table 13 gives an overview of the parameters used and the calculation factors considered for landed cost calculations.

Imported Material		CIF		FOB	
		EUR (indexed)		**EUR** (indexed)	
Ex-factory cost				**100.00**	
Packing					
Freight			3.00%	3.00	variable on goods
Insurance			0.25%	0.25	
Sub-total:		**100.00**		**103.25**	
Assessable value for customs	*101.00%*	*101.00*	*101.00%*	*104.28*	customs adds on 1%
Basic customs duty	10.00%	10.10	10.00%	10.43	
CVD	12.00%	13.33	12.00%	13.77	
Cess on CVD	2.00%	0.27	2.00%	0.28	
Education cess	1.00%	0.13	1.00%	0.14	
Special Additional Duty	4.00%	4.99	4.00%	5.16	
Clearing charges	5.00%	5.00	5.00%	5.16	
Local freight: Mumbai Port to Pithampur	2.00%	2.00	2.00%	2.07	
Total		**135.83**		**140.24**	
Less refundable:					
CVD		13.33		13.77	
Cess on CVD		0.27		0.28	
SAD		4.99		5.16	
Total refundable		**18.59**		**19.20**	
Net landed cost		**117.23**		**121.04**	

Table 13: Landed cost calculations[150]

As it can be seen in the table above, there are two different calculations of net landed cost. CIF and FOB are two different types of contracts buyer and seller agree upon before purchase of goods.

CIF (Cost, insurance freight) is a contract when seller has delivered the goods; he has to comply with the contract by producing conforming documents of the delivery to the buyer. The main feature of CIF contract is that the contract is fulfilled after seller

[149] http://www.pegasus.co.uk/downloads/marketing-materials/landed-costs-datasheet.pdf, date of access: 22.08.2016,

[150] Informtion provided by Dr. Raphael Petry (Personal communication, 21.07.2016)

produces the documents of delivery and not the delivery of goods physically.[151] In CIF contract buyer only pays the cost of customs or duties if any.

FOB (Free on board) is described as a flexible instrument. Unlike CIF contract in FOB seller has to bear all the costs of goods once they are delivered on the mentioned loading port.[152] As MAN India and MAN Germany are subsidiaries of MAN, it was assumed the method of import will be easily agreed upon as CIF. All the calculations are done based on the assumption that method of shipment will be CIF.

Table 14Table 14 shows the result of the net landed cost calculations done for axle. It was found that even after all the cost associated to import of axles, the material cost of the axles is almost the same as that of the cost of existing axles made at MAN India for CLA products. TG axles are technologically far advanced than CLA axles. The results of net landed cost calculations showed that TG axles will be only 0.14 % more expensive than current CLA axles even after import costs. It shows a great potential to takeover TG axles for CLA products.

Material cost of CLA axles	Net landed cost of imported TG axles	Difference
XXXX	XXXX	0.14 %

Table 14: Analysis of landed cost calculations[153]

4.6.3 Customer TCO

Based on the findings in the previous chapters; it was surely worth to investigate further about the concept of takeover of axles. It is also very important to investigate how these new axles will affect performance of the vehicle and impact on the customers' TCO. Further investigation is done on the basis of lubrication oil used in the axles and the weight difference between axles.

Lubrication oil

Lubrication oil is very important in axles as it helps to minimize the friction losses and improve the life and reduce the downtime of the axles and its components. It also gives axle components protection against oxidation, rust and copper corrosion.[154]

[151] Cf.http://farin-farinratna.blogspot.co.at/2010/11/differences-between-cif-and-fob.html, date of access: 08.10.2016
[152] Ibidem
[153] Own illustration

Lubrication oil contributes to the maintenance cost of the customers. Therefore change in required quantity of lubrication oil will affect the customers' TCO. From available internal data regarding oil quantity requirement of TG and CLA axles, the difference in required oil quantity was analysed. Table 15 shows the required oil quantity difference between TG and CLA axles.

	TG Axles[155]	CLA Axles	Difference
Lubrication oil Quantity (Litre)	27.4	43	15.6

Table 15: Required lubrication oil quantity for axles[156]

This difference in required oil quantity will surely affect the TCO. To analyse the impact of oil difference saving potential calculations were done. Parameters used for the calculations are listed below:

- Required oil quantity per vehicle (litre)
- Total usage of vehicle in lifetime (km) = 600000[157]
- Recommended oil change interval (km) = 60000[158]
- Rate of oil per litre (euros/litre) = 3.3[159]

Table 16 shows the results of saving potential calculations done to analyse the impact of oil quantity difference.

Oil quantity difference (litre)	Total usage (km)	Oil change interval (km)	No of oil change intervals in lifetime (#)	Oil price (Euro/Litre)	Saving potential /lifetime/vehicle (Euro)
15.6	600000	60000	10	3.3	515

Table 16: Saving potential due to oil quantity difference

[154] Cf. George E. Totten (2006), p 3-2
[155] Information provided by Thomas Reiter (Personal communication, 29.06.2016)
[156] Information provided by Mahesh Patil (Personal communication, 05.07.2016)
[157] Ibidem
[158] Information provided by Debajyoti Adhikari (Personal communication, August 18, 2016)
[159] Ibidem

Weight

In this section of the chapter impact of change in weight is investigated. Weight of the vehicle plays an important role in performance of the vehicle. Heavier vehicles need more energy to get moving.[160] Heavier vehicles have higher inertia and higher rolling resistance which demands more energy to move the vehicle. Hence reduction in vehicle weight can considerably affect the fuel consumption. [161]

To understand the change in weight of TG and CLA axles, a weight comparison was done. The results of mentioned weight comparison are shown in Table 17. Conducted comparison study indicated that there is marginal difference of 166 kg in the overall weight of the axles for selected reference trucks.

	TG axles (kg)	CLA axles (kg)	Difference (kg)
Weight	XXXX	XXXX	166

Table 17: Weight comparison of axles[162]

As already discussed in this section, reduction in weight can considerably affect the fuel consumption of the vehicle. In special case of commercial vehicles, it also can add value in terms of additional payload. Hence further investigation in this section is focusing on two aspects of the impact on vehicle due to weight reduction. These two aspects are customer value due to improved fuel consumption and customer value due to additional payload.

Customer value due to improved fuel consumption

This section depicts the change in fuel consumption due to lower weight of the vehicle. To understand the effect on fuel consumption due to change in weight, it is important to understand the relation of vehicle weight and fuel consumption. Formulae below give an overview of the relation between vehicle weight and fuel consumption.

$$\text{Fuel } consumption = \frac{velocity}{Power\ X\ Specific\ fuel\ consumption}\ X\ 845 \quad \text{[g/Kwhr]}$$

Equation 1[163]

[160] Cf. http://www.nrcan.gc.ca/energy/efficiency/transportation/cars-light-trucks/buying/16755, date of access: 09.08.2016
[161] Ibidem
[162] MAN internal data, Own illustration
[163] Cf. Rajamani, R (2006), p.117

$$Power = \frac{Workdone}{time} = \frac{W}{t} = \frac{Force\ X\ Displacement}{time} = \frac{Resistance\ X\ velocity}{\eta\ (efficiency)}$$ [Kw]

Equation 2[164]

$$Resistance\ (R) = Rolling\ resistance + Gradient\ resistance + Air\ drag$$ [N]

Equation 3[165]

$$Rolling\ resistance = Mass\ (M)\ X\ Cr\ (coefficient\ of\ rolling\ friction)$$ [N]

Equation 4[166]

Equations above give an overview of the relation between fuel consumption and vehicle weight. Fuel consumption is dependent on velocity of the vehicle, engine power and specific fuel consumption of the engine. Fuel consumption is inversely proportion to the power. From Equation 2 it can be seen that power is directly proportional to the resistance offered to vehicle. Rolling resistance is also directly proportional to the mass of the vehicle.

Fuel efficiency for reference truck from MAN India is calculated for two different scenarios. First scenario is with existing configuration of selected CLA truck and another is configuration of CLA truck with existing axles replaced by axles from TG vehicles. Main consideration for these calculations is the difference in vehicle weight due to lighter axles from TG product range. Fuel efficiency was calculated for different conditions viz. low medium and high revolutions of engine. Fuel consumption is a very dynamic parameter and hence for comparison the values of fuel consumption at top gear top speed conditions were considered as reference. Figure 35 give and overview of the difference in fuel consumption due to lower weight of the axles.

[164] Ibidem
[165] Ibidem
[166] Ibidem

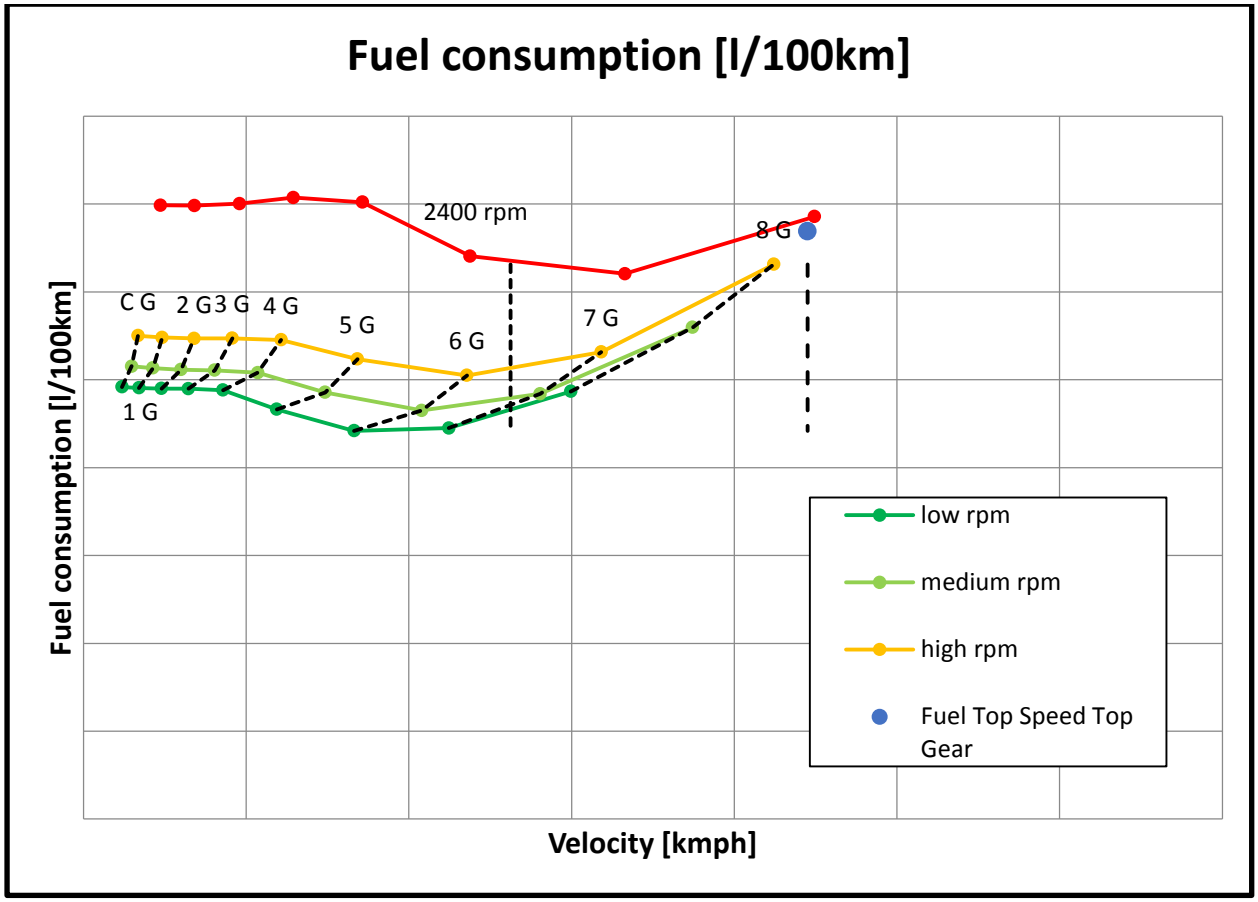

Figure 35 : Fuel consumption with CLA axles[167]

Blue dot in the figure above shows the absolute value of fuel consumption of the vehicle with current axles used in CLA products in India. This absolute value is considered as reference to analyse the difference in fuel consumption. It is the value of the fuel consumption at top gear top speed condition. These calculations are static and on real vehicle these effects can vary due to dynamic behaviour of the vehicle. Figure 35 shows the fuel consumption with TG axles.

[167] Own illustration

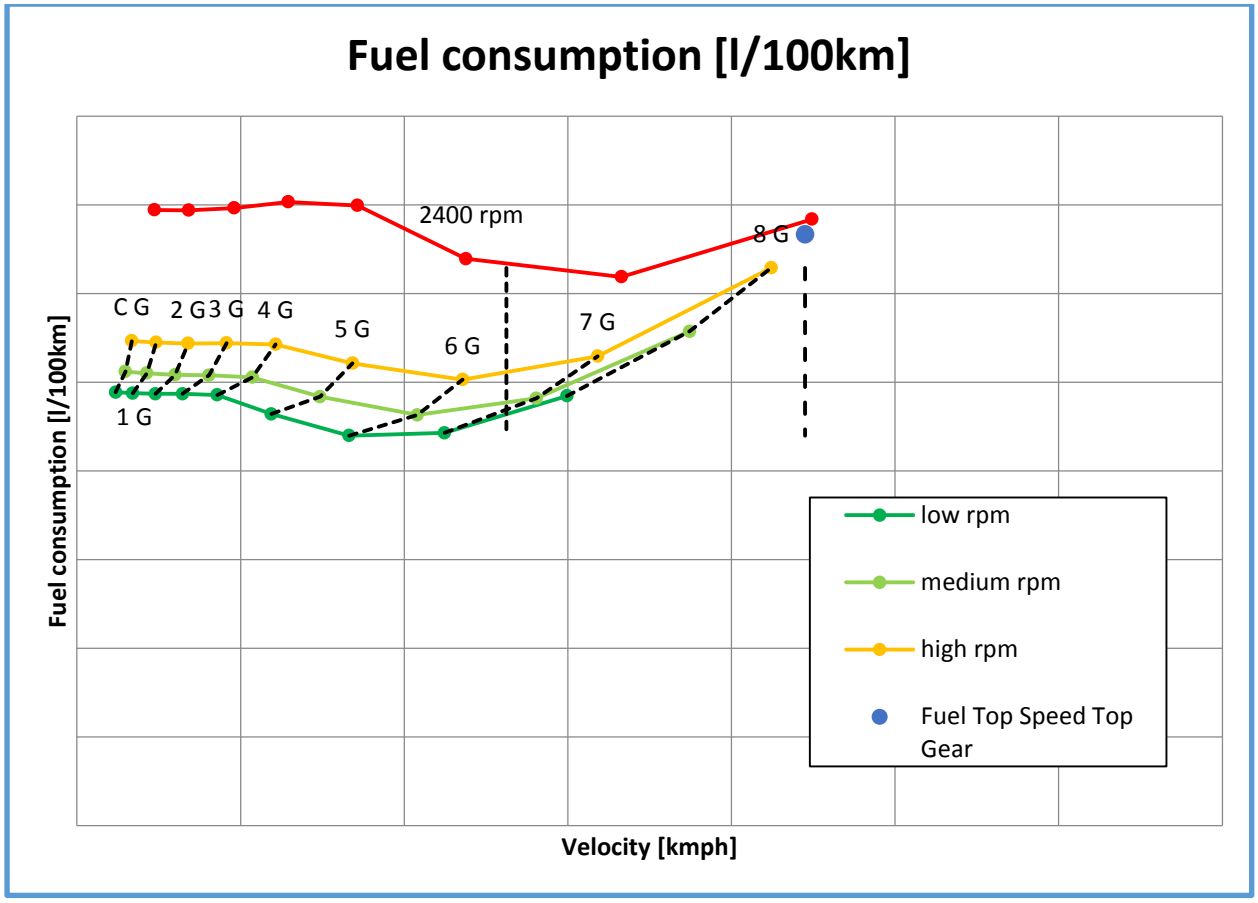

Figure 36: Fuel consumption with TG axles[168]

As the weight difference in mentioned two axles is only 166 kg, the difference in fuel consumption on the graph is very minor. Table 18 lists the difference in fuel consumption observed in the Figure 35 and Figure 36.

	With CLA axles	With TG axles	Difference (l/100km)
Fuel consumption (l/100km)	XXXX	XXXX	0.11

Table 18: Difference in fuel consumption

Positive difference indicates that fuel consumption is better with TG axles. The calculated difference in fuel consumption will surely lead to saving in fuel cost. For calculating fuel cost savings following parameters are considered.

- Difference in fuel consumption
- Total run in lifetime

[168] Own illustration

- Fuel price

Table 19 shows the potential of fuel cost savings due to improved fuel consumption. These calculations are done using a previously developed calculation tool for vehicle performance analysis. This tool was developed at MAN India for analysing the current products and upcoming vehicles.

Difference (l/100km)	Total run in lifetime (km)	Fuel price (€)	Saving potential (€)
0.11	600000	0.85	561

Table 19: Saving potential due to improved fuel consumption[169]

Customer value due to additional payload

Due to overall lower vehicle weight, trucks cannot only improve fuel consumption but also relieve load on traffic network.[170] It is possible due to the fact that lighter trucks can transport more freight.[171] Due to this additional weight more freight can be carried on each individual journey, which results in fewer journeys required overall. This leads to a considerable cost saving at the end of year. [172]

For calculating the saving potential due to additional payload, standard calculation tool was used. This tool is used in MAN Germany's marketing department to estimate the saving potential due to MAN Germany's "Lightweight Construction" initiative[173]. Table 20 gives an overview of the parameters used for calculation and flow of calculation.

Parameters	Value	Unit
Usage Time	XXXX	Year
Average mileage/year	XXXX	km
Fuel consumption	XXXX	l / 100km
Fuel price	XXXX	€
Additional Profit	XXXX	%
Improvement in fuel consumption due to weight reduction	XXXX	l / 100 kg

[169] Ibidem
[170] Hill, et al.(2015), p. 01
[171] Cf.http://www.truck.man.eu/de/en/man-world/technology-and-competence/lightweight-construction/Lightweight-construction.html, date of access: 10.10.2016
[172] Ibidem
[173] Ibidem

Fuel cost	XXXX	€
Weight reduction	XXXX	kg
Customer benefit due to reduction in fuel consumption	XXXX	€
Customer benefit due to additional payload	XXXX	€
Additional earning	XXXX	€ / vehicle / year

Table 20: Calculation tool for additional profit due to extra payload[174]

This tool gives the absolute value of savings potential named as additional earning. If there is some improvement done on the product range, MAN takes the one third of the potential saving and gives the customer two third of the total value. As per this norm customer can realize only 66 % of the total potential of saving. Table 21 shows the results of the calculation after taking all parameters and conditions into consideration.

Total saving potential due to increased payload (€)	Additional profit to customer (66% of the total) (€)
1257	829

Table 21: Additional profit for customer due to increased payload

[174] Mercel Karl (Personal communication, 05.07.2016)

5 Conclusions and recommendations

This chapter provides conclusions with reference to the research questions. This chapter summarises all the potential solutions, potential of cost saving, identifying the aggregates with highest potential of saving and analysis of feasibility study conducted for takeover of aggregates by MAN India. This chapter also gives a solid ground of information for further recommendations and possible activities at MAN Germany. Research questions are answered one by one in this chapter and additional conclusions and recommendations are also outlined.

1. *What are the potential solutions in aspect of product management to bring MAN Trucks India in profitable business operation?*

After operation of over a decade in India, MAN is still struggling to make a mark in Indian market. Hence some steps need to be taken to bring MAN India in profitable business. To outline the potential solutions, it was necessary to understand the current situation of MAN India in India commercial vehicle industry. Section 3.1 depicts the current position and problems MAN India is facing. Section 3.2 conveys reader the reasons behind downfall of MAN India and also forms a strong background for the potential solutions. The potential solutions which could help MAN are explained in detail in section 3.4. After analysing the potential solutions it was found that first two solutions are not feasible. First solution is not feasible because it demands huge amount of investment and MAN Germany's board has already taken a decision in recent past to not invest more in MAN India's operation. The second potential solution was ruled out due to the fact that it is existing practice followed by MAN India and it hasn't turned out to be the effective one.

All three potential solutions can be observed in the Figure 37. Pros and cons of all three solutions are also listed in the figure. Most feasible solution worth investigating further is marked with green tick mark in the figure below.

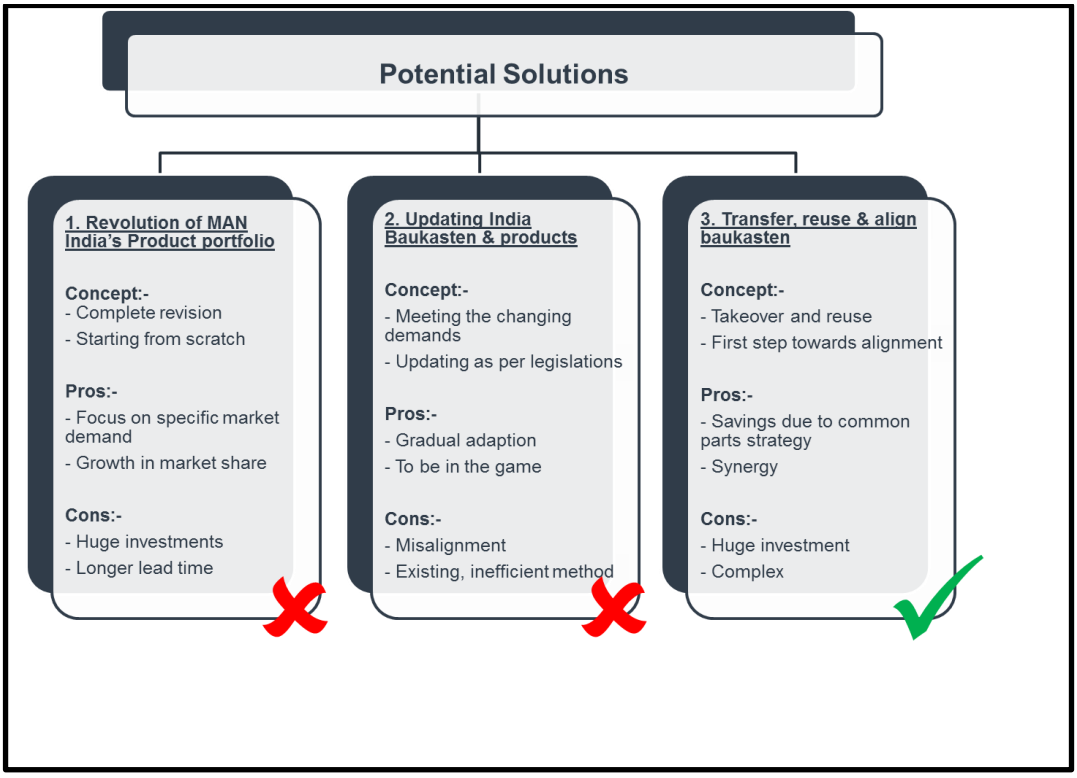

Figure 37: Conclusion of potential solutions

2. *Are there some aggregates made cheaper by MAN Truck & Bus, Germany which can be taken over by MAN Trucks India?*

There are some aggregates in Germany which are made cheaper than in India due to economy of scale. MTI is a low volume subsidiary of MAN India with average annual volume of 3000 trucks[175] whereas MTB makes 75000 vehicles on an average.[176] Due to this huge difference of volume economy of scale effect cannot be realized at MAN India and hence technologically critical aggregates like axles are cheaper in Germany than in India.

Table 22 outlines the aggregates which are made cheaper in Germany than in India indicating the difference in material cost. Rear axle is an aggregate with high material cost and with highest difference in material cost hence it can be taken over by MAN India to achieve the aim of cost saving. Other aggregates like lighting, propeller shaft and wheels also show the difference in material cost but due to low material cost these were not investigated further. But surely these aggregates can contribute huge savings in long term goals.

[175] Cf. MAN internal data 2016
[176] Cf. MAN SE (2016)

Aggregate	Material cost difference
Lighting & electronics	-7.73 %
Rear axle	-17.04 %
Propeller shaft & bearings	-16.57 %
Wheels & tires	-1.33 %

Table 22: Material cost comparison results

3. *Will it be beneficial from TCO perspective to take over aggregates from MAN Truck & Bus, Germany?*

MAN India will surely be benefitted by taking over technologically advance axles from MAN Germany which will cost almost the same as that of currently used axles by MAN India. To investigate whether it will be beneficial to MAN India or not it had to be investigated by keeping different aspects in mind. These different aspects were aggregate feasibility, landed cost of axles and customer TCO.

Section 4.5 depicts the feasibility of the axle replacement. Axles were investigated for parameters like load capacity, axle ratio, connecting flange, lubrication oil and vehicle performance. Most of the parameters are found to be feasible.

For takeover of TG axles MAN India will have to import these axles from MAN Germany. These import activity will surely contribute additional cost of transportation, import duties and etc. To evaluate what will be the total cost of the axles for MAN India, landed cost calculations were done. These calculations are explained in detail in section 4.6.2. The results showed that landed cost of imported axles will be approximately same as that of current CLA axles. It will be still beneficial to takeover these axles as these axles are technologically advanced which are suitable for European standards and they are lightweight. Though it doesn't show any cost saving after import, it will sure add technological value and lower weight benefit. Table 23 the results of landed cost calculations.

	Difference (€)
Material Cost	+ 8

Table 23: Results of landed cost calculations

Next parameter for investigation was lubrication oil quantity and potential of saving due to difference in required quantity. It was explained briefly in section 4.6.3. Table summarises the difference in required oil quantity and potential of saving per vehicle per lifetime.

	TG Axles	CLA Axles	Difference	Saving potential /lifetime/vehicle (Euro)
Lubrication oil Quantity (Litre)	27.4	43	15.6	515

Table 24: Potential saving due to lubrication oil

Further aspect for investigation was the weight difference and benefits due to lower weight. The detailed analysis of weight difference and calculation of potential saving is presented in the section 4.6.3. Lightweight vehicles can either take the benefit of improved fuel consumption due to lower weight or vehicles can carry more payload. Hence difference of weight can give saving in two criteria; better fuel consumption or increased payload. Table 25 shows the potential of saving due to improved fuel consumption and due to additional payload.

Difference in weight (kg)	Difference (l/100km)	Fuel price (€)	Saving potential(Fuel consumption) (€)	Saving potential(Additional payload) (€)
166	0.11	0.85	561	829

Table 25: Result of saving potential due to lower weight

This chapter concludes all the calculations done to estimate the potential of saving if MAN India takes over TG axles from Germany. In section 4.6 different aspects for investigation were mentioned in the Figure 34. In relation to that the saving potential for each aspect is depicted in the figure to conclude this research work.

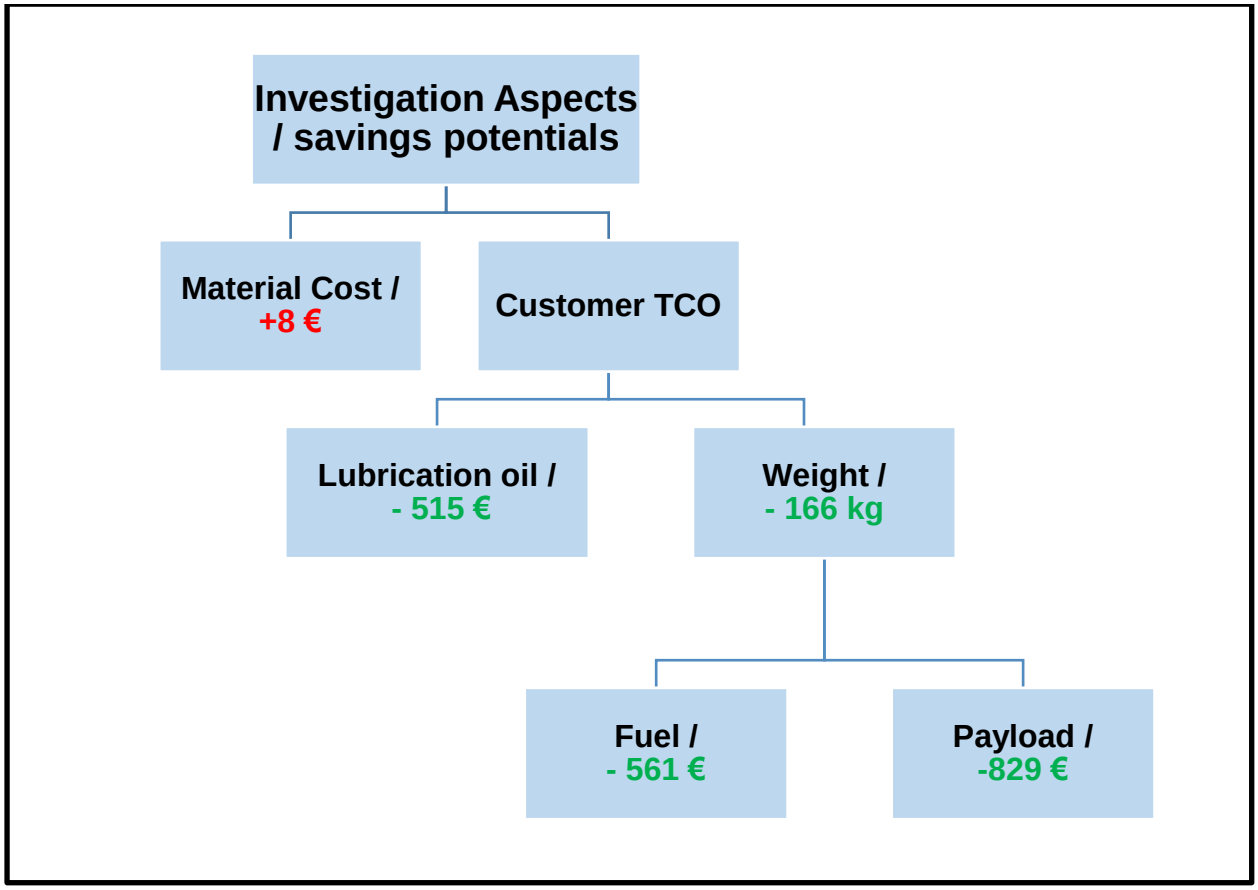

Figure 38: Results of savings potential

As only one of the benefits due to weight can be realised, the total cost benefit per vehicle in lifetime can be either 1068 euro or 1336 euro.

The results show that takeover of axles will be a great initiative towards the goal of maximizing common parts strategy.

5.1 Future recommendations

This study has mainly focused on finding the aggregates with potential of cost saving and feasibility of those aggregate for takeover by MAN India. This research gives reader the knowledge about how to find the potential of cost saving and benefits of those components' takeover. There have been many other findings which were interesting but not included in this study. By correlating this study to perform other interesting investigations would be fascinating. Further studies which could be worth to work on are listed below;

- Making MAN Trucks India engineering centre and supplying part to other subsidiaries as internal vendor.

This recommendation arises from the findings in this thesis that some components are made way cheaper in India than in Germany. If some engineering efforts are made towards the feasibility study, some interesting facts can be found. The recommended aggregates for this kind of study are listed in Table 26.

Aggregate	Material cost difference
Exhaust system	**90.67 %**
Chassis	**58.74 %**
Steering	**77.93 %**

Table 26: Aggregates with potential to make in India

- Aligning MAN India's product architecture with MAN Germany to take benefit from modular product architecture and minimize the product development cost and enable easy transfer and reuse of aggregates (modules).

These are some topics author specifically recommends for further research which might help MAN India to be better aligned with MAN Germany and be a strong market player in Indian commercial vehicle market.

- Involve MAN India in common product development process under Volkswagen Truck & Bus to take the benefit of lower development costs and economy of scale effect.

6 Bibliography

Anderson, A. (1998). *Best Practices: Building You Business with Customer-Focused Solutions.*

Avak, B. (2007). Variant management of modular products families in the market phase.

Bennett, A. R. (2003). The Five Vs - A Buyer's Perspective of the Marketing Mix. Marketing Intelligence & Planning.

BMW Group. (2016). *BMW Investor Presentation.*

Borden, N. H., & Marshall, M. V. (1959). *Advertising Management: Text and Cases.*

Burt, Dobler, & Starling. (2003). *World Class Supply Chain Management.*

Cadle, J., Paul, D., & Turner, P. (2010). *Business analysis techniques, 72 essential tools for success.* BCS The chartered institute for IT.

Chandel , A. (2014). Strategy Analysis of MAN India.

Chong, K. (2003). The Role of Pricing in Relationship Marketing - A Study of the Singapore Heavy Equipment Spare.

Culliton, J. W. (1948). *The Management of Marketing Costs. Boston: Division of Research, Graduate School of Business Administration, Harvard University.*

Delaney, L. (2013, 05 15). *eCommerce.* Retrieved 08 22, 2016, from Bolgs.pb: http://blogs.pb.com/ecommerce/2013/05/15/what-is-a-landed-cost-and-why-its-essential-in-global-trade/

Dr. Cooper, R. G. (2007). *The PDMA Handbook of New Product Development, Second Edition.*

Duffy, & Wright. (2015). *Fundamentals of Medium-Heavy Duty Commercial Vehicle Systems.*

Ehmke, C., Fulton, J., & Lusk, J. (2010). *Marketing's Four P's: First Steps for New Entrepreneurs.*

Ehrenspiel, K. (1995). *Integrierte Produktentwicklung. Methoden für Prozeßorganisation, Produkterstellung und Konstruktion.*

Ellram, L. M. (1996). *A Structured Method for Applying Purchasing Cost Management Tools.*

Goi, C. L. (2009). *A Review of Marketing Mix: 4Ps or More? .*

Greener, S. (2008). *Business Research Methods.*

Grönroos, C. (1994). *From Marketing Mix to Relationship Marketing: Towards A Paradigm Shift in Marketing.*

Gupta, S. P., Sharma, A., & Ahuja , S. (2009). *Cost Accounting.*

Haines, S. (2008). *The Product Manager's Desk Reference.*

Heina, J. (1999). Variantenmanagement: Kosten-Nutzen Bewertung zur Optimierung der Variantenvielfalt.

Hill, Norris, Kirsch, Dun, McGregor, Pastori, et al. (2015). *Light weighting as a means of improving Heavy Duty Vehicles' energy efficiency and overall CO2 emissions.*

Kerin, Hartley, & Rudelius. (2001). *Marketing, The Core, 4th Edition.* McGraw Hill Publishing.

Kotler, P. (1984). *Marketing Management: Analysis, Planning and Control (5th ed.).*

Kotler, P., Armstrong, G., Brown , L., & Adam, S. (206). *Marketing.*

Kotler, P., Keller, K. L., Brandy, M., Goodman, M., & Hansen, T. (2009). *Marketing Management.* Pearson education.

KPMG. (2016). *India Economic Survey 2015-16 - Key Highlights.*

Kurz, J. (2013). *Variant Management-Which approach fits for my product?*

Lehnerd, A. P., & Meyer, M. H. (2011). *The Power of Product Platforms.*

MAN Internal Data. (2015). *Sales Figure of India.*

MAN SE. (2016). *2016 Half-Yearly Financial Report.*

MAN Truck & Bus AG. (2016). *MAN T&B-Board Visit India.*

MAN Truck & Bus AG. (2016). *Task Force India Kick-Off.*

MAN Trucks India. (2016). Corporate Portrait Year 2016.

McCarthy, J. E. (1964). *Basic Marketing. A Managerial Approach.*

Needham, D. (1996). *Business for Higher Awards.*

Palmer, A. (2004). *Introduction to Marketing - Theory and Practice.*

Prasad, L., & Gulshan, S. S. (2011). *Management Principles and Practices.*

Rajamani, R. (2006). *Vehicle dynamics and control.*

Rathnow, P. J. (1993). Integriertes Variantenmanagement -Bestimmung, Realisierung und Sicherung der optimalen Produktvielfalt.

Ratna, F. (2015, 11 05). Retrieved 10 08, 2016, from Farinratna Blogspot: http://farin-farinratna.blogspot.de/2010/11/differences-between-cif-and-fob.html

Rhonda, A. (2000). *Successful Business Plan: Secrets and Strategies.*

Schlagel, A. (1978). *Betriebswirtschaftliche Konsequenzen der Produktdifferenzierungdargestellt am Beispiel der Variantenvielfalt im Automobilbau.*

Singh, M. (2012). *Marketing Mix of 4P'S for Competitive Advantage.*

Singh, U. (2016). *Investigation of MAN Cargo Line Asia (CLA) Product Portfolio in Terms of Cost & Development of Product Management Tool- PREP "Produkteigenschaftsprofil.*

Stalk, G., & Hout, T. M. (1990). Competing Against Time – How Time-Based Competition is Reshaping Global Markets.

Stark, J. (2004). *Product Lifecycle Management: 21st Century Paradigm for Product Realisation.*

Totten, G. E. (2006). *Handbook of Lubrication and Tribology, Vol-I.*

7 Weblinks

MAN Trucks India: http://www.mantrucksindia.com/company/mti-at-glance/ , date of access: 20.04.2016

Oracle Blogspot: https://blogs.oracle.com/PLM_Cafe/en/entry/variant_management_which_approach_fits , date of access: 12.10.2016

Wikipedia:http://images.google.de/imgres?imgurl=https%3A%2F%2Fupload.wikimedia.org%2Fwikipedia%2Fcommons%2Fd%2Fd5%2FProduct_life-cycle_curve.jpg&imgrefurl=https%3A%2F%2Fen.wikipedia.org%2Fwiki%2FProduct_life-cycle_management_(marketing)&h=667&w=1448&tbnid=RIemEpI8iYn4IM%3A&docid=OaXwab3KOOhN7M&ei=N6wIWImeLMvTgAaSh72oAw&tbm=isch&iact=rc&uact=3&dur=342&page=0&start=0&ndsp=15&ved=0ahUKEwjJldWupenPAhXLKcAKHZJDDzUQMwgdKAEwAQ&bih=638&biw=1366 , date of access: 20.10.2016

Management e-books: http://www.free-management-ebooks.com/faqst/boston-01.htm , date of access: 21.10.2016

MAN Trucks TCO: http://www.truck.man.eu/de/en/long-haul-transport/total-cost-of-ownership-_tco_-optimizer/TCO-Optimizer.html, date of access: 01.11.2016

MAN TCO WebApp: https://my.man-mn.com/tcowebapp/index.html#/truck , date of access: 14.11.2016

MAN Sales & Service: http://man.etpl.ch/truck/global/en/services-and-parts/maintenance-and-parts/service-contracts/tco-services/TCO-services.html , date of access: 14.11.2016

Economic Times: http://articles.economictimes.indiatimes.com/2012-06-1/news/32352375_1_truck-makers-generation-trucks-truckmakers, Date of access: 21.04.2016

MAN Trucks India, Products: http://www.mantrucksindia.com/products-service/products/man-trucks/man-tipper-range/overview/ Date of access: 24.05.2016

PEGASUS UK: http://www.pegasus.co.uk/downloads/marketing-materials/landed-costs-datasheet.pdf, date of access: 22.08.2016,

Farin Ratna Blogs: http://farin-farinratna.blogspot.co.at/2010/11/differences-between-cif-and-fob.html, date of access: 08.10.2016

NRCAN: http://www.nrcan.gc.ca/energy/efficiency/transportation/cars-light-trucks/buying/16755, date of access: 09.08.2016

MAN Worldwide: http://www.truck.man.eu/de/en/man-world/technology-and-competence/lightweight-construction/Lightweight-construction.html, date of access: 10.10.2016

8 List of figures

9 List of tables

10 List of abbreviations

AMW – Asia Motor Works

BCG – Boston Consulting Group

CIF – Cost Insurance Freight

CLA – Cargo Line Asia

CV – Commercial Vehicle

FOB - Free On Board

GDP – Gross Domestic Product

HCV – Heavy Commercial Vehicle

HP – Horse Power

JV – Joint Venture

MFTPL – MAN Force India Private Limited

MTB – MAN Truck & Bus, Germany

MTI – MAN Trucks India

TCO – Total Cost of Ownership

TG – Trucknology Generation

TGS- Trucknology Generation Small

11 List of formulae

Appendix