Building best practice automotive after sales network

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Building Best Practice Automotive After Sales Network:

The Volkswagen Case

Gerlinde Mikolik

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Building Best Practice Automotive After Sales Network: The Volkswagen Case

Doctor of Business Administration

June 2012 / 2016

Gerlinde Mikolik

Tilburg University

Abstract

Purpose – This thesis aims to analyze one of the most economically successful industries in Germany – the automotive industry – in terms of service operations and networks. Research of the automotive After Sales service network lacks the necessary fine details and industrial feedback. The purpose of this thesis is to present insights and lessons learned from studying the After Sales service network of Volkswagen in order to define a roadmap for further research and to discuss the needs of the sector.

Design / methodology / approach – The proposed research methodology relies on extensive external and internal research with a qualitative and quantitative approach. Based on structured, in depth interviews with 108 members of the network, ranging from the main decision makers to specialists involved in the processes of the After Sales service network, and our own direct observation, we arrive at the future After Sales needs of the industry. The objective of the interviews is to highlight the most important activities in the service delivery operations within the network. Using numerical data, Data Envelopment Analysis (DEA) is performed to determine the "efficient frontier" of service operations. From the important elements discussed and the best practices a set of key performance indicators are identified. In order to achieve an in-depth understanding of their general business models a benchmarking analysis was then carried out between six companies from industrial sectors complementary to the automotive business.

Findings – From the case study the authors identify the main success and failure key factors to consider in the After Sales service network. The study shows that this sector deals with variety and process complexity that are not so easy to describe. The study additionally indicates that existing models are either outdated or describe only partially the After Sales topics in the automotive industry. Furthermore, relying on current state of the art methods, the thesis highlights the focus of the research, particularly with respect to the development of a "best practice" network that captures the dynamics of After Sales activities in the light of new technological developments and the experience gained from the benchmark with other industries.

Originality / value – The identification of the success and failure key factors and their corresponding technologies, processes and human perspectives is aimed at providing links between theoretical models and practical implications for both academics and industrialists. The challenges and developmental areas for an After Sales service network are proposed in order to provide the basis for new network models that capture the state of the art dynamics and the evolution of automotive After Sales service operations.

Acknowledgments

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Many thanks too, to all the partners from the retail and wholesale businesses of the Volkswagen organization who were interviewed, as well as to the departments from the Volkswagen Group and Brand involved in the core processes analyzed. The list of at least 200 involved here is simply too long to mention each person individually.

My thanks go too to the interview partners in the benchmark phase. For reasons of confidentiality it is not possible to mention them here by name.

I gratefully acknowledge the administrative support from the CentER, the graduate program of the Tilburg School of Economics and Management, at Tilburg University, which permitted me to undertake this research. I would also like to thank the department of Econometrics and Operations Research for their administrative support and the very interesting discussions.

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Abbreviations

Abs.	Absolute
API	Current Product Information
AR	Augmented Reality
ASD	After Sales Department
AST	After Sales Technical Department
ATBAS	System Maintenance Enhancement
Autopart	Dynamic Parts Ordering System (retail)
B2B	Business to Business
B2C	Business to Customer
BER	Block Exemption Regulation
BEV	Battery Electric Vehicle
BM	Business Model
BTO	Built to Order
CEO	Chief Executive Officer
CM3	Contribution margin three
CROSS	Dealer Management System
CSS	Customer Satisfaction Survey
DAT	German Automobil Treuhand GmbH
DC	Distribution Center
DEA	Data Envelopment Analysis
DISS	Direct Information System Service
DMS	Dealer Management System
DSS	Dealer Satisfaction Survey
EBIT	Earnings before interest and taxes
ELSA	Electronic Service Information System
EPE	Every Part Every Day
EPB	Electronic powered pallet conveyor
ET 2000	Parts ordering system
ETKA	Electronic Parts Catalogue
EU	European Union
FAP	Problem solving process
FDM	Fused Deposition Modeling
FTE	Full-time Equivalent
Gen. rep.	General repair
GPS	Global Positioning System
HR	Human Resources
HU/AU	General inspection / Exhaust emission test
IACS	International Association of Classification Societies
IDIS	Dynamic Parts Ordering System (wholesale)
IoT	Internet of Things

IT	Information Technology
KBA	Kraftfahrt Bundesamt / Federal Office for Motor Traffic
KD nr.	Repair operation number
KLT	Electronic powered pallet conveyor for small parts
KPI	Key Performance Indicator
LCV	Light Commercial Vehicle
LI	Labour Intensity
M&A	Merger & Acquisition
MD	Master Depot
MDE	Mobile data compilation
MRO	Aircraft Maintenance Repair and Overhaul
NCBS	New Customer Buyer Study
NORA	Non-Organized Discount Beneficiary Buyer
NPS	Net Promoter Score
Nr	Number
NRC	Non Routine Cards
OBD	On Board Diagnosis
OEM	Original Equipment Manufacturer
OES	Original Equipment Supplier
OTC	Genuine Parts Centre
OTLG	(Volkswagen) Genuine Parts Logistic Supplier
PC	Personal Computer
PCC	Priority Customer Complaint
Q-Dept.	Quality Department
QR	Quick Response
R & D	Research & Development
RFID	Radio-Frequency Identification
ROI	Return on Investment
SA	Service Advisor
SAP	Parts Ordering IT System
SMS	Short Message Service
TA	Technical request
TCO	Total Cost of Ownership
TKP	Workshop Planning System
TPI	Technical Product Information
TPL	Technical Problem Solutions
TPS	Time Planning System
VAG Dealer	Name of Volkswagen Group Dealers used in the past
VAS 505x	Diagnosis device
VAUDIS	Dealer Management System
VDA	German Association of the Automotive Industry
VMI	Vendor Management Inventory

VR	Virtual Reality
VST	Volkswagen After Sales Technical Department
VW	Volkswagen
VZ	Distribution Centre
W & G	Warranty & Goodwill
WE	Warehouse Inbound Area
Wi-Fi	Wireless Fidelity
WPS	Time Planning System
WT	Maintenance Table
ZE	Time units

1. Introduction

1.1 Introduction: Service Operations in the Automotive Industry Business - Background and Motivation

This thesis aims to analyze one of the most economically successful industries in Germany – the automotive industry – in terms of After Sales service operations and networks. The international competition in this industry is intense. Technological innovations are quickly imitated by the competition as "good service" can set a brand apart by providing a unique experience and creating customer satisfaction. This results in customer loyalty, increased revenues throughout the distribution chain, and repurchasing.

Service in the automotive business sector is very competitive. Apart from legal regulations, the main challenges are new product technologies, IT, Internet, data usage – the so-called "Big Data", diverse and changing customer expectations, and the difficulty finding good employees. These challenges require new ideas and innovation in operations and organizations. There have been no major innovations in the product service operations and network for many years. The automotive industry, considering apart the technical IT support, advanced equipment and tools, still sells and services cars more or less as it did a hundred years ago.

In the automotive business in general, and in the Volkswagen Group in particular, we distinguish between visible processes – the so called "core processes" – and the processes invisible to the customer. The "core processes" have basically remained unchanged in the Volkswagen brand for at least 12 years. Yet repairs and parts costs in After Sales are continually increasing as many dealers use the profitable After Sales business to subsidize losses in other areas. Although this procedure is understandable from an entrepreneurial point of view, in the long-term, it leads to decreasing customer loyalty. The proposed research will use empirical data from the VW automotive group as a case study and from other service networks as benchmarks (IT, logistics and aircraft service).

The stakeholders are primarily involved in the service and parts divisions in the entire distribution chain including dealers, the wholesale market, the VW brand and Group and the After Sales division responsible for the German market.

1.2 Research question

Due to the aspects mentioned above, it can be asked how a service organization, particularly Volkswagen, can organize its service operations in the supply chain to increase output, efficiency, customer loyalty, satisfaction and profitability.

Main points to be addressed:

- Based on the analysis of four major processes in the After Sales business: repair process, warranty & goodwill, parts sales, and reverse service (or parts return process) what does the best dealer practice model look like?
- What are the main characteristics of a successful business?
- What can be learned from other industries (IT, logistics and aircraft service)?

- What new technologies and practices can be used and adapted to the specific needs of service operations?
- What are the best KPIs to control the operations at different levels?
- What does the structure and design of an integrated multi-attribute set of measures at every level of the service supply chain look like? The created model should be applicable to other industries too.

This thesis will explore, in depth, the contents of the points listed above.

1.3 Literature research

The literature reviewed addresses the existing best practices in the automotive and aircraft industry and the broad service sector in general.

Table 1: Literature Research (1)

Publication	Contractual relationships	Organization	Analysis set up	Business models Operational efficiencies	Product development Strategy	Process visualisation Time measure urements	Supply chain model	Performance measurement KPIs	HR
1	✓	✓		✓					
2		✓	✓			✓			
3				✓					
4	✓				✓				
5				✓	✓				
6		✓		✓		✓			
7						✓	✓	✓	
8								✓	
9		✓					✓	✓	
10				✓	✓			✓	
11		✓						✓	
12		✓		✓			✓		
13		✓							✓
14		✓		✓					✓
15		✓	✓			✓		✓	
16		✓							
17		✓	✓	✓	✓	✓	✓	✓	✓

The comprehensive literature overview can be found at the end of the thesis. For reasons that will be described further only one part of the literature was used for the main areas described in the literature research Table 1 above. In the literature research Table 2 the exact title and author are listed. It was ensured that all strategic, tactical and operational aspects were covered by the literature research.

Table 2: Literature Research (2)

	Publication and Key Learning's	Strategic	Tactical	Operation-al
1	Performance Contracting in After Sales Service Supply Chains (Kim, Cohen, Netessine; 2007)		✓	✓
2	Seeing the Whole mapping the extended value stream (Jones, Womack; 2003)	✓	✓	✓
3	Service, services and products: rethinking operations strategy (Spring, Araujo; 2009)	✓	✓	
4	Towards an operations strategy for product-centric servitization (Baines, Lightfoot, Peppard, Johnson, Tiwori, Shebab; 2008)	✓	✓	
5	Service Architecture and Modularity (Voss, Hsuan; 2009)	✓		
6	Understanding and Managing the Service Supply Chain (Ellram, Tate, Billington; 2004)	✓	✓	
7	Automotive supply chain models and technologies: a review of some latest developments (Coronado Mondragon, Lyons, Michaelides, Kehoe; 2006)		✓	✓
8	Consolidation of performance measures in a supply chain (Sambavisan, Nandam, Mohamed; 2009)			✓
9	Impact of the Global Economic and Financial Crisis over the Automotive Industry in Developing Countries UNIDO Working Paper 16/2009 P. Wad Copenhagen Business School		✓	
10	Performance measurement of the after sales service network - Evidence from the automotive industry (Gaiardelli, Saccani, Songrini; 2007)	✓		✓
11	After Sales Service Supply Chains: a Benchmark Update of the North American Computer Industry (Cohen, Agrawal; 1999)	✓		✓
12	A Process Reference Model for Service Delivery in After Sales Field Service Network (Hertz, Finke, Verhaselt; 2011)			✓
13	The Fifth Discipline (Senge; 2004)	✓	✓	✓
14	Nobody ever gets credit for fixing problems that never happened Creating and sustaining process improvement (Repenning, Sterman; 2001)		✓	✓
15	Critical Chain (Goldratt; 1997)	✓	✓	✓
16	The Checklist Manifesto (Gawande; 2009)	✓		✓
17	The Toyota Way (Liker; 2004)	✓	✓	✓

Table 3: Overview of publications and key learnings

Publication and Key Learning's	
1	**Performance Contracting in After Sales Service Supply Chains** (Kim, Cohen, Netessine; 2007) • how a different contract can reshape the service support and supply chain • the key idea is to replace fixed-priced service offers by payment related to the product availability by tying a supplier's compensation to the output value of the product generated by the buyer • the approach reduces cost of ownership and increases the contractual flexibility • an important prerequisite for the successful implementation is to change the focus from the individual service actions and parts levels to the outcomes, the level of product availability
2	**Service, services and products: rethinking operations strategy** (Spring, Araujo; 2009) • firms do not give enough attention to the management of supplementary services; they do not know what customers want, how much they cost to provide, which to offer as a standard, which as an option, how to price them • four business models were identified: embedded services, comprehensive services, integrated solutions and distribution control • performance- based logistics involves the supplier retaining ownership of the capital asset, and being paid according to usage, whilst incurring the costs of maintenance and provision of spares; relocates risk, encourages better performance and cost reduction instead of depending on high-margin spares sales
3	**Towards an operations strategy for product-centric servitization** (Baines, Lightfoot, Peppard, Johnson, Tiwori, Shebab; 2008) • the authors recommend focusing on the customer and not on revenues or capacity utilization • in the aerospace sector the engine manufacturers developed a product-centric servitization by moving from transactional to relational relationships; they have come to recognize that, in the past, the marketing of services was different to that of products, but products and services are often inseparable • the starting point is always to understand customer value requirements by using the marketing profile • in service operations value is delivered through skilled employees who have good customer relationship and communication capabilities • services, like customer segmentation must also be categorized; the authors suggest categories of product, service and use oriented services • the authors recommend a small inventory (in After Sales parts and special tools), short repair times and rapid delivery of products • it is important to process as little information as possible, to provide a pure signal and no noise by pulling down info from top management levels to operative levels and to define the shortest possible lead time by creating continuous flow • the ideal state is achieved when all actions create value, there are zero defects and consumer response is instantaneous
4	**Service Architecture and Modularity** (Voss, Hsuan; 2009) • competitiveness implies the possession of unique service modules or elements not easily copied in the short-term by competitors, the ability to exploit these through replication across multiple services and for multiple sites and the presence of a degree of modularity • the service design or architecture has six dimensions: product modularity, component complexity, product platforms, loosely coupled interfaces, component commonality and number of components, and two domains: process and supply chain

Publication and Key Learning's	
	• an important element in service design is AGILITY, the ability to respond rapidly and effectively to changing market demands • the general principle for cost-effective customization is that standardized processes should be designed first and customized sub-processes should be developed later • modularity has five important dimensions: interfaces, commonality sharing, degree of coupling, platform, systems and components • operational efficiency can be achieved through division of labor, a cheaper labor force and standardized training
5	**Understanding and Managing the Service Supply Chain** (Ellram, Tate, Billington; 2004) • supply chain management is the management of processes, information, goods and funds from the earliest supplier to the ultimate customer, including disposal • human performance is unique regardless of training and background • services are often more difficult to visualize and measure; historically "service level agreements" have not been as precisely and finely tuned as specifications for manufactured goods • a lack of a supply chain management is linked to the lack of control over service purchases • the service supply chain is wrought with uncertainty because services cannot be inventoried, a focus on capacity levels and flexibility vs. inventory buffers is required. There is a tradeoff between capacity level and variability (customer waiting and service time) • outsourcing brings advantage in scope and scale but also increased costs associated with financial controls, service level management and procurement costs. In areas heavily outsourced control is quite limited. As long as organizations are not giving up core competencies, or business control, and continue to improve on ability to coordinate and control a global enterprise, the outsourced services can continue to be a core competitive advantage
6	**Automotive supply chain models and technologies: a review of some latest developments** (Coronado Mondragon, Lyons, Michaelides, Kehoe; 2006) • a measurement tool has to capture the state of the supply chain in terms of: synchronization, bullwhip effect, pipeline inventory, cycle times, stock-out and backorder incidents, sunk costs, invested capital, and ROI • business drivers affecting supply chain management are: cost management, constant change in customer needs, unpredictable new business opportunities, environmental sustainability, adoption of IT resources and/or manufacturing technology, performance and stabilization, reduction vs. elimination of waste, slim profit margin • new technologies, such as web services, wireless applications and advanced software applications, can help to facilitate supply chain collaboration
7	**Consolidation of performance measures in a supply chain** (Sambavisan, Nandam, Mohamed; 2009) • examples of performance measurement criteria
8	**Impact of the Global Economic and Financial Crisis over the Automotive Industry in Developing Countries** **UNIDO Working Paper 16/2009** P. Wad Copenhagen Business School • a good proposal to structure the value chain in up- and downstream parts • in the upstream part we have suppliers and business services • in the downstream part we have: logistics, transport, vehicle financing and insurance, dealers, after sales services and recycling
9	**Performance measurement of the after sales service network – Evidence from the automotive industry**

	Publication and Key Learning's
	(Gaiardelli, Saccani, Songrini; 2007) • service represents "one of the few constant connections that customers have with a brand" influencing customer satisfaction and loyalty • as a source of competitive advantage and business opportunity, after sales requires a shift from a traditional product centric view, in which after sales is considered a "necessary evil", to a customer centric view • the coordination of complex global networks of company activities has become a primary source of competitive advantage • a supply chain measurement system must emphasize three separate types of performance resources that have different goals: resource, output, and flexibility measures
10	**After Sales Service Supply Chains: a Benchmark Update of the North American Computer Industry** (Cohen, Agrawal; 1999) • obsolescence is the largest cost component for managing parts inventories (up to 34% of the inventory investment), especially for the non-enterprise segment • companies with relatively lower inventory investment, relative to service revenue, have high parts availability levels suggesting that better management practices can lead to both: lower inventory levels and high customer service • pooling, sharing of inventory across locations at the same level, has the potential to increase inventory turnover and customer coverage
11	**A Process Reference Model for Service Delivery in After Sales Field Service Network** (Hertz, Finke, Verhaselt; 2011) • activities were categorized according to their value adding characteristics in the service network • the most essential for delivering service to the customer are productive activities that can be divided into three categories: administrative, technical support and transfer activities • indirect activities, such as organizational meetings and training, are not directly adding value, but might be necessary or could create value by improving qualification in the network
12	**Nobody ever gets credit for fixing problems that never happened** **Creating and sustaining process improvement** (Repenning, Sterman; 2001) • the performance of any process depends on two factors: the amount of time spent working and capability or improvements over time • failures when introducing new methods has its roots in how the introduction of a new improvement program interacts with the physical, economical, and psychological structures in which implementation takes place; it could be either a human resources vs. leadership problem or a systemic problem, created by the interaction of tools, equipment, tasks and managers • the system structure leads even talented managers to believe that their problem lies in the attitudes and characters of people that work for them • a problem is the "Capability trap" when organizations are stuck in a vicious cycle of declining capability; the proposed solution is increased improvement and maintenance

The other literature listed at the end of the thesis could not be used because some publications were outdated, do not reflect best practices, or the procedure was described abstractly, making the practical applicability extremely difficult. Having reviewed many articles dealing with business models, steering and human resources, we shaped the framework of the analysis by using the main steps described in *Seeing the Whole by* Jones, D., & Womack, J. (2003) and Jeffrey K. Linker's *The Toyota Way* (2004). Whyle A. Gawande's *The Checklist Manifesto* (2009) was helpful in developing the systematic approach in interviews by using a checklist so that, after the interviews, the retail business units visited could be easily compared; E. M. Goldratt's *Critical Chain* provided valuable information and insight when constraints of business units were identified. Also remarkable was P. Senge's *The Fifth Discipline* (2004); besides gaining valuable insights by using the eleven laws in finding explanations for the actual situation in the businesses visited, the book impressively demonstrated the necessity for every business to become a learning organization in order to master future challenges. Good guidance in looking for supply chain models was provided in articles such as *Automotive supply chain models and technologies: a review of some latest developments,* Journal of Enterprise Information Management by A.E. Coronado Mondragon, A.C. Lyons, Z. Michaelides, D.F. Kehoe. One focus of the literature research was to identify the KPIs that best describe the performance of an organization or business (see source 7 to 11, 15 and 17 in the literature Table 2).

While papers such as Implementation of a *Lean Model for Carrying out Value Stream Mapping in a Manufacturing Industry* by Ramesh, V. were useful as a surrounding paper, the best practice articles and business and steering models listed under points 1, 4, 5, 13, and 14 will be used in the third step in developing an integrated framework for the After Sales business.

The aim of this thesis is the development of an integrated framework for efficient service operations, including recommendations for the network design, taking into account all stakeholders in the supply chain.

1.4 Approach

The foremost idea in defining the research question was based on the observation that the automotive After Sales business could be improved by using and adapting principles and methods used in other industries and in the field of Business Operation research. The first step after making such an observation is an extensive external and internal literature research. It is essential to base empirical data on theoretical assumptions and therefore to verify or modify the underlying theories.

According to the Psychology Writing Center (2005) there are two different approaches to conducting a literature review. Firstly, an area of research is chosen, all relevant articles and books are read and organized in a meaningful way. Secondly, a topic or point in support of the researcher's line is chosen and studies in accordance with the chosen line of argumentation are then selected.

In this thesis the second approach was predominantly used.

External literature sources were books, papers and articles in well-known magazines. Internal sources were process descriptions, studies and the reporting system.

As already mentioned under point 1.2., a desk-based study and models used in the literature were not sufficient, not only because of the complexity and variety of the processes and businesses that often cannot be covered by standardized descriptions, but also because empirical data, in order to be understood, need a connection to theoretical data.

The second step was in-depth interviews with employees and specialists involved in the four processes analyzed, and direct observation. According to Bryman (2004) walking around and observing is not sufficient when the tasks are not simple. The collection of observational data can range from indirect, informal and casual data collection to direct and structured observation. In this research direct observation consisted of the collection of information on subject performance either directly, by observing and recording processes, or from objective recordings of managers and specialists.

Further, a standardized checklist was developed for the interview.

This procedure will also be applied for the benchmark with other industries. In a further step the best elements from the interviews will be combined to create the actual best practice dealer model. Based on the results of the benchmark with other industries, this model will then be improved on in the fifth chapter. Finally, the model will be abstracted and generalized so that it can be applied in other industries too.

1.5 Main subject of the study

The focus is on the service operations in the automotive industry with a detailed analysis of four major processes in the After Sales business (mentioned above) in order to find the current best dealer practice model. The research activities are based on the VW brand and the German market. For this purpose nine dealers of varying size from three regions were selected. At the wholesale level two regions were analyzed and interviewed. All relevant persons involved in the functions of the processes analyzed were interviewed.

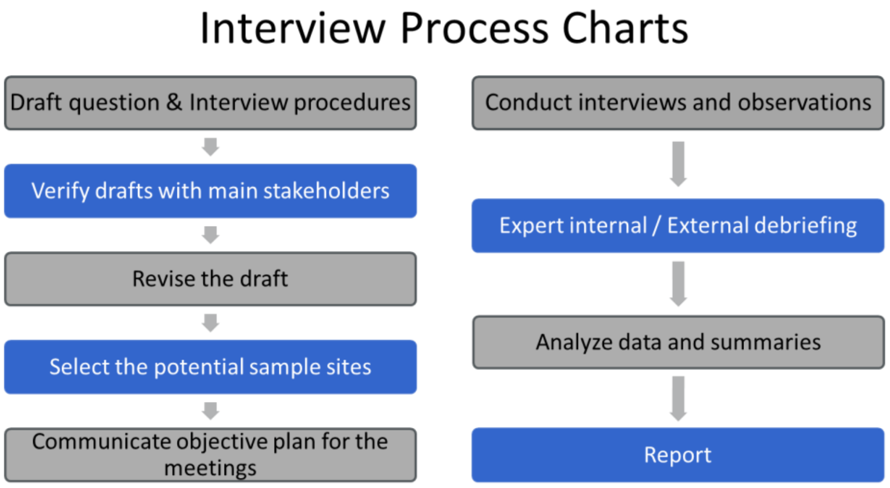


Figure 1: Interview planning, main process steps

1.6 Structure of the thesis

The introduction provides background information regarding the research question and problem to be solved, the approach used and the subject of the study. The following points will also be addressed in this thesis:

- Details regarding the environment of the automotive industry in the context of VW are included in chapter two.
- Chapter three contains information regarding the interview approach and methodology used, the time needed and difficulties experienced.
- We describe the core processes analyzed in the service operations in chapter four. Apart from the steps and operations, we also provide information regarding time measurements.
- In chapter five, in addition to an overview of KPIs used, we describe the dealers' current best practice model by combining the best elements from the dealer sample visited followed by a discussion reflecting the results described in chapters three and four, discussing effects, opportunities, and feasible scenarios. The chapter closes with a conclusion that contains a synthesis of the research until that stage, by emphasizing the usefulness of the topic and preparing the ground for the next research steps.
- Chapter six contains the statistical methods used to evaluate the efficiency of the retail businesses visited by using a multi-criteria approach and comparing the results of the new method with the two-criteria method usually used in reporting. The chapter closes with a recommendation for the next steps to be taken.
- In chapter seven of the thesis we describe the benchmarking process, the checklists used, the insights gained and the conclusions reached after a qualitative analysis of the insights. The businesses we analyzed came from the following sectors: IT services and consulting, automated manufacturing and robots, aircraft maintenance and engineering, freight transportation & warehousing and distribution & supply chain solutions, and the high tech industry.
- We address all the relevant topics concerning the future strategic positioning of After Sales in chapter eight, beginning with topics that describe customer expectations regarding service in 2020-2025, and the product/service portfolio, including added value services. In a comprehensive holistic strategic view we then indicate the short, middle, and long term activities necessary to achieve the vision and the measurable targets on the path to the final goal. The chapter closes with a summary.
- Finally, in chapter nine we summarize the evaluation of the research work, briefly discuss the methods used and make recommendations for future research.

The outline of the research is illustrated in Figure 2.

Figure 2: Outline research

2. About the environment of the automotive industry

Key characteristics of the automotive industry in Germany, the VW Group, OEM and at the wholesale level in the German market

Before we look more closely at the key characteristics, we must first briefly review the current situation in the German automotive industry. The economic results of the German automotive industry can be seen as a significant success because the industry is able to satisfy customer expectations in terms of quality, safety, efficiency, comfort and image. Citing VDA2, every seventh job (approximately 720,000) depended on this industry at the end of 2012. The automotive sector is so dominant due to outsourcing activities from the production of components, to development activities, training, advertising etc. and including the wholesale and retail distribution network. Nowadays, many other businesses depend or rely, as suppliers, on the success of this sector. Important economic and social factors that contribute to the economic success of the automotive industry in Germany:

Several factors in the automotive industry have an influence on the After Sales business. The most important are: customers, business network structure, technology and internet, human resources, regulations and trade restrictions. In what follows we describe the key characteristics of each element.

Customers

- Higher share of business and fleet customers than private, with specific requirements and greater bargaining power
- Polarity of customers' behavior due to dissimilarity of income – two dominating customer groups – comfort oriented high income customers and price sensitive low income customers
- Individualization: High need for differentiation and individualization in services and products.
- Declining buyer loyalty to brands and branded networks

Business network structure

- Market: Stagnant service revenues in mature markets due to low frequency of repairs, despite higher number of vehicles and higher costs for repairs
- Competition: Intense competition through aggressive growth strategies of workshop chains
- Distribution channels: Market introduction of alternative distribution channels supported by the Internet
- Distribution network: Consolidation of independent workshops and smaller family businesses for the benefit of large firms and chains. Establishment of cross-national players on wholesale and retail levels as well as cross-national customers

Technology - Product technology

- Technological innovation: emphasis on ongoing development of existing technologies, but also new technologies such as hybrid electric engines
- Product technical futures such as electrics / electronics / mechatronics: Significant higher share of electrics, electronics and mechatronics in products that further increase the importance of diagnostic expertise
- Product Cost of Ownership / warranty: Importance of Cost of Ownership and warranty costs, requiring high quality and durability of vehicles and spare parts

Workshop technology

- Increasing investments in diagnostics, reduced possibility of cost transfer to retail
- Workshop operations: High importance of efficient service processes for customer satisfaction and cost effectiveness, and to prevent repeated repairs in the dealership

IT Systems and Internet

- High importance of supportive IT-systems, as these can be seen as competition and cost factor
- Strong affinity to Internet and customer preference for online service transactions
- Important source of information that influences customer decisions
- Social networks are becoming more important for advertising and influencing opinions
- BIG DATA vs. business analytics, gain useful information from the data deluge.

Human Resources (HR)

- Satisfying the demand for specialists difficult due to fluctuation and increasing requirements on quality,
- High relevance of comprehensive HR-management in dealerships.

Regulations and trade restrictions

These are numerous. Most important to the automotive business is BER (Block Exemption Regulation) a competition-restricting law that regulates the sales and service of cars in the EU. The current situation in the automotive business sector can be summarized in a few words; besides legal regulations (BER, emission laws, etc.) the main challenges are new product technologies, diverse and changing customer expectations, and the difficulty finding good employees. These challenges require new ideas and innovation, especially in operations and organizations. There have been no major innovations in the product service operations and network for many years. Although the business is so successful, there have been no significant developments – only incremental changes.

Let us now turn to Volkswagen. According to the Volkswagen Group's 2011 financial statements, the Group is one of the leading automobile manufacturers worldwide, having sold 8,361,294 vehicles in 2012. The sales revenue was 159,337 million Euros and the profit after tax was 15,799 million Euros. The market share increased by 14.3% to 12.3% worldwide. Presenting an attractive and innovative range of products, the Volkswagen brand sold more than five million passenger cars worldwide in 2011, an increase of 13.1 percent over 2010. The sales revenue increased in the same year by 18% to 94,690 million Euros and the operating profit by 74.7% to 3,796 million.

In the German market the brand sold approximately 10% of all cars produced in 2011. According to the Kraftfahrt-Bundesamt (KBA) (2012) on 1 January 2012 a total of 9,111,165 cars of the Volkswagen brand were officially registered, representing a market share of 21.2 %, making it the market leader. In March 2012, Volkswagen's distribution network in Germany comprised, in total, 1,161 full function dealerships and 1,205 contractual workshops. 556 of these workshops also had an agency contract. In this distribution network Volkswagen works with independent entrepreneurs. 46 businesses belong to the Group – the so called own retail businesses. The Group volume brand Volkswagen has the distribution network with the highest density of all OEMs in the German market.

Volkswagen's German market is characterized by stagnant service revenues, as in all mature markets. Due to increasing vehicle quality the frequency of repairs is decreasing, but in these markets in general, and in Germany in particular, the profits are high because of the larger number of vehicles and the higher costs for repairs. An increase in the market share in mature markets, even by a few percentage points, is difficult. One major inhibiting factor is the strong competition.

As a market leader the brand faces strong competition, especially in After Sales, from Fast Fit repairers/repair shop chains. The competition in segments II and III, through aggressive growth strategies of workshop chains, is intensive. We observe the development of few, but strong chains (examples of chains based on their frequency: Maisterhaft, 1a autoservice, Bosch Car Service, point S, AutoMobil, PROFISERVICE, AUTOFIT, ad-AUTO DIENST, A.T.U., etc.). In recent years, we have also observed an upgrading of services: increased intensity of competition in segment I, resulting from the expansion of services provided by Fast-Fit repairers, extending to full service garages, offers for premium segment cars and offers for fleets.

Independent workshops are also competing for market share in After Sales, but they are not as well organized as the chains. The procurement of technical repair information or diagnostic devices is costly, and they do not have the bargaining power of the chains when purchasing parts. In segment III, where the major criterion for the customer is the price, branded workshops can still make money by selling, through NORA, parts to the independent workshops and by helping them with technical repair information. Branded workshops are not able to offer the same, or lower, prices than the independent workshops because of the standards they have to maintain. We have also observed increased intensity of competition through integrated After Sales strategies of other OEMs (service as communicated differentiation, e.g. 7 years warranty by Chrysler GERMANY) where the warranty is used as a strategic instrument to increase customer satisfaction and loyalty, but also to push sales. Volkswagen's main distribution channel is through contractual wholesale and retail. The introduction, by OEMs, of alternative distribution channels online for accessories and parts has already been implemented, but there are at least two factors inhibiting this development. Firstly, customers seldom have the knowledge to fix or change parts themselves, so they have to go to a workshop and secondly, the contractual partners, wholesale and retail, perceive the direct distribution channels as internal competition. There is an alternative solution such as helping the retail business to set up an online shop. Regarding historical development of network structure, a common retail organization of the Volkswagen and Audi brands, called the VAG dealer, was developed in the '70s. The network had a high density, so that a customer could easily reach a workshop, and this boosted car sales. In subsequent years, when the company bought Seat, in 1986, and Skoda, in 1991, these brands were also sold and repaired by the VAG Dealer organization. At the beginning of the '90s, when brand image became more important, it was decided to separate the common network as much as possible. This process took several years as contracts had to be canceled, criteria defined for the network reorganization, and new contracts, with standards and investment necessities, had to be drawn up. After a period of monitoring, it has since been ascertained that the Volkswagen service customer in Germany is prepared to drive up to 30 km, or half an hour, to the next branded workshop. In contrast, the sales customer is prepared to drive longer distances to buy a car as a new car of the Volkswagen brand is bought in Germany, on average, every six years (NCBS, 2008; VW Group Internal Analysis, 2007/2009).

A permanent task of wholesalers and OEMs is to optimize the distribution network with the target, not only, of having enough capacity via the right format, from a customer perspective, for the different needs (full function dealership, Direct Express for basic service repairs etc.) but also, of maximizing market exploitation from the perspective of dealers and investors and, at the same time, reducing investments and operational expenses. Currently, a core element is the market area concept, "to form a cohesive market area based upon customer behavior and sales and service potential, while preserving the investor and wholesale perspective" (Volkswagen Retail Strategy - The Handbook, 2012). The target is to reduce the number of contractual retail partners in metropolitan and urban areas, enabling the investor to invest in and manage multiple locations, in order to maximize synergies. In rural areas the synergies will not be that significant, and it is also possible to operate in a multi-brand dealership or workshop. Because this thesis emphasizes the Service operations, I will concentrate only on the future After Sales formats. These are:

- Full function operations format with all service offerings "100% service".
- "100% - X" where some service packages are deselected from the format above and it must be guaranteed that the deselected packages are provided by other locations in the local network. Examples of deselected packages: engines, convertible roof, driving assistance systems, hybrid technology etc.

Body and paint is not part of the full function operation, but is an additional service that can be offered.

The question to be answered is to see how other industries that show similarities to the automotive industry have found better solutions allowing them to react more flexibly when faced with capacity fluctuations.

3. Details of Interview Methodology, approach used

3.1 Study Design

The thesis attempts to address the question: How can service set Volkswagen apart from other brands by increasing customer satisfaction and loyalty, simultaneously increasing revenues in the distribution chain, taking into consideration the trends and the current situation described above?

3.2 Stakeholders

The information was gathered from management and from those specialists involved in the processes which are the subject of the analysis at Volkswagen Brand in the German market. The following functions were involved:

- Retail: Manager, After Sales Manager, Parts Manager, service advisor, warranty specialist, workshop manager, parts employee, technicians, info counter staff
- Wholesale: Managers and employees of the functions involved (market management, service marketing, technical department including warranty, logistics, IT department)
- Group/OEM: Managers and employees of the functions involved (concept departments, technical department including warranty, logistics master depot Kassel)

Depending on the content of the proposals in the eight and ninth chapter, some of these functions and managers will be able to implement necessary measures. The extent of the implementations will depend on the value of the necessary investments and expected benefits.

3.3 Methodology

Regarding the scientific focus and scope, the research moves from the operational perspective of analyzing process efficiencies towards a more strategic perspective of network structure. It starts with an industrial exploration and is completed with a comprehensive analysis of service operations in automotive networks based on the empirical data from the VW automotive group and best practice examples from other service networks (IT, aircraft, and logistics companies). This serves as a platform for concentrating on the final analysis and synthesis of those concepts and theories particularly important to the restructuring of networks.

After a comprehensive analysis of the relevant literature a checklist was developed containing questions to be asked and topics to be analyzed in all business units and departments interviewed. This checklist helped to discuss all relevant points systematically, avoid forgetting issues and standardize the interviews, enabling a comparison. The main method used was direct observation, real-time measurements of the process steps and in-depth interviews conducted with all relevant personnel. To reduce time and costs it was decided to analyze nine dealers vs. service businesses of varying size. Three large, three mid-sized and three small businesses were chosen. To assess the differences between the regions in the German market and to obtain a more realistic picture, the businesses were located in three different regions. Other selection criteria for the retail businesses were:

- All location possibilities must be covered: large cities, mid-sized cities and rural areas
- The majority selected were privately owned, but one VW dealership was included
- There were differences in the general management of the businesses as the majority of the big dealerships had employed professional managers, whereas the mid-sized and small dealerships, with one exception, were manager-owned businesses
- All locations had more than one VW Group brand contract, either in sales or after sales. In terms of processes and functions there was no distinction
- The business should have covered all relevant functions from sales to After Sales. This was only achieved in 33% of the locations.

The After Sales processes analyzed were first mapped after the internal literature research and the existing process documentation had been verified, adapted and modified in the nine visits at retail level. Besides detailed process steps with time measurements, general data were compared starting with organization, number of locations, employees' contractual details, services provided, performance related KPIs (financial and operational) and customer satisfaction KPIs.

The emphasis was on finding bottlenecks and improvement potential primarily in the business units visited, but also at wholesale and OEM level. At wholesale level the comparison could be made only partially and based on two regions. The main scope of the comparison was to identify the "ideal retailer" based on best practice examples experienced at the nine dealers. Based on these results, connections between operational KPIs were identified. The findings of the analysis will be discussed with the main stakeholders in the After Sales divisions of the Group, the OEM and the wholesale German market. Results are clustered in different categories:

- those with a general character that must be addressed at Group level, internationally
- those at OEM level, taking into consideration similarities between markets or best practices, that can be transferred to other markets
- those to be addressed at the wholesale level, such as national programs for all or varying retail categories; an adaption to other markets must be established
- finally, individual results and measures for retailers to be monitored at the wholesale level.

The interview process was conducted as follows:

- At the wholesale level the interviews were conducted at headquarters and in two of five geographical regions. This also applied to the logistics function which is bundled in a separate company, owned to 52% by the VW Group. The other owners are large dealer groups.
- In terms of logistics, the so called OTLG, it was suggested that two regions best cover the diversity of the wholesale functions in the analyzed market. At the OEM level all departments that cover the processes analyzed were visited and interviewed. The mentioned checklist was partially used at wholesale and OEM level too. At the retail level questions were put to those responsible for the different functions. The average time needed for an interview at the retail level varied because of the business size. The average time needed for the analysis and interviews in big dealerships was 8-10 hours, in mid-sized dealerships 7-8 hours, and 5-6 hours in small dealerships.

- The interviews always started with the General Manager and continued with the After Sales Manager and Parts Manager. Next, all necessary persons involved in the four processes analyzed were interviewed and time measurements made – at least two per operation step. The sequence was in accordance with staff availability and daily work priorities.
- The first visits and interviews took place in May 2013 and the last ones were conducted in December 2013. A further factor, besides availability, was the dimension and the complexity of the organization. Often, after interviewing the necessary persons involved in the processes, it was established that additional people had to be interviewed for a deeper understanding. At the wholesale level approximately ten days were necessary to interview all the necessary managers, employees, and specialists. At OEM and Group level seven days were necessary. At the wholesale, OEM and Group levels the interviews were spread over an interval of eight months.
- The interview checklist had 31 questions starting with general information about the business or department size, location, organizational structure and service provided. This was followed by questions regarding processes, IT systems used and process costs. Finally, steering KPIs and communication issues were queried. The checklist can be found in Appendix 1.
- For time measuring a stop-watch was used and, starting with the third dealership, a voice registration device was used in order to better capture all relevant points and to speed up the process. In all visited locations a minimum of two people were interviewed about the operations and process steps.
- Regarding KPIs the target was to have a minimum of two sources that could deliver the same KPI. For example, for parts revenue two sources were compared: firstly the service analysis and secondly the values, which are saved in the IT system FAKT.

An interview statistic is provided in Table 4:

Table 4: Interview statistics

Nr	Level value chain	Size	Nr. Of interviewed people
1.	Retail	Big	23
		Middle	18
		Small	15
2.	Wholesale		37
3.	OEM & Group		15
	Total		**108**

In these first three chapters the **major emphasis** was on the research question, the structure of the thesis and the approach and methodology applied. Finally, the automotive industry key characteristics were described and analyzed. In the next chapter the key After Sales processes in the Volkswagen network will be analyzed.

4. VW Retail Processes

In this chapter the main After Sales process will be described and analyzed, starting with the interaction with the customer and continuing with the necessary activities at the wholesale and OEM level to ensure that everything runs smoothly in front of the customer. Due to resource-related issues and time constraints, the analysis is qualitative; the sample at the retail level was limited to nine businesses in three regions, but these were all relevant and representative of the German market.

In the nine retail businesses visited the first process analyzed was the repair process, including repeat repairs.

4.1 Repair Process

The diagram below indicates the main process steps. **Appendix 2** contains the detailed process steps, including time measurements, location and IT systems. There are differences in execution between the businesses analyzed regarding task division, time taken and quality. Repair process retail

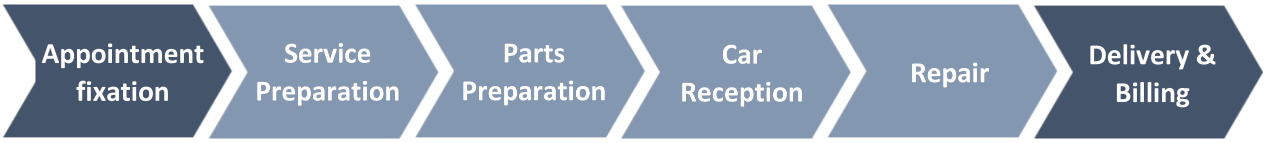


Figure 3: Repair, main process steps

<u>Step one</u> – an appointment is made when the customer makes contact. This can be done by phone, online or in person. In two thirds of the cases appointments are made by the Info Counter employees, and in one third by the service adviser; this applies to small dealerships or workshops where employees have to fulfill more functions. In almost all cases IT systems recommended by the Group and OEM are used for scheduling (TKP and WPS). There are differences in dealer management systems (DMS) used. Two of the large dealers, belonging to chains, use DMS developed and adapted for their own organizations (CARE and Dr. Hoffmann). The other businesses use the recommended systems CROSS or VAUDIS.

According to the service core process description the following information must be checked:

- verify or register (new) customer data (customer contact details)
- verify or register (new) car data (license plate, car identification code, car repair
- history, last appointment, wheel change, HU/AU, number of kilometers driven)
- note problem as described by the customer in DISS
- clarify customer mobility - workshop and service adviser capacity.

Then, in agreement with the customer, an appointment is made with a reminder to bring all necessary documents – vehicle papers and service history. There are small differences in procedure between the mid-sized/large dealerships and the smaller ones, but all follow the core process of the brand. The time needed varies from between 2-3 minutes up to 10-15 minutes when the customer is new and all data have to be registered. For regular customers the information need only be verified which takes less time. Regarding the resources needed for this operation: mid-sized and large dealerships employ 3 to 5 employees, often with part-time contracts and helped by apprentices. In small businesses there is 1 person helped by the service adviser.

Table 5: Repair process step one

	Process step	Time min.	Comment	Resources	Comment
Step 1	Appointment fixation	2-3	regular customer	3-5 employee	in mid-sized/large dealerships often with part-time contracts and helped by apprentices
		10-15	new customer	1 employee	in small dealerships helped by the service adviser

The number of dealerships visited is too small to claim statistical significance in quantifying the contact channels, but according to the questioned businesses, these days, 80% of customers contact the dealership by telephone, 15% come in person and only 5% use the Internet.

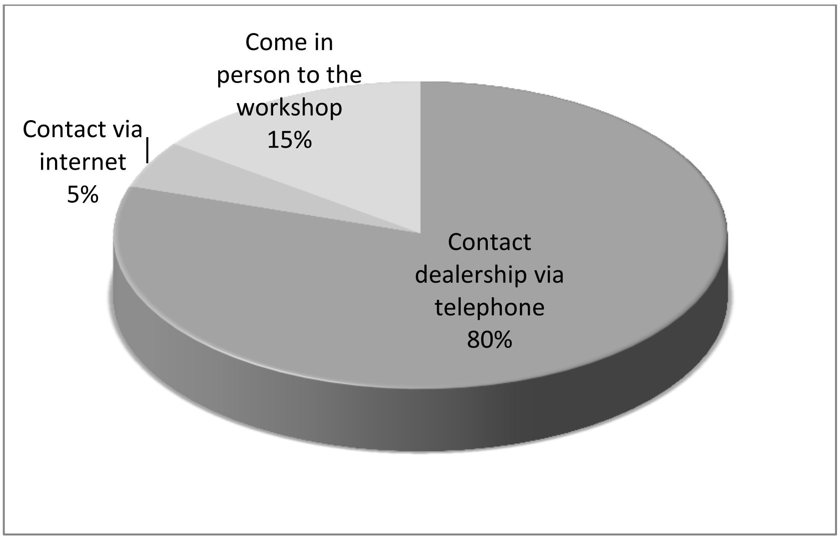


Figure 4: Ways and frequencies to contact the dealership

Therefore we can conclude that the customers in the German market are conservative; new processes, such as the Internet, cannot be easily introduced.

Step two – appointment disposition is carried out, in the majority of dealerships (80%) together with step one, as the necessary operations are:

- verify customer and car data,
- record the problem in DISS,
- check for recalls in ELSA,
- check workshop and service adviser availability.

Order preparation is carried out at this point in only a few cases. If appointment making and disposition is split and carried out by different functions (as is the case in 20% of the workshops, a mid-sized and a large one) it takes between 1 and 4 minutes. On average 10 to 25 appointments are made per employee per day (Large Dealer 1 very professional). 1 to 2 people, in overlapping shifts, are engaged in this activity and, if necessary, an employee from the info counter assists them. Steps one and two take 10 – 20 minutes in total and if appointment preparations are also carried out it takes 23 minutes.

Table 6: Repair process step two

	Process step	Time min.	Comment	Resources	Comment
Step 2	Appointment disposition	1-4 10-20	in 20% of the cases done by a separate function in dealerships where step 1 and to are done together	1-2 employee 1 employee	in mid-sized/large dealerships in overlapping shifts if needed with help from info counter

Step three –appointment preparation is usually completed by the service adviser, but also by dispatch, info counter and, in one case, by the parts employee. The general problem here is that only the service adviser has any technical qualifications. Order preparation completed by non-technical staff works best when repair packages are defined.

The main operations here are:

- open the customer job card (for 80% of the cases it takes 1-2 minutes – up to 5 minutes when done by info counter – the system used is the DMS)
- check parts availability (1-3 min up to 5-6 min in the case of repeat repairs, system used is ETKA); parts not available in stock are ordered 2-3 days before the appointment - prepare the necessary documents (on average this takes 3 min and 5 in case of repeat repairs; system used is the DMS)
- recording a DISS comment is mandatory in cases of warranty repairs and desirable in other cases (one comment takes 2-3 min, in cases of complex repairs or accidents up to 30 min and the system used is DISS)
- read necessary TPIs.

Table 7: Repair process step three

	Process step	Time min.	Comment	Resources	Comment
Step 3	Appointment preparation	5-40	5 min. if done by the SA and only 1 part necessary 40 min. in case of accidents	Service Adviser (SA)	the number of service advisers depends on the size of the organization

There are different ways to complete the order preparation. In some businesses it is done immediately after appointment making and disposition, in others, during the day, as time allows.

In most cases the service adviser needs an hour a day to prepare all job cards for the following day.

Step four – car reception (termed at Volkswagen "Dialog reception") and can be more precisely termed car and customer reception.

The following operations are part of this step:

- welcome customer and discuss job card (check documents, no. of kilometers and customer mobility which will be done at the info counter). This takes on average 5 min and 10 min in case of repeat repairs
- the car is then driven to the dialog reception area. Before the vehicle is put on the lift, the number of kilometers driven and, ideally, the wash wipe are checked. This process takes 10-15 min; with a special form 5 min
- complete necessary documents after verifying the car
- summarize findings, arrange delivery time, print order to be signed by the customer. The last two operations take 3-5 min

Total step takes between 20 and 30 min, 20 min when reception is not carried out. It is completed by the service adviser and the systems used are the DMS, ELSA, ETKA, and DISS when additional points have to be included.

Table 8: Repair process step four

	Process step	Time min.	Comment	Resources	Comment
Step 4	Car reception	20-30	20 min. if a good preparation was done or a special form is used	Service Adviser (SA)	the number of service advisers depends on the size of the organization

Good coordination between the steps, appointment making, appointment preparation and car reception, is crucial for providing good service to the customer.

Step five – car repair is executed by the workshop.

The operations here are:

- diagnosis,
- car repair,
- finish 2nd page of DISS comment, in case of warranty attach the completed green label to the damaged part, package the warranty part and deliver it to the warranty specialist.

If necessary, questions are addressed online to the wholesale technical support. The wholesaler has two hours to answer the questions. In most cases they are answered more quickly.

At wholesale level 53 experts are responsible for 2,400 service points and approx. 32,000 technicians. The experts have workshops and analysis devices identical to those of the dealers. In 1 month the wholesalers receive 8,400 technical requests plus 3,000 paint requests, totaling 11,400 requests / month or 136,800 / year.

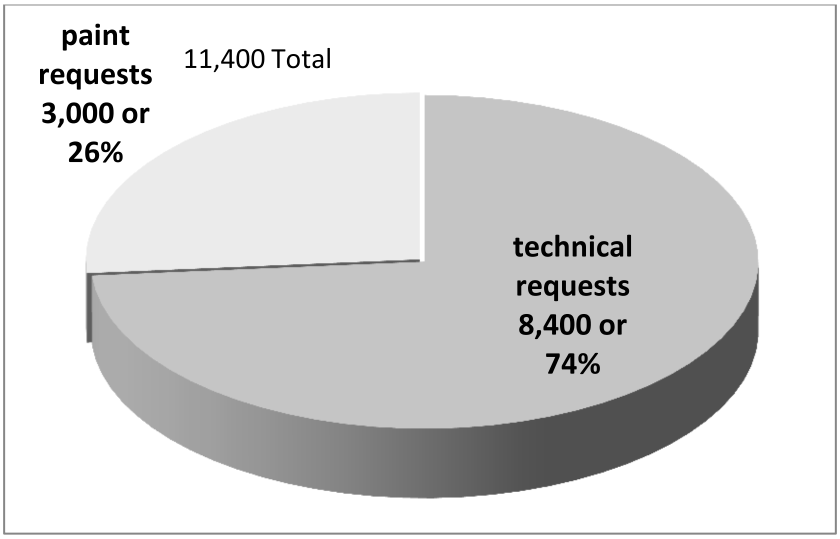


Figure 5: Structure of monthly technical requests

The average time needed to answer a request (wholesale - retail) is **15 min** plus the time until it is opened. The average total time until an answer reaches the retailer is **56 min**, requiring **3.8 dialogs** between wholesale and retail technical support. The process at wholesale level is illustrated in **Appendix 3**.

On analyzing the distribution of the technical requests per car-age since 2006 we can conclude that: until 2006 about 80% of technical requests came from segment I cars. In 2012 this quota dropped by 5% while at the same time the quota for cars aged 4-6 years increased to 18%. The same trend can be observed for cars older than 6 years. I interviewed, on average, 39 employees at wholesale level during the analysis which lasted 40 weeks. The average number of answers per employee per week was 50.

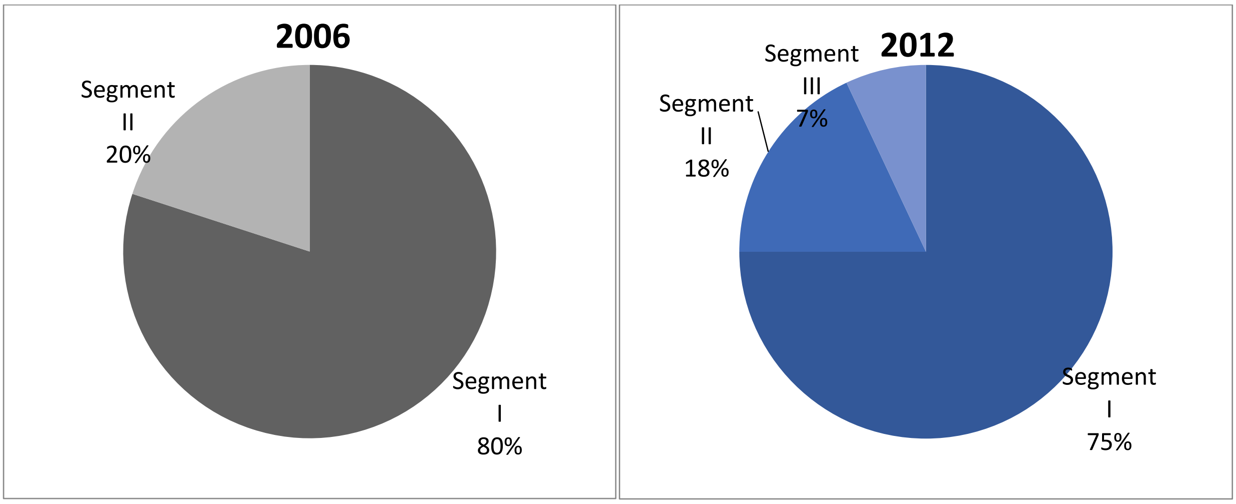


Figure 6: Evolution percentage of technical requests per car segment

In complex cases when the wholesaler cannot solve the problem the OEM is involved.

A **DISS level 3 message** must be sent to the OEM within **2 hours**. The average answer time in such cases is 20 min and 10 hours if every link in the chain is needed to solve the problem: R&D, Quality Assurance and other technical departments in After Sales.

A Priority Customer Complaint (PCC) is written if there are 3 car down cases or 5 cars with the same problem. The target for writing a PCC is 18 weeks, but this depends on how fast the problem spread is localized and how many departments have to be involved. In 52% of the cases PCCs are closed < 18 weeks, 41% between 19-50 weeks and the rest between 51-100 weeks. The collaboration between wholesale Germany – OEM is very good –17% of all PCC cases come from this market. In this step no time measurements are indicated because the repairs differ widely and every repair has a defined duration.

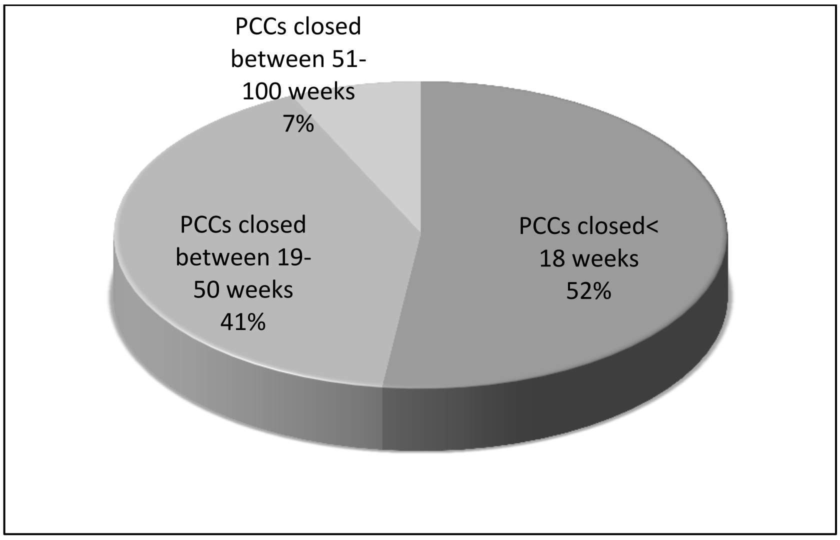


Figure 7: Percentage of duration to close a PCC

The repair process is not part of the analysis but a description can be seen in **Appendix 4**.

Two further operations on completion of the repair are important:

- a quality check carried out by either the service adviser or the workshop manager; in cases of repeat repairs or complex problems, by both. On average it takes **5-10 min**
- a test drive – carried out in 80% of cases by the service adviser himself (because he often also delivers the car to the customer) or by the workshop manager. In cases of repeat repairs or complex problems the test drive is undertaken by both and takes **7-8** min or up to **30 min** if noises were the claimed problem

Step six – return of vehicle includes the following tasks:

- create and verify the invoice done by the service adviser; this takes **5 min** on average **(5-7 min)** and in some complex cases up to **30 min**. The system used is the DMS
- print the invoice and explain it to the customer – done by either service adviser or info counter when service adviser is not available. The task takes **5 to 10 min**, usually 5 min when done by the info counter.

Table 9: Repair process step six

	Process step	Time min.	Comment	Resources	Comment
Step 6	Return of vehicle	10-40	40 min. in some complex cases	Service Adviser (SA) or Info Counter	the number of service advisers and info counters depends on the size of the organization

Step seven –payment is handled in almost all cases by the info counter, but in one case, a small business, by the service adviser or parts employee. The task takes **1-3 min.**

Step eight – the final step is job card archiving, done by the info counter staff. It takes **1-3 min** per job card and in most cases paper is archived. In a few cases a special system is used.

Fortunately, in cases of repeat repairs, in principal, the same steps are followed. Good examples are when the job card is marked (red bullet) so that all personnel involved recognize immediately that special attention is required. Another difference is that the appointment making and disposition can be done faster when the car was in the workshop only a few days previously; sometimes this also applies to car reception. **The actual total time needed for car repair is between, best case, 48 min and, worst case, 97 min.** This time was measured on location at the various dealers. The total time for all steps cannot be simply obtained by adding the minimum or maximum time per individual step as the performance for each step varies from dealer to dealer. In each case the best and worst performance times were recorded and entered in the tables.

4.2 Warranty and Goodwill

The second major processes analyzed were the warranty and goodwill processes. Without going into detail, these two processes have a different background. Whereas the warranty is a statutory claim of the customer during the guarantee time required by law, goodwill is a voluntary service provided by the service partner, and paid for by the service partner and the OEM. Although goodwill is voluntary it can be used as a strategic instrument to increase customer satisfaction and loyalty and ensure future business. The warranty period required by law in Germany is two years for new products and one year for used products and services. It guarantees a customer that the supplier of a product will fulfill any promises in terms of quality, and specifies the conditions under which the OEM, or dealer, will repair or replace defective parts free of charge for a stated period of time if the quality promise is not fulfilled. Warranty can also be used as a strategic instrument, when the aim is to promote sales or to increase market share, by extending the two year guarantee period. VW in Germany offers two years warranty for cars and parts; dealers offer a one year warranty for repairs. Currently **the average share of warranty and goodwill at retail level in the German market is 15%.** In this analysis a complete separation of the shares held by warranty and goodwill was not possible. The warranty and goodwill processes were also observed and analyzed in all nine workshops visited. In 90% of all cases warranty claims were recognized for all repairs. In one case the workshop decided not to take on body and paint warranty cases as they are more complex to handle. There are differences between the workshops in terms of organization: the large and mid-sized dealerships followed the OEM recommendation of installing a warranty specialist function. The analysis revealed that large dealers have, on average, 1.5 to 2 warranty specialists per location, mid-sized, one per location (often consolidated in one location). Only in small businesses is this function also undertaken by the service adviser. The specialization in warranty and goodwill leads to an increase in professionalism and fewer mistakes in the processing of claims throughout the organization. The analysis revealed that there is no major difference in the process quality between businesses that employ warranty specialists and businesses where the service adviser undertakes this function.

The diagram below shows the main process steps. The detailed process steps can be found in **Appendix 5**, including time measurements, personnel responsible for the process and the IT systems used. There are small differences in execution between among the analyzed retail businesses in terms of task division, time needed and quality.

Figure 8: Warranty and goodwill, main process steps

The total handling time for warranty claims and parts at retailers depends on their complexity process retail and takes between 15 min (in best cases) and up to 3 hours for cabs or police cars. The warranty process is partially automated to make sure that the retailer gets the money on time. A prerequisite is that the claim request is completed correctly. The handling of the warranty parts is described in Appendix 6. The VW regulation differs to that of other brands: all warranty parts in Germany are sent back to the wholesaler by parts logistics of the OTLG except parts that are sent directly to the OEM, producer or test centers. At wholesalers parts are stored for 30 days. If nobody requests them they are scrapped. The process could be simplified if there were a direct link between parts fitted in cars and warranty claims. The earliest moment to recognize a warranty claim is at car reception. The latest is during car repair.

High importance is given to the definition of warranty and goodwill criteria. There are differences between wholesale and retail criteria. The OEM checks the wholesaler for wholesale criteria, and the wholesaler checks the retailer for the retail criteria. All criteria are permanently optimized by the wholesalers and OEM. The criteria are important because the process is automated. In 2012, 91% of disallowed claims were rejected due to wholesale criteria; 7% were rejected due to wholesale and OEM criteria; only 2% were rejected due to OEM criteria.

Table 10: Percentage of rejected claims

Percentage of rejected claims 2012 (%)		
Rejected by wholesale	Rejected by wholesale and OEM	Rejected by OEM
91	7	2

OEM is not involved in operative issues except for warranty PCCs. **The answer must be delivered within four weeks** and a decision is made by a panel. If a claim is completed correctly and is justified the approval is made by the system. This is one of the main improvements – first pay, then check the claim.

In 2012 retail submitted 22 million W&G claims; 80-90% of these claims were processed automatically; 10-20% (100,000 – 200,000 claims) were checked manually by the wholesalers. At wholesalers this work is split between central staff and field force. Claims are regionally allocated.

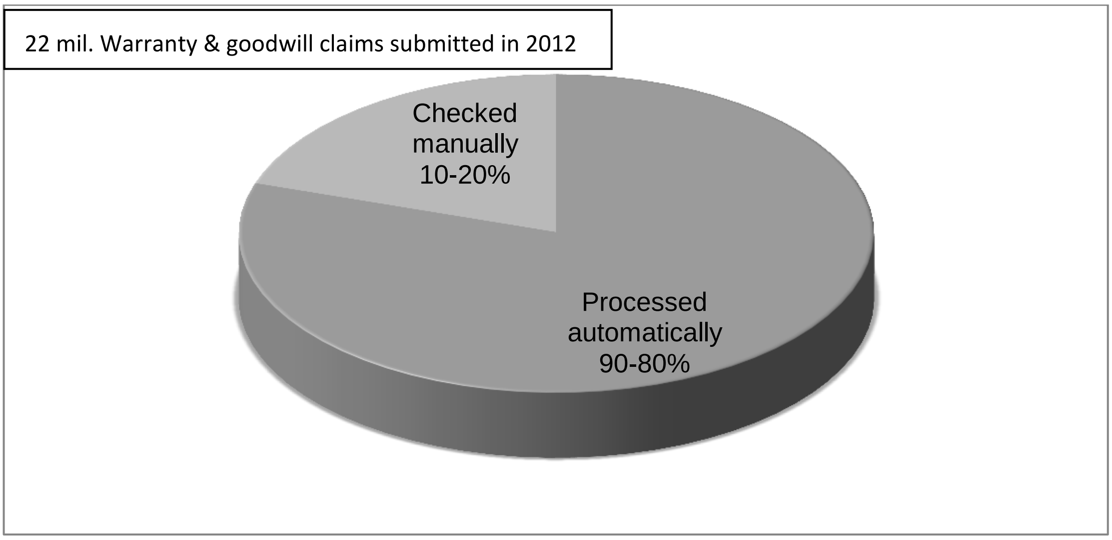


Figure 9: Percentage of claims processed automatically vs manually checked in 2012

The trend observed over a period of 8 years, 2004 to 2012, saw a drop in warranty cases from 80% to 50% while goodwill cases increased from 20% to 50%. Furthermore, due to the increased product quality, the number of problem cars decreased, but no clear focal points can be recognized which makes it difficult to allocate resources in order to solve the issues.

Table 11: Percentage of warranty and goodwill requests

Year	2004	2012
Percentage of warranty requests (%)	80	50
Percentage of goodwill requests (%)	20	50

The total lead time from the retailer to OEM is, in the **best case, 8 days** to receive the money. In the **worst case it is 33.5 days** (to be finally checked with Warranty department) in cases where the part has to be checked too. The retailer needs, on **average, 7.5 days** to submit a claim after repairing a car. There are also dealers that submit claims daily, but they are a minority. The shortest time needed to process a warranty claim in which a part must be checked is 24 h until that part is registered. **Payments are made every 14 days**.

On average 7,000 invoices per day reach the wholesalers, but this differs from month to month.

7 – 12 days hand in claim	7 days send part	3 – 14 days wholesale	1 – 14 days payment

Figure 10: Timeline to process warranty and goodwill claims

The wholesalers receive 6-8 containers a day with warranty parts that are processed in the goods receiving area by 4 employees (1 shift). The other 20 employees check the parts and the claims. Three groups process 400 to 450 claims per day. Depending on the technical issues there are differences in time required:

- the group responsible for chassis processes 40-60 claims/shift and needs ø 8- 15 min/claim
- the group responsible for the body processes 30-40 claims/shift and needs ø 10 min/claim
- the group responsible for engines processes 40- 50 claims/shift and needs ø 10- 15 min/claim. The trend in the warranty and goodwill area is similar to that in technical support as product quality increases, but no clear focal points can be identified making it difficult to allocate resources in order to solve the issues.

4.3 Parts Sale

The third major After Sales process is the parts sales process. The workflow below captures the main steps at retail level. Detailed process steps at wholesale and Group level are in **Appendix 7**.

Figure 11: Parts sale, main process steps

Autopart calculates parts needed and automatically sends orders to wholesalers. Parts are received within **24h**. ATBAS bundles parts orders and sends them to ET 2000 Master. The **lead time for parts sales** when parts are available is, in the best case, **5 min** and, in the worst case, **16 min for one part**. This increases by 5 min when additional parts for service are ordered and by **30 min in cases of accident cars,** when several parts may be required. Large dealerships employ 6 to 9 employees plus a manager in the parts department; mid-sized dealers: 2 to 6 employees plus manager; small sized dealers: 1, max. 2 or multi-function work split.

Table 12: Employees in parts departments according to dealer size

Dealer size	Nr. of parts employee	Parts Manager
Large	6-9	1
Middle	2-6	1
Small	1-2 or multi-function work split	-

The aim is for retailers to store parts with quick turnover with **inventory coverage of 1.5 /1.7 months**. To ensure availability standard stock coverage of 6 to 8 weeks is preferable. Loyalty to

OTLG is 96 % because ordering is easy and service good. Almost all businesses in Germany are linked to Autopart.

There are three kinds of parts stocks at retail level:

- firstly, those ordered manually by dealers,
- secondly, parts initially ordered for a NORA or counter customer but unused and which Autopart recommends returning and finally,
- provisional stock fully managed by Autopart with a turnover time of 0.9 months.

The value chain connection between retail and wholesale is made when retailers place orders in SAP. The ordering employee either receives the answer that all parts are available or only some. These are delivered by a cross dock process known internally as car down. The main steps in this process are visualized in **Appendix 7.**

The volume of orders is not constant but Mondays are always busier than Fridays. The VZ reacts by storing fewer Autopart deliveries on Mondays and Tuesdays and more at the end of the week. The wholesale logistic regions in general, and VZ Mitte – one of the regions in focus, have a target of same day delivery. This region has, on average, a delivery rate of 99% in 24h; 97% from own warehouse storage and 2% from cross dock. A wholesale region stores approx. 89,000 to 91,000 parts allowing a delivery rate of 97% in 24h which is economically more feasible than storing 350,000 parts to achieve a delivery rate of 99%-100%. There are some differences between VZ Mitte and the other regions. Firstly, the cross dock volume is higher, due to the proximity to the master depot in Kassel, meaning the transport time to the VZ is very short. All other VZs receive parts via road and rail. Secondly, it has differing IT Systems with MDE devices, a Resource Steering Unit and a sorter for small parts. The sorter has a consigning capacity of 3,500 positions – much faster than manual sorting. It checks and consolidates all orders assigned to a customer and sends them to one of 352 delivery points. As soon as the package has passed the final point the IT System SAP receives a signal that the order has been consigned. Sorter capacity: 12,000-15,000 parts a day. In the second region visited the cross dock volume is 4% because it is used when the buffer in the inbound area increases. In 2012, when referring to one position at wholesale level, this means seven parts behind one position.

Parts are delivered to retailers twice a day. Some exceptions are made in locations where the distance to the retailer is short; here three deliveries per day are made.

Orders received by 6:00pm are delivered overnight, by road, by 7:00am except to locations where early deliveries are not allowed. This is the so-called volume delivery that accounts for an average of 70% of the volume ordered and is free of charge for retailers. The dealerships visited almost all have better figures for volume deliveries as they represent an opportunity to save transport costs. Orders received by 11:00am are delivered on the same day by 3:30pm. This is the so-called express delivery, using smaller vehicles, for a flat rate paid by retailers - approx. 2,900 EUR a year.

Table 13: Parts delivery type, cost, timeline

Delivery type	Percentage share of volume ordered (%)	Costs	Orders received up to	Order delivered up to	Comments
Volume delivery	70	free of charge for retail	6:00 p.m.	overnight up to 7:00 a.m.	except locations where early deliveries are not allowed
Express delivery	30	flat rate	11:00 a.m.	day delivery up to 3:30 p.m.	

The value of the different parts and accessories stored is 200.7m €, in 370,000 m3, for 46 days (1.5-1.6 months). 90% of the revenue is realized from 10 to 12% (10,000) parts positions. The average turnover is 3.5 – enough for 4 months. There are differing parts categories. Thousands of fast turnover parts are sold every day with a turnover of 9 -12 a year – coverage of 6 weeks. Slow turnover parts (1 a year – only a few sold a day) have a high delivery rate. Whereas fast turnover parts are stored in the OTCs, mainly in OTC 1, slow turnover parts are stored in the warehouses of service providers with low rental costs. However, these parts must be delivered to Kassel within four hours. It is planned, in future, to deliver these parts directly to customers instead of via Kassel. The warehouses belong to OTLG but the shipping companies do not; there are 2-3 logistic providers per region.

OTLG has 30 logistics experts; each assists 80-90 retail businesses in logistics issues. In the logistics chain three main IT systems are used: - ET2000 (SAP) to order parts - ETKA – product descriptions – to select parts and - Autopart - dynamic parts planning and working system that calculates the parts needed and automatically initiates replenishment. IDIS is the counterpart to Autopart at the wholesale level which additionally calculates box size. Parts ordered remain in the inbound area buffer for 1-2 days in busy times. A continuous flow is not always realized, there are peaks and dips. The difference between Group logistics and wholesale logistics is that Group only stores containers with one part type in the main master depot in Kassel and has few customers that order large volumes. In contrast, wholesalers have many customers ordering small volumes and receive containers with mixed products which are time consuming. The diagram in Figure 12 describes the Group supply chain.

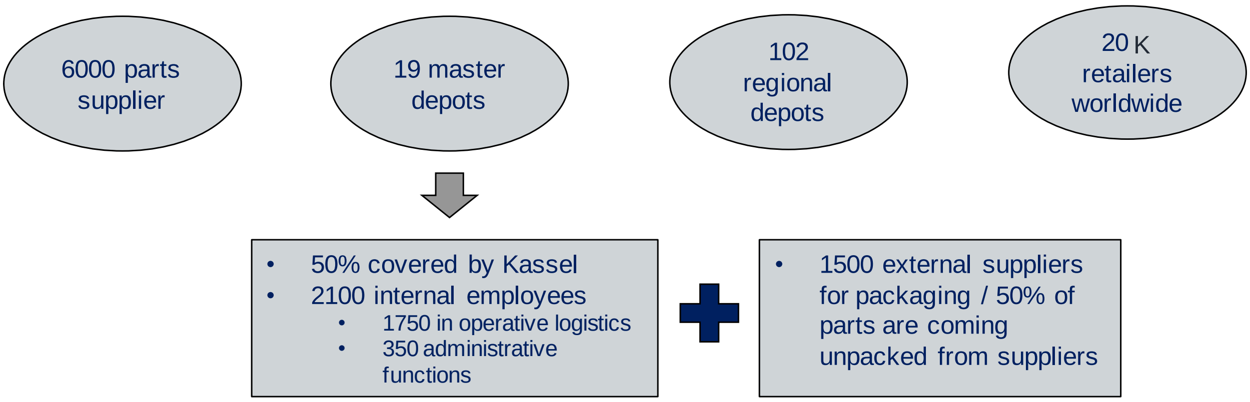


Figure 12: Brief description Group supply chain

The main master depot, with an output of 50% of the total parts business, is in Kassel. There are in fact five warehouses – OTC 1 to 5. In 2012 approx. 444,000 parts types, with an inventory value of 803m EUR were stored on 1,1m m², with a turnover of 5,5b EUR. In essence 1,750 internal employees plus 1,500 externals from suppliers, totaling 3,250 employees, receive, store, pack and repack parts ready for delivery. There is no precise monitoring of the volume of the German market; a good estimation is 25% of the business volume. Resources are estimated at 18-20%. The relation of business volume to resources is not linear because the German market differs to other markets, as in Germany many processes are standardized and optimized. The same IT systems are used; there is transparency, the use of multi-way containers, good infrastructure and information flow and no repacking. Repacking accounts for 30% of capacity.

The illustration in Figure 13 describes the target delivery rate at different levels in the supply chain.

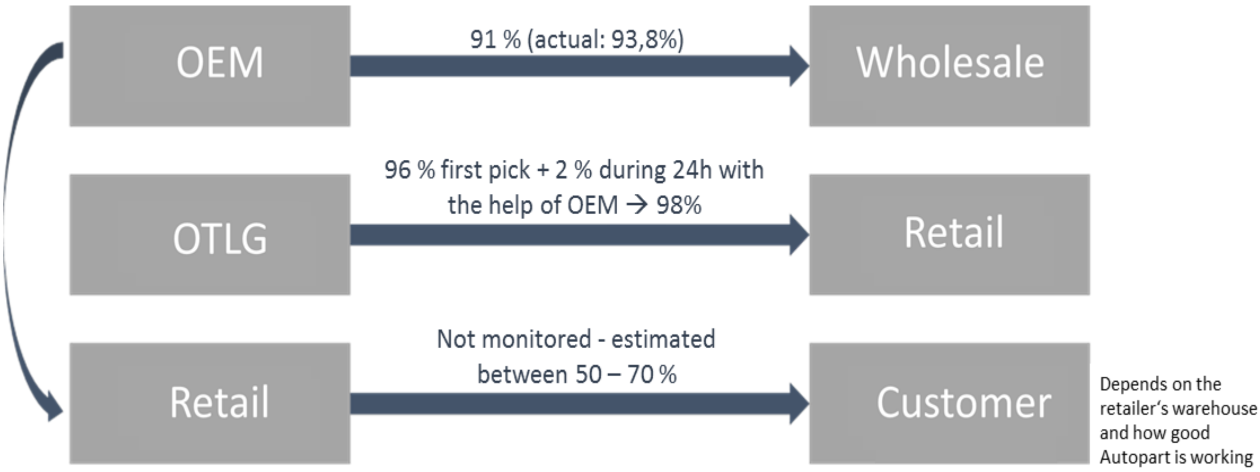


Figure 13: Target delivery rates

The logistics process in Germany has 4 levels: Group/OEM - OTLG - retail - customer. As mentioned above there are two types of orders: volume orders (91% of all volume orders are based on Autopart and IDIS prognoses) and express orders.

The lead time is:

- Volume orders: maximum **six days** (OEM - wholesale) plus **two days** (wholesale - retail), totaling **eight days**
- Express orders: **delivered from OEM via wholesale to retail within a maximum of 24 h**.

The volume order delivery is free of charge whereas express deliveries are charged. The proportion of volume to express orders has changed over time at Group/OEM level from **80/30** to **50/50**. The advantage of volume orders is that they even out the order flow. The share of express orders has increased because the process is quick and simple. When a dealer knows in the afternoon what parts he needs he orders using the ET2000 system, the Kassel depot packs the order that afternoon and the logistics companies load the orders between 10:00pm and 6:00am. The majority of Group/OEM employees work for volume deliverers.

At this level three main steps are necessary:

- parts ordering from suppliers, after negotiations, and setting the on time delivery
- ensure that parts are sent to packer, and that parts are packed and sent to the warehouse
- goods receiving, storage, consignment and shipment of parts.

For the delivery of parts from OEM to wholesalers, the OEM is responsible. Due to capacity constraints the output remains stable at 65,000 to 70,000 orders per day, maximum 80,000.

Using cross dock, parts can be delivered from inbound to outbound within 90 minutes. Crucial for success is the labeling of parts. The cross dock process is not part of ordinary operations in the master depot in Kassel. It is used mainly for recall or marketing activities. A reason for this is that the main logistics system does not support this process and 50% of parts are not packed. According to the employee interviewed, cross dock will not increase delivery rate but will decrease costs. Currently, the cost level in Kassel is 37%. In 2012 it was 39%, which is high because 50% are strategic stocks which amount to only 9.5% of revenue. If these stocks could be eliminated the ø turnover in Kassel would increase from 3.8 to 6 a year. Another factor limiting flexibility at Group level is the presence of strong unions. The current organization allows a flexibility of 5%; compensation is made via express orders. Volume orders are completed in the morning and express orders in the afternoon; fluctuation in orders is compensated for by delivery time. The order flow is erratic. A monetary measurement of the daily volume orders fluctuates between 19 and 30m EUR per day. The advantage in Germany is that good forecasts can be made for daily orders. In other countries this is very difficult.

Due to limitations of time and resources the analysis in the master depot in Kassel was carried out mainly in OTC 1. This is the main warehouse with a high degree of automation. 500 employees, 350 in operative areas, work there in 3 shifts. In the other OTCs, employees work in two shifts. The inbound system in OTC 1 is automated to 98% due to EPB and KLT. The remaining 2% are, for example, containers which do not fit on the EPB. Empty containers in OTC 1 are automatically changed for full ones. More staff is needed In OTCs 2 and 3 for inbound activities than in OTC 1. Fast turnover parts are stored in OTC 1. 50% - 60% of peaks occur here. It is also responsible for 50% of revenue and delivery rate. Inventory coverage in OTC 1 is 14 days and the storage is chaotic. The degree of automation in the consignment area is 5%. More details regarding daily workflow can be seen in **Appendix 8**. In the outbound area of OTC 1, employees work in 3 shifts. The total area of 21,000m² is made up of 9,000m² rail freight, 4,000m² air freight and 8,000m² sea freight.

Table 14: Overview space outbound area master depot Kassel

Total outbound area Kassel (m^2)	Total outbound area OTC 1 (m^2)	Outbound area rail freight OTC 1 (m^2)	Outbound area air freight OTC 1 (m^2)	Outbound area see freight OTC 1 (m^2)
30,660	21,000	9,000	4,000	8,000

The total outbound area of the master depot is 30,660m² and the yearly output is 15,000m³ air freight, 450,000m³ sea freight and 25,000 freight cars.

The claim rate in 2012 was 0.25%. 12 employees are needed for the process if a container is stored in the wrong location and 15 are needed if EPB is not functioning.

The master depot has a central inbound control unit for all OTCs, but does not know what is delivered when. The first control is performed by the central control unit, the second exact control by each OTC's control unit. A better synchronization of the inbound receiving area is necessary.

4.4 Returns process

Finally, the returns process does not play a major role in the supply chain. The main steps are illustrated below.

Figure 14: Returns process, main steps

The returns are fixed and criteria were known in all businesses visited. The analysis focused on incorrect deliveries or parts ordered and never collected. The difference in the percentage of returns varies depending on the dealership size and business volume. The assumption that the rate of returns depends on the size of a dealership and the amount of business (larger dealerships have more returns) is not always valid.

There are two examples of a mid-sized dealer having a better quota than small businesses and an example of a larger dealer being better than a mid-sized one. A low returns quota also depends on the qualifications of the retail staff. A good example is mid dealer three with 41% of higher qualified staff in the workshop.

Table 15: Percentage parts returns quota

Dealer size	Returns quota %
Small	1 – 1.58
Middle	1.39 – 2.59
Large	2.35 – 3.48

The detailed process description can be seen in **Appendix 9**. The process, after a diagnosis is performed by a technician, can take a few minutes if the part is needed by a wholesaler and up to 3 days if it must be returned to the Group. The part is sent back through the logistics channel and payment is made within 2-4 days (up to 12 days during vacations).

In essence, in order to provide perfect service to customers, besides providing individual treatment and many other supportive processes and operations, a retailer must carry out repairs as quickly as possible and in a professional manner and the necessary parts must be available. Regarding the repair process there is an evolution to the lifetime technical support of a car. Challenging for technical product support is the need to be familiar with a variety of cars and the number of problems to be solved with the same resources. At the same time as car complexity has increased new technologies have been developed. Workload and the speed and pressure required to solve problems are increasing and customers are demanding immediate answers to their queries. Globalization is an added factor – many production locations export worldwide meaning problems are no longer market specific, they are global. The complexity of the organization means that, in order to achieve results, other departments with no managerial authority and supervision are needed. Better IT systems and evolution/analysis tools (data warehousing) provide a competitive advantage. Warranty and goodwill have also undergone a transformation, being used as a strategic instrument to increase customer satisfaction and loyalty and ensure future business. Parts sales arise from repairs, but as not all vehicles go to the branded network NORA it is also possible to increase revenues by selling parts to competitors in the After Sales business. In parts sales, the repair process, parts availability and short delivery times are all major requirements. Fortunately, the backorder process with a maximum of 3.5% does not play a significant role in the supply chain. Most importantly, at the center of every business are the employees, qualified and motivated employees, who help to achieve the goals set for customer satisfaction and economic results.

In the following chapter we will describe and analyze the best practices in the value chain.

5. Revealing the Best Dealer Practice Model

In this chapter the best practice examples at the retail level will be analyzed by considering outputs related to operations, resources needed, organizational structure and financial and qualitative results. Factors that affect performance, relationships between organization, resources and output will be described. The Section 5.1., introduces our proposal of five KPIs. The second section, Section 5.2., reflects the results described in chapters four and five, discussing effects, opportunities, and feasible scenarios. In this section topics are divided into the following five categories: customers, processes and organization, flexibility, KPIs and contractual relationships. The aim is to achieve a competitive, sustainable advantage by considering trends, the changing environment and the current situation. The chapter closes with a conclusion, 5.3., based on the summary of the analysis conducted in the Volkswagen value chain.

Running a profitable After Sales operation nowadays is a challenging task. Faced with a number of external pressures, such as eroding profit margins, higher and changing customer expectations, rapidly changing technology and increasing competition, only automotive companies which follow best practices and have appropriate and effective KPIs to regulate and steer their business will achieve higher returns and customer satisfaction in the After Sales service network.

The analysis conducted in the nine retail businesses visited used the following methods: direct process observation, time measurement, and interviews with all managers and specialists along the value chain, from retail to OEM and Group, involved in the four core processes described in detail in chapter four.

From experience it was known that the businesses have to be categorized in terms of size. In After Sales this can be best expressed by considering the number of key functions and the number of work bays.

When considering the market network and all business fields, the first three businesses can be termed large, the next three mid-sized and the last three small. However, a detailed view of their After Sales business reveals that this categorization is not that clear. For example mid-sized dealerships have a similar number of technicians or service advisers as the large ones. The same applies to the parts business or apprentices.

Looking at all the businesses we conclude that the share of technicians is between 15% and 32%, the share of parts employees between 5 and 13%, service advisers 6 to 14%, and apprentices 6 to 29%.

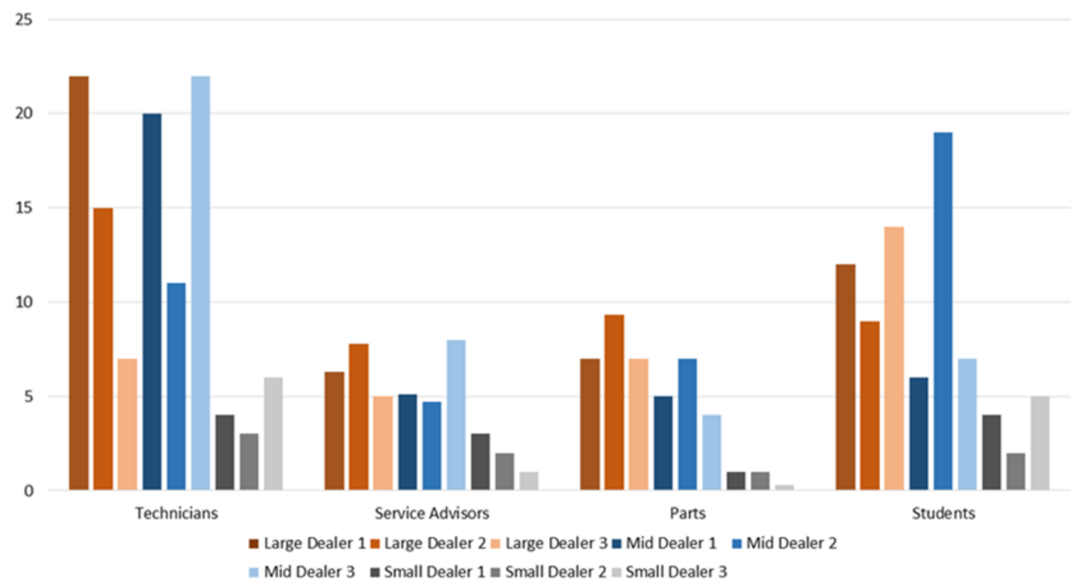


Figure 15: After Sales functions in percentages

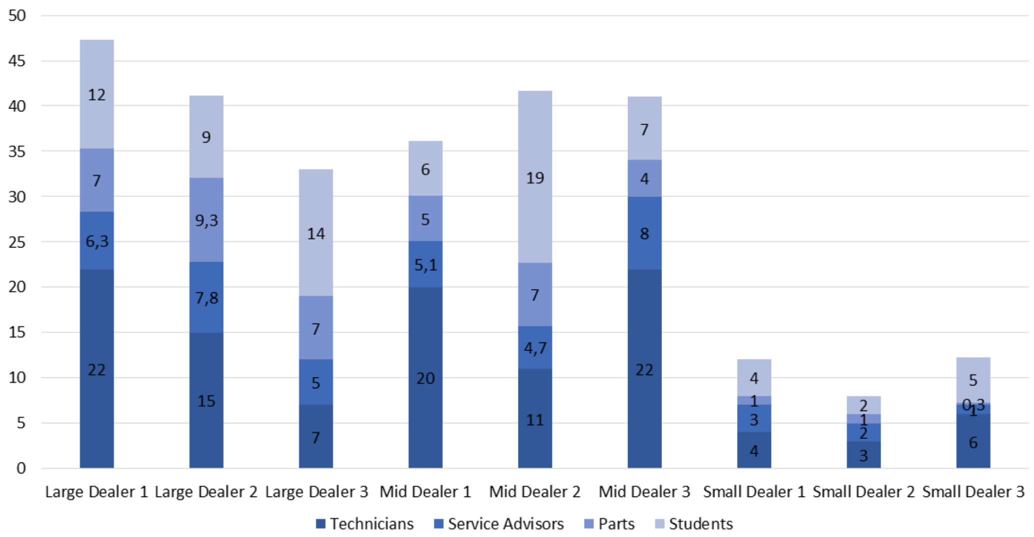


Figure 16: Absolute number of employees in After Sales

The same observation applies to the retailer's infrastructure, some mid-sized dealerships have the same number of dialog receptions and work bays as the large ones. Exceptions are businesses such as body and paint that are seldom found in small dealerships. The difference in terms of size and number of employees is more obvious between small businesses and the rest.

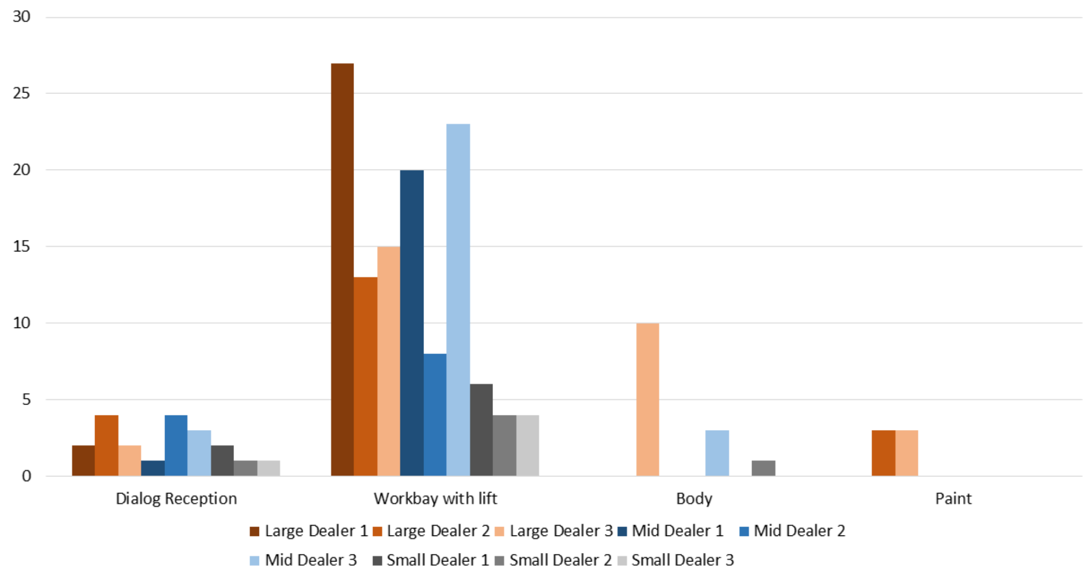


Figure 17: Workbays

As a general observation it can be said that the dealerships visited use many different KPIs depending, among other factors, on the size of the business. While smaller businesses concentrate on the standardized KPIs requested by the wholesaler and OEM, mid-sized and big businesses have defined additional KPIs to cover their individual requirements.

These KPIs were collected and aggregated to five core aspects to be measured at retail corporate level. Further, the core KPIs were detailed across two to three further levels comprising business level and team/employee level. Before describing the expected correlations between the core KPIs it should be clarified that many of the collected data must be seen in relation to the previously measured figures (yearly, quarterly and monthly) and the average values.

In the following section, the five core KPIs and their expected correlations will be explained using a model, and then the detailed KPIs on levels two to four will be illustrated. The model is a combination of generally accepted KPIs and new KPIs.

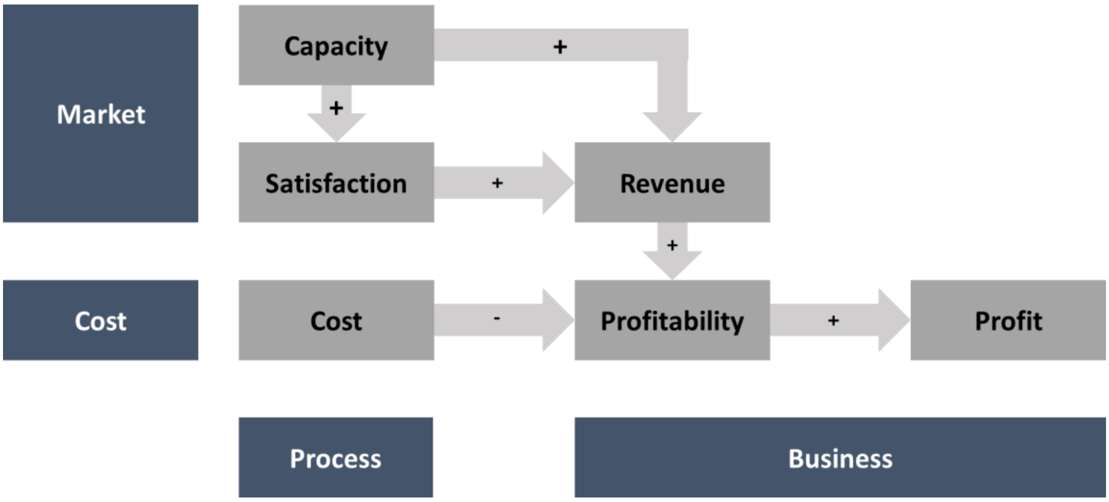


Figure 18: Key After Sales KPIs in the business environment and their correlations

The model comprises four dimensions: market, costs, processes and business. The market dimension deals with aspects of supply and demand that can be measured by capacity, customer satisfaction and revenue. It can be assumed that capacity influences customer satisfaction positively. Capacity is also a moderator for revenue. Additionally, customer satisfaction has a positive influence on revenue.

Another dimension is costs that negatively correlate with profitability. Although not considered a core KPI, profit is a necessary condition for the sustainable business success of a company. Thus, from a business perspective there is positive influence from revenue on profitability and from profitability on profit.

The measurability of this model is ensured by KPIs arranged on four levels like a pyramid. At the top are five aggregated KPIs:

- sales revenue across all businesses
- customer satisfaction index
- capacity
- total costs incurred by the business
- profitability measured by the overall profit margin.

In the following step the five core KPIs were detailed on two to three more levels, such as business level, team and FTE level. (See illustration including example below). The practical relevance of a level depends on the management level. The General Manager considers primarily the corporate level, while a department manager looks at the business level and a team leader at the FTE-level. Thus, the KPIs presented below can be viewed at these respective levels – each level depends on the purpose and measure of control of the observing person.

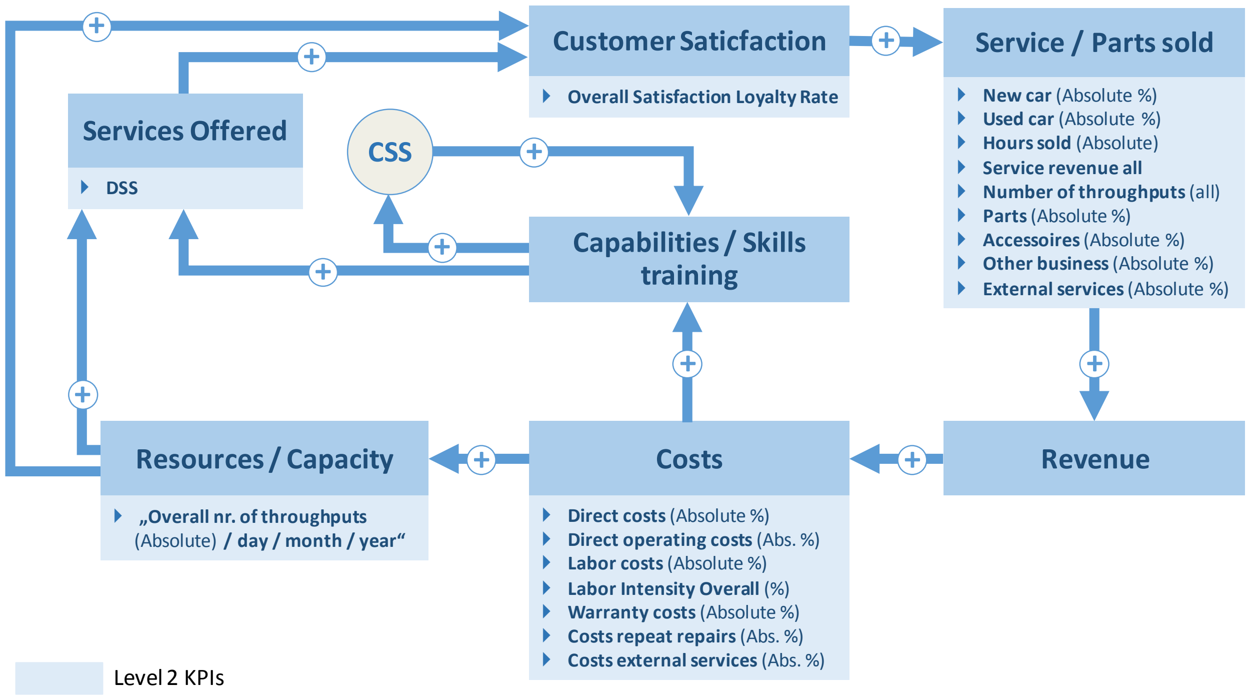


Figure 19: Key Level 1 and Level 2 After Sales KPIs and their correlations

5.1 Best Practice KPI Model Proposal

The suggested KPI pyramid consists of pre-existing figures and new ones highlighted in magenta. The reason behind the KPI aggregation was the need to find some figures that can be used to efficiently control the business. Generally, the large and mid-sized retail businesses have employees that deal with reporting, whereas in small dealerships there is not many staff available for administrative tasks, and therefore managers need some KPIs that efficiently indicate business performance.

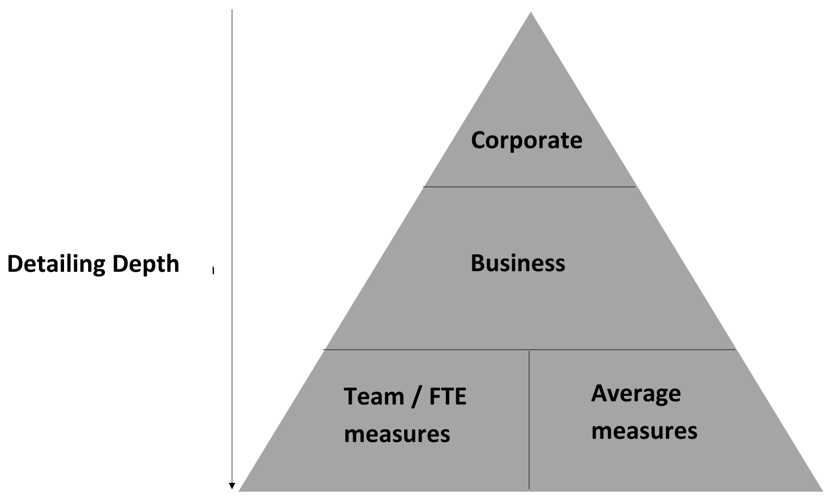


Figure 20: KPI aggregation levels

It was soon clear that caution must be used when comparing the data of different dealerships in terms of size and organization. Certain operations, steps, and KPIs are comparable among all businesses, but for others a breakdown by size is more appropriate. The best example is the customer satisfaction survey where small businesses, due to the close relationship with their customers, have a clear advantage over bigger businesses where the relationship is more impersonal. It was not practical to separate the share of the Volkswagen brand from that of other brands. Therefore, when considering the financial KPIs, the business as a whole is analyzed subsequent to the analysis of the After Sales department. Sales and other business are summarized, as the analysis concentrates on After Sales.

Many of the KPIs chosen are already part of the existing reporting system; others are new. However, the definition and understanding of each of these KPIs varies widely since a large car industry like VW has a complex combination of business units, dispersed systems, and a proliferation of parts at different levels of the network.

Ideally, these KPIs are reported consistently at every level, but with different aggregation degrees since at the wholesale and OEM levels consolidated figures are appropriate for the network and wholesale regulation respectively. Therefore, at the wholesale and OEM levels, KPIs dealing with the regulation of the network are added. Finally, if a detailed analysis is required, more KPIs are necessary to obtain a clear picture of the reasons for deviations from a market average or from the Top 100.

The visualization which best pictures the KPI selection is on the next three pages.

No. KPI	Level 1	Level 2	Level 3	Level 4
1	Sales Revenue/Turnover (including comparison to previous years figures)	New car (Absolute, %)	Revenue/Turnover per FTE new car (absolute, %, monthly, yearly)	Coverage margin/FTE new car sales (Absolute, %, month/year)
		Used car (Absolute, %)	Revenue/Turnover per FTE used car (absolute, %, monthly, yearly)	Coverage margin/FTE used car sales (Absolute, %, month/year)
		Hours sold (Absolute)	Hours sold gen. rep./body/paint (Absolute)	
		Service revenue all	Service revenue gen. rep./body/paint (Absolute, %, month/year)	
			Revenue/Turnover per FTE in service (absolute, %, monthly, yearly)	Coverage margin/FTE service (Absolute, %, month/year)
			Revenue/Turnover per productive FTE in service (absolute, %, monthly, yearly)	Coverage margin/per productive FTE service (Absolute, %, month/year)
		Number of throughputs (all)	Average nr. of Througputs/day/month/year	
			Throughputs/productive FTE/day/month/year	Throughputs per productive FTE gen. rep./body/paint
		Parts (Absolute, %)	Parts sales own workshop (Alsolute, %, day/month/year)	
			Parts sales to NORA (Absolute, %, day/month/year)	
			Parts sales counter (Absolute, %, day/month/year)	
		Accessories (Absolute, %)		
		Other businesses (Absolute, %)		
		External services (Absolute, %)		
2	Customer Satisfaction Index (CSS) comparison with Top 20% on every level	Overall Satisfaction Loyality Rate	Customer treatment (measured in points)	Explanation of the work
				Staff friendliness
				Responding to customer wisches
				Expert advice
				Discussion of the work on the vehicle
				Reccomendation Inspection/Repair
				Staff trustworthness
			Process	Replacement mobility offer
				Repair/car delivered on time
			Communication price - performance ratio	Price - performance ratio
				Tasks completed
				Invoice explained
			Repair quality	Repeat repair
				Proper execution of the work
		Dealer satisfaction survey (DSS) at wholesale level	Volume of activity (nr. of calls / day/month/year)	
			Topics	
			Employee qualification	Qualification Management
				Nr. of technicians
				Nr. of technician specialists
				Nr. of service advisors
			Contracts (type: nr. of work hours per week)	
			Employee (incl. Management) satisfaction survey	

Figure 21: Current and additional significant KPIs (1)
Black: current measured KPIs
Magenta: additional meaningful KPIs

No. KPI	Level 1	Level 2	Level 3	Level 4
3	Capacity Average waiting time for customer (days)	Overall nr. of throughputs (Absolute) / day / month / year	Nr. of throughputs (gen. rep. / body / paint) /day/month/year	Nr. of technicians (Absolute, %)
				Nr. of technician specialists (Absolute, %)
				Nr. of service advisors (Absolute, %)
				Nr. of parts employee (Absolute, %)
				Nr. of apprentices (Absolute, %)
				Nr. of car receptions (dialog receptions)
				Nr. of workbays with lift
				Ratio Service advisor/Technicians
			Capacity levels (%)	
4	Total costs (Abs.) month/year	Direct costs (Absolute, %)		
		Direct operating costs (Abs.,%)		
		Labor costs (Absolute, %)		
		Labor Intensity Overall (%)	Labor Intensity new cars (%)	
			Labor Intensity used cars (%)	
			Labor Intensity service (%)	
			Labor Intensity parts (%)	
			Labor Intensity other business units (%)	
		Warranty costs (Absolute,%)	Warranty audit result (Absolute and %)	
		Costs repeat repairs (Abs.,%)		
		Costs external services (Abs.,%)		
5	Profitability Profit Margin Overall (%) per month/year	Profit margin new car (Abs.,%)		
		Profit margin used car (Abs.,%)		
		Profit margin service (Abs.,%)		
		Profit margin parts (Abs.,%)		
		Profit margin other business units (Abs.,%)		
		Gross profit overall (Abs.,%)	Gross profit new cars (Abs.,%)	
			Gross profit used cars (Abs.,%)	
			Gross profit service (Abs.,%)	
			Gross profit parts (Abs.,%)	
			Gross profit other business units (Abs.,%)	
		Total profit (Abs.,%)	Total profit new cars (Abs.,%)	
			Total profit used cars (Abs.,%)	
			Total profit service (Abs.,%)	
			Total profit parts (Abs.,%)	
			Total profit other business units (Abs.,%)	
		Contribution margin three (CM3) (Abs.,%)	CM3 new cars (Abs.,%)	
			CM3 used cars (Abs.,%)	
			CM3 service (Abs.,%)	
			CM3 parts (Abs.,%)	
			CM3 other business units (Abs.,%)	

Figure 22: Current and additional significant KPIs (2)
Black: current measured KPIs
Magenta: additional meaningful KPIs)

No. KPI	Level 1	Level 2	Level 3	Level 4
5	Profitability Profit Margin Overall (%) per month/year	Annual workshop performance (%)	Annual performance gen. rep. (%)	Rate of attendance gen. rep. (Abs., month/year)
				Productivity gen. rep. (%)
				Performance gen. rep. (%)
			Annual performance body (%)	Rate of attendence body (Abs., month/year)
				Productivity body (%)
				Performance body (%)
			Annual performance paint (%)	Rate of attendence paint (Abs., month/year)
				Productivity paint (%)
				Performance paint (%)
			Worked hours per productive workshop FTE (Abs., month/year)	Worked hours gen. rep. per productive FTE (Abs., month/year)
				Worked hours body per productive FTE (Abs., month/year)
				Worked hours paint per productive FTE (Abs., month/year)
			Service revenue/Throughput all (Abs., year)	Service revenue/Throughput gen. rep. (Abs., year)
				Service revenue/Throughput body (Abs., year)
				Service revenue/Throughput paint (Abs., year)
			Worked hours (workshop) all (Abs., month/year)	Worked hours gen. rep. (Abs., month/year)
				Worked hours body (Abs., month/year)
				Worked hours paint (Abs., month/year)
			Ratio hours sold/hours overall (%, month/year)	Ratio hours sold/hours overall gen. rep. (%, month/year)
				Ratio hours sold/hours overall body (%, month/year)
				Ratio hours sold/hours overall paint (%, month/year)
			Worked hours/hours sold overall (%, month/year)	Work hours/hours sold gen. rep. (%, month/year)
				Work hours/hours sold body (%, month/year)
				Work hours/hours sold paint (%, month/year)
				Worked hours / throughput gen.rep. (Abs., year)
				Worked hours / throughput body (Abs., year)
				Worked hours / throughput paint (Abs., year)
			Service revenue/throughput all (Abs., month/year)	Service revenue / throughput gen. rep. (Abs., month/year)
				Service revenue / throughput body (Abs., month/year)
				Service revenue / throughput paint (Abs., month/year)
			Hours sold/throughput all (Abs., year)	Hours sold / throughput gen. rep. (Abs., year)
				Hours sold / throughput body (Abs., year)
				Hours sold / throughput paint (Abs., year)
			Ratio worked hours/hours sold all month/year	Ratio hours worked /hours sold gen. rep.
				Ratio hours worked /hours sold body
				Ratio hours worked /hours sold paint
			Worked hours/hours paid all month/year	Worked hours / hours paid gen. rep.
				Worked hours / hours paid body
				Worked hours / hours paid paint
			Target hourly rate/achieved hourly rate	Target hourly rate / Achieved hourly rate gen. rep.
				Target hourly rate / Achieved hourly rate body
				Target hourly rate / Achieved hourly rate paint
			Service degree (logistics to NORA)	
			Investment in inventory	Parts
				Warehousing
			Parts availability	Backorders
			Logistic costs/Sales revenue NORA	
			Parts Tracking (Lead time)	

Figure 23: Current and additional significant KPIs (3)
Black: current measured KPIs
Magenta: additional meaningful KPIs

5.1.1 Sales Revenue

Sales revenue is one first level KPI and the precondition for a sustainable business. Sales revenue is detailed at the second level for all main retail functions. In a small service business the manager only has to monitor the number of daily throughputs in order to get a feeling for the business volume. Knowing the number of throughputs one can estimate the sales in service and parts. The parts sales through the dealership's own workshop make up a certain percentage of the service revenue. Through regular reporting the average revenue per throughput is known and the parts sales of the dealership's own workshop is, for example in Germany, on average equal to the service sales. Besides these simple sales estimations for the main After Sales functions, by increasing the number of throughputs the parts sales of the dealership's workshop will increase too. The more business is outsourced, and depending on the business volume in service, the higher the revenues from external services. The reason one dealership has an extremely low income per productive employee per month is the low hourly rate achieved. The aim should be to achieve the target hourly rate fixed according to the price level in the respective region and by the competition. Low hourly rates often indicate a rural dealership and/or an economically weak region.

The Table 16 below contains an overview of where the dealerships are located.

Table 16: Overview dealership locations

	City	Countryside
Large	Large Dealer 1 Large Dealer 2	Large Dealer 3
Mid-sized	Mid-sized Dealer 2	Mid-sized Dealer 1 Mid-sized Dealer 3
Small	Small Dealer 1	Small Dealer 2

Due to reasons of confidentiality, the results were indexed. The best in class dealer or dealers were equated with 100% and the results of the other dealers were shown in relation to these businesses.

The following two illustrations show the revenue in After Sales in the main functions and the revenue per productive employee per month, firstly per dealership and secondly, categorized based on the respective KPIs.

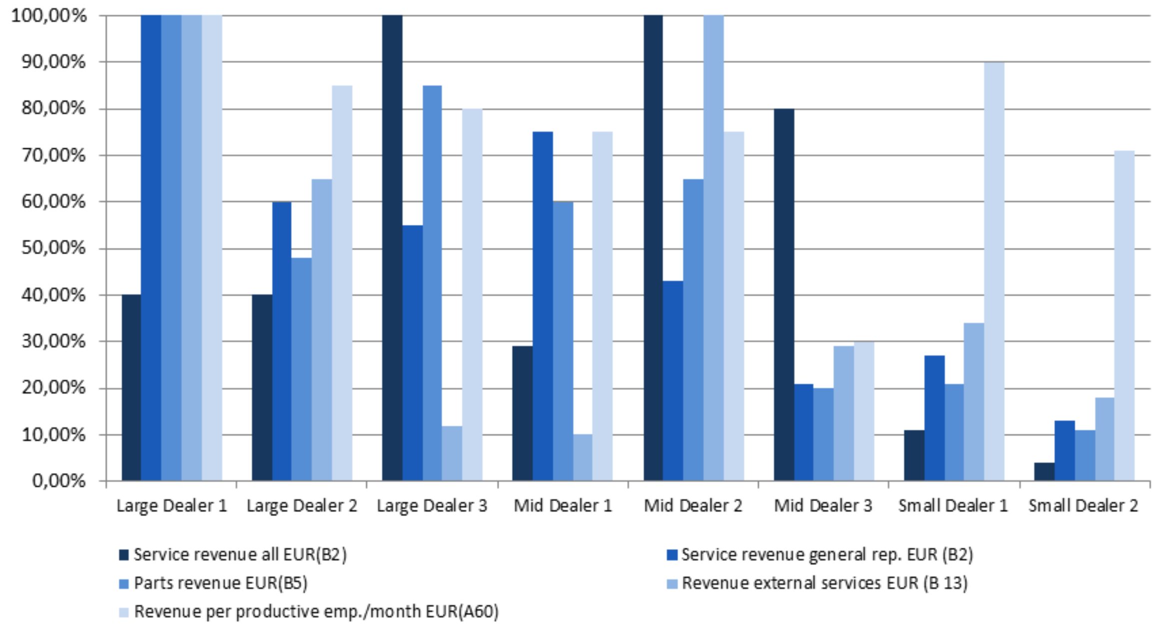


Figure 24: Revenue main After Sales functions per dealer

We conclude that there are no major financial differences in terms of revenue between large and mid-sized dealerships. Differences exist between small dealerships and the other two categories. The difference in the category small dealerships between the best and the worst is below 10%. Comparing the revenue per productive employee per month, with one exception, the differences between the analyzed businesses are up to 30%. This can be interpreted as an argument for using specialists; as bigger businesses that have specialized functions earn more revenue per productive employee than small businesses.

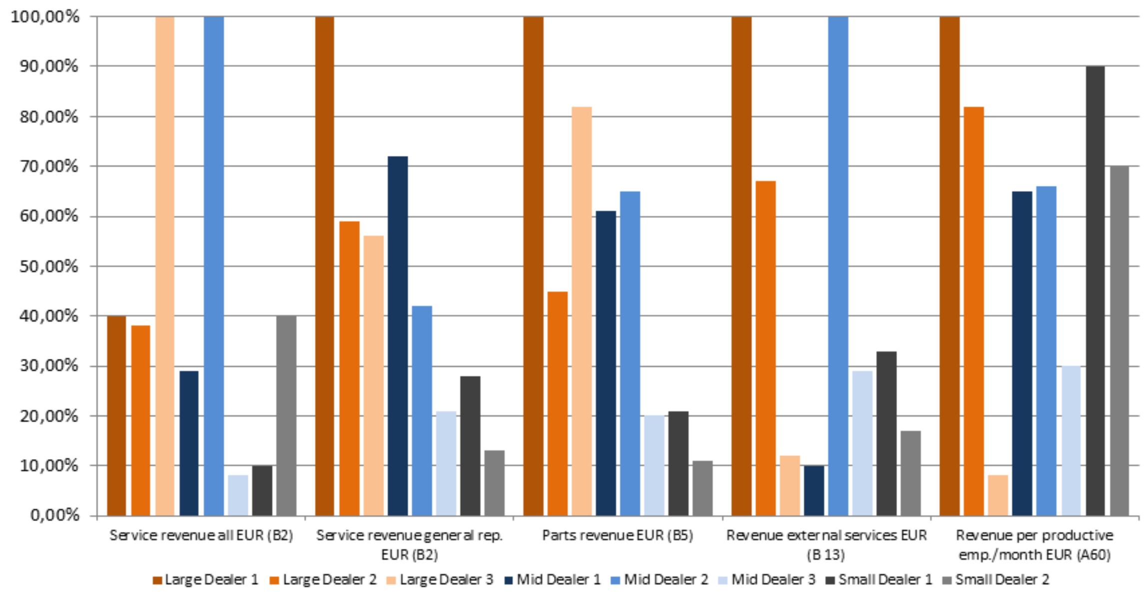


Figure 25: Revenue main After Sales functions, dealer comparison

By comparing the service revenue and the parts revenue, we realize that differences range from almost zero up to twenty percent. This proportion differs from country to country; in Germany, on average, the service revenue equals the parts revenue. When there are differences, especially when parts revenue exceeds the service revenue, this is an indication for a strong parts business. More revenue from parts business is achieved when parts are actively sold to NORA and counter customers.

The illustration in Figure 26 shows the revenue per FTE in After Sales and in the main categories, service and parts, in percentage. The best performance is achieved by Large Dealer 2. Key influence factors are the ratio between productive and unproductive employees and the total number of employees, since for small businesses it is more difficult to cover the infrastructure costs.

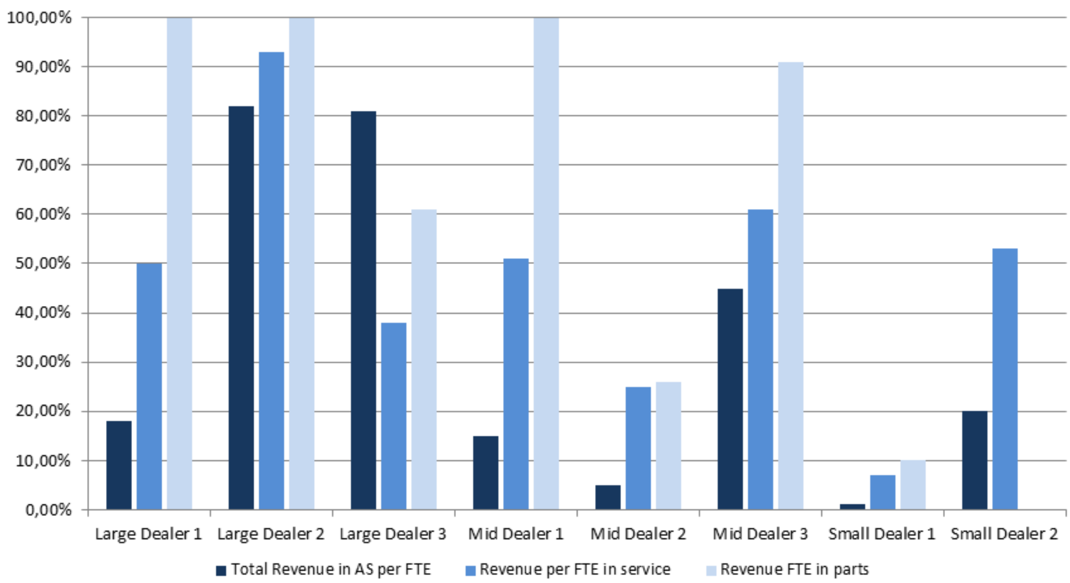


Figure 26: Revenue per FTE in After Sales

On levels three and four the sales figures are further detailed per FTE, month, year and the coverage margins per FTE are calculated. The illustration in Figure 25 right, which reflects the revenue per productive employee per month for all After Sales functions and the revenue for the major function service and parts (Figure 26), supports the hypothesis that lower hourly rates and fewer parts sales through the workshop result in lower revenue per service throughput. The difference in terms of revenue per throughput all between the businesses analyzed is lower than when the businesses are compared only in the area of general repair. The major influencing factors are the parts business and the overheads, meaning that the bigger the overheads the higher the costs. The maximum difference between Service Revenue per Throughput General Repair and Service Revenue per Throughput All was 35%.

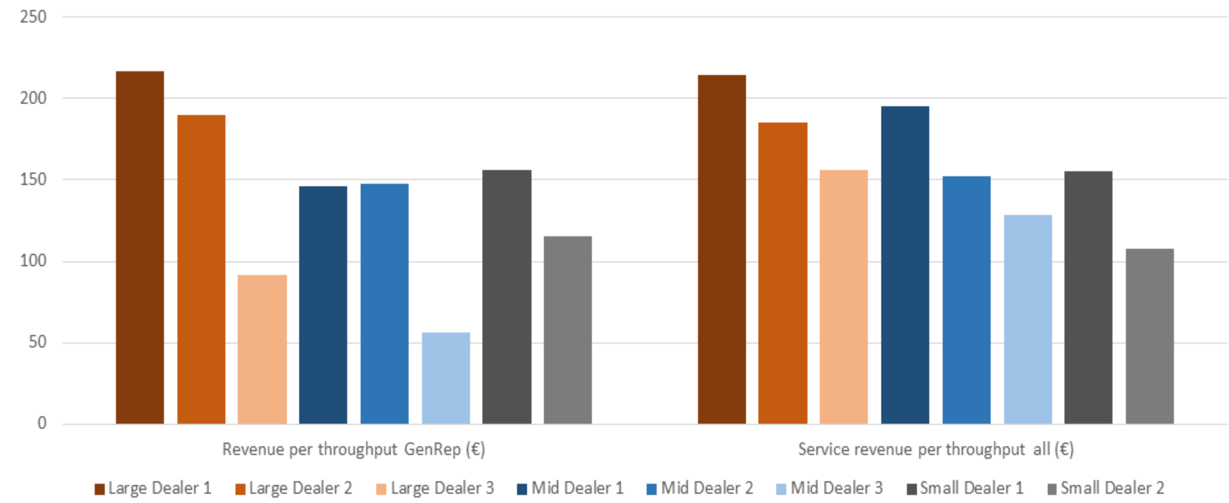


Figure 27: Revenue and Service Revenue per throughput

The difference between the highest and lowest ranking is significant, averaging approximately 70%. The majority of the businesses differ by 20% to 25% from the best performer in this category. The next observation is that half of the retailers visited earn similar revenue per productive employee per month for service and parts. The remaining retailers have strengths in either service or parts businesses.

5.1.2 Customer Satisfaction Index

Another first level KPI is a measurement of the customer and dealer satisfaction and loyalty. Volkswagen, like other passenger car groups, participates in both a Group internal and a club survey in order to have a comparison with the competition. The main survey is the Group internal survey – the so called "Customer Satisfaction Survey" (CSS) – a well-developed study that also indicates which measures can increase the rankings in the various categories.

Table 17: Customer Satisfaction Survey main KPIs

No.	Retail Business	Overall Satisfaction Average Germany 8.5 Top 20% 9.0	Loyalty Average Germany 10.7 Top 20% 11.1
1	Large Dealer 1	8.5	10.8
2	Large Dealer 2	6.8	9.1
3	Large Dealer 3	8.1	10.0
4	Mid-sized Dealer 1	8.1	10.6
5	Mid-sized Dealer 2	8.9	10.5
6	Mid-sized Dealer 3	8.1	11.2
7	Small Dealer 1	9.3	11.0
8	Small Dealer 2	9.0	11.2

As the CSS is not the major subject of this dissertation, it will not be described in depth. Here only a few remarks. Almost all dealers visited have a CSS performance between average Germany or almost average Germany and Top 20% Germany. Two smaller dealerships are even above average. One large dealer is underperforming because of a combination of employees' communication skills, customer treatment and processes. A second study is the "Dealer Satisfaction Survey" (DSS) which is not carried out as often as the CSS. The following criteria were added to the KPI of the DSS at level three: employee qualification, contract (type) and retail employee satisfaction survey. Employee qualification has a direct impact on customer satisfaction and service quality. The contract type (permanent or temporary employees) is important not only in terms of satisfaction, but also in terms of worked hours. Finally, employee satisfaction surveys are done regularly only at the OEM/Group level. It is advisable to continually survey the employee satisfaction at every level. A recently held survey at retail level, carried out in eight major markets, revealed that manager perceptions often differ from those of the staff and the fluctuation is underestimated. Also newly introduced on level four is management qualification, which is especially important at retail level. In Germany, at retail level, for important functions like sales, service, parts manager, and other functions below, assessment centers are scheduled because it is recognized that staff quality is then higher than when using traditional application procedures.

5.1.3 Capacity

Not yet monitored as a KPI, capacity is the "average waiting time for customers" measured in days. The waiting time has a direct influence on customer satisfaction and is also a good indicator for capacity shortages. The retail business owner has a tendency to ignore long waiting times for customers, firstly, because capacities planned well in advance provide stable income, and secondly, capacity shortages require investments in infrastructure and human resources.

On the second level is an easy to measure KPI: the overall number of throughputs that is further detailed on level three across general repair, body and paint, and finally, on level four, the absolute and relative number of key functions in the service area and infrastructure KPIs such as the number of car receptions and work bays with a lift.

5.1.4 Costs

An indispensable element of every reporting system is cost monitoring. Therefore, on level one, the total costs are listed from the business perspective. On level two, these costs are detailed as direct costs, direct operating costs, labor costs, warranty costs, costs for external services and two new KPIs: costs repeat repairs and labor intensity overall. Labor intensity is defined as the ratio of labor costs to total costs, excluding deductions. On level three, labor intensity is further detailed across the main business activities at retail level.

There is a direct relationship between business volume and costs. Due to the parametrization, the best performers in terms of costs are the businesses with the lowest percentage of costs per function. The best performers are, on average, the mid-sized businesses. Large retailers have, on average, the highest costs. There are significant differences in terms of costs between small, mid-sized and large retailers and also in the main functions service and parts.

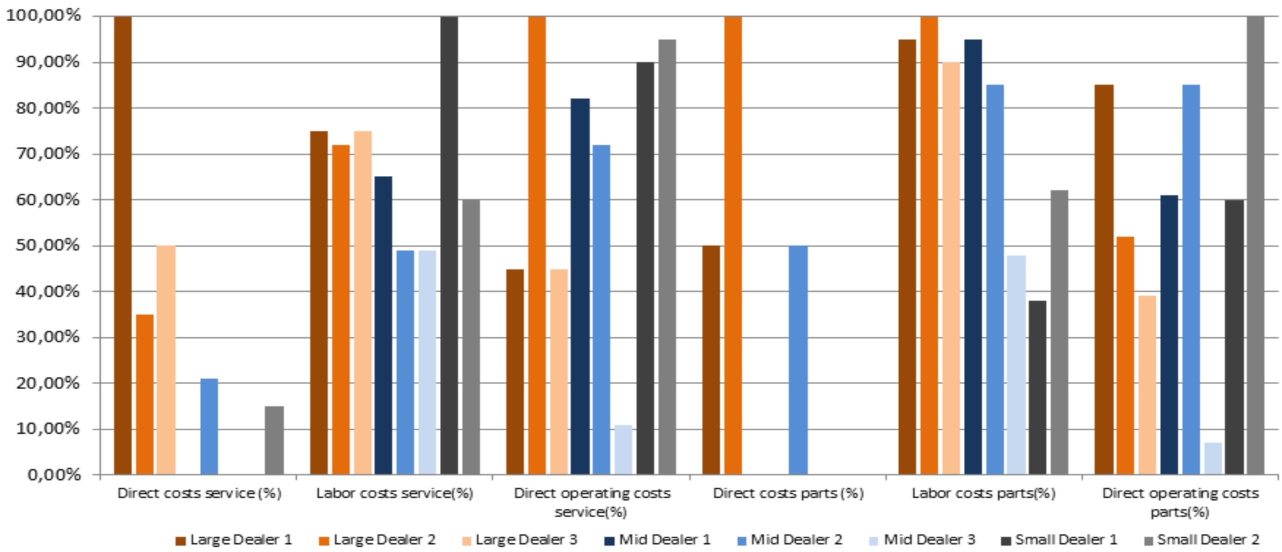


Figure 28: Comparison cost categories in After Sales

The observations above are a general statement. Looking at the analyzed businesses we observe different levels of cost structure depending on the structure of the dealership. Not illustrated in this Thesis are the costs for the new and used car business, whereby in the used car business the differences between the dealerships are even more extreme than in the new car sales. We can also observe partial differences between large-medium and small for both the service and parts businesses.

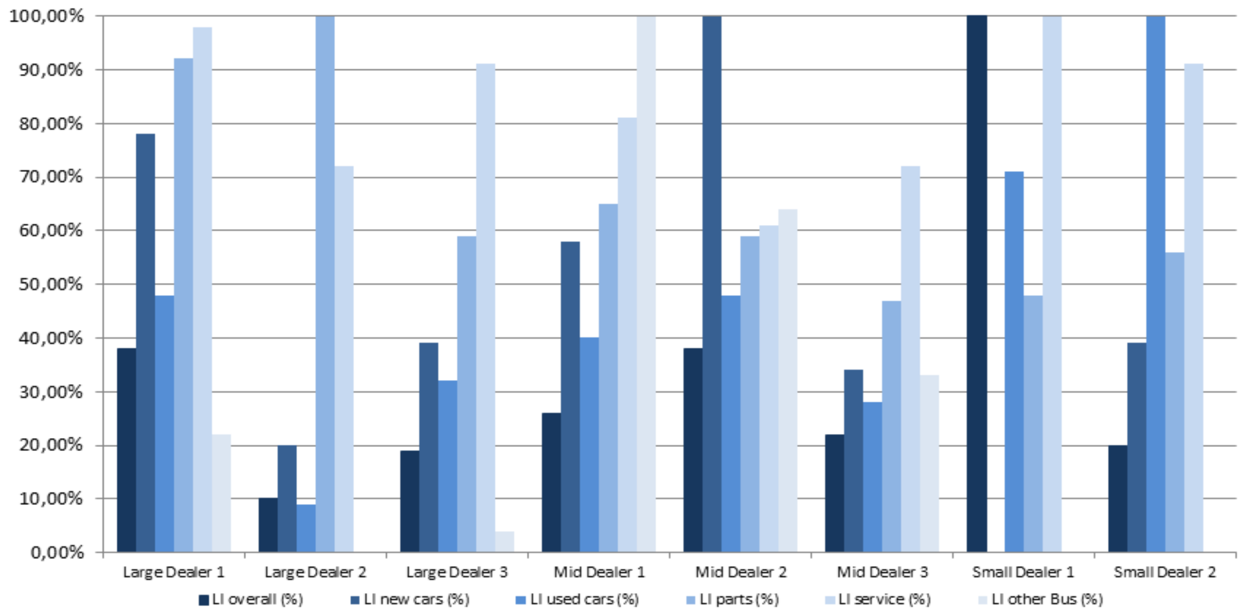


Figure 29: Labor Intensity

Labor intensity is defined as labor costs over total costs excluding deductions. High labor intensity is positive, indicating that one person can cover several functions, often the situation in small retail shops. A high value for labor intensity increases the workshops flexibility. In general, labor costs in After Sales are higher than in new and used cars sales. Businesses strong in After Sales have LI of between 50 and 80 % in service. The relation labor intensity service / parts is 4-5 to 1. However, since there are differences in labor intensity between dealerships of almost 50%, especially in sales, a deeper analysis of labor costs must be carried out.

5.1.5 Profitability

The last aggregated first level KPI is **profitability**, further broken down on level two as profit margins across the main retail business fields. Looking at the illustration in Figure 30 we conclude that all dealers are making a profit. Gross profit overall is broken down across the main business fields on level three. Total profit and CM 3 are detailed on level three, similarly to profit margins. In all cases the service and parts business is profitable with a negative CM 3 in other business and in the used car business at two dealers.

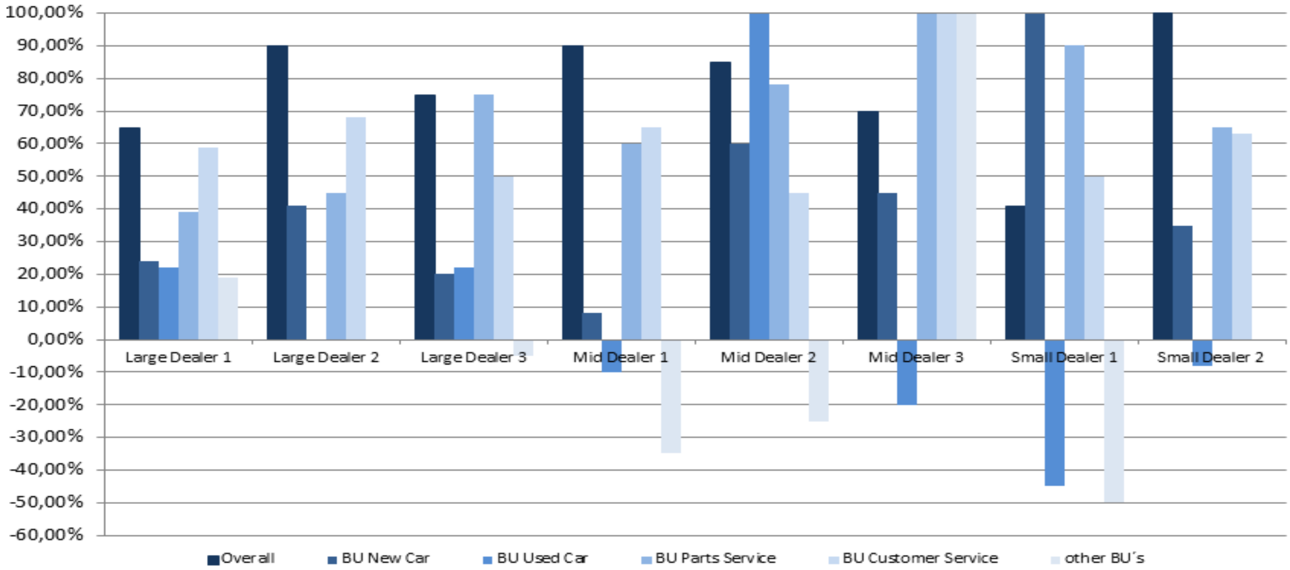


Figure 30: Profitability overall and per dealer per function

A frequently used KPI is the contribution margin three (CM 3) defined as total profit minus direct costs, labor costs, and direct operating costs. Although new car sales amount to 50% of revenue, the high costs mean that the contribution margin for the whole business is around 7%. The service and parts business contributes to a much lower share of the total revenue, around 30%, but the CM 3 is almost 50%. Looking more closely at the businesses analyzed and comparing the revenue with CM 3 for service and parts we see a similarity in percentage of service revenue, with the exception of Small Dealer 1 which does not have a VW new car sales contract. It is an indication of very similar or standardized business. Further, the slighter differences in CM3 compared to the best indicate a predetermined cost structure. The differences in parts revenue are higher due to the different use of the parts business opportunities. The trend shows a similar CM 3 in the parts business; large retailers have a lower CM 3 than mid-sized and small businesses.

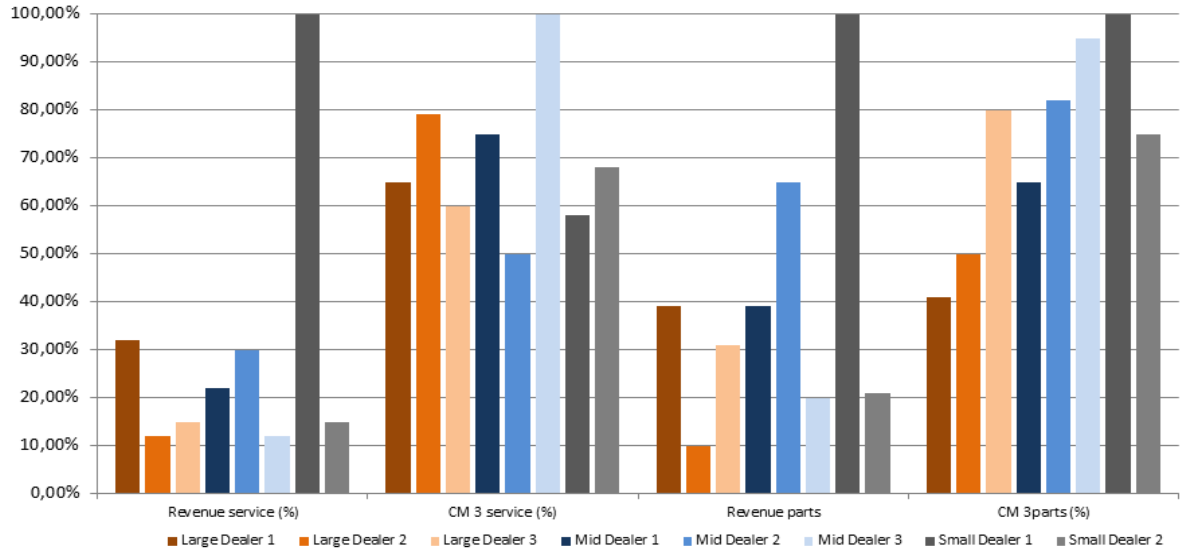


Figure 31: Revenue and CM 3 Service and Parts

Other insights can be gained by comparing the direct costs, labor costs, and direct operating costs of the four business areas mentioned in the section (see Figure 32). The direct costs are higher in sales than in After Sales due to the acquisition prices for cars. In service the labor costs are the highest due to the higher number of employees as labor intensity in this business area is higher.

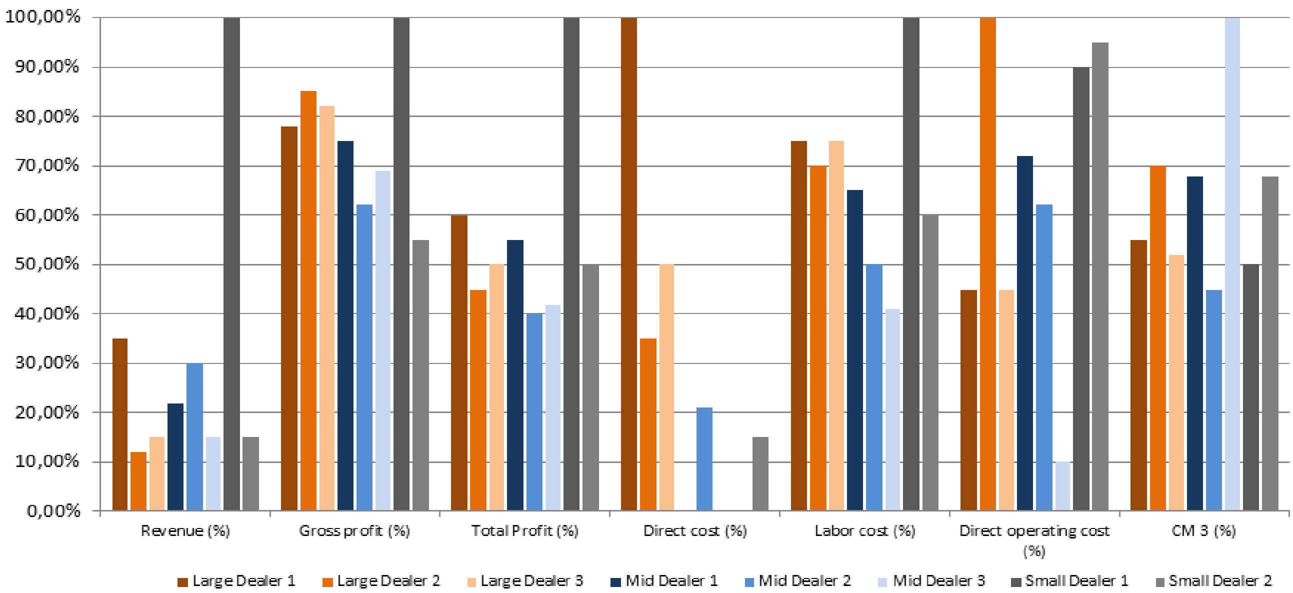


Figure 32: Profitability and cost in the service business

Looking at the service business in more detail there are differences of about 20% in service revenue, except Small Dealer 1 which is dominant. In Gross Profit (leaving out Small Dealer 1) the larger dealers obtain the better results. Total Profit also reveals low fluctuation between the analyzed businesses, except the best which is higher by 50% (Small Dealer 1). There are marked differences between businesses regarding Direct Cost, but in general the larger dealers have higher costs. Regarding Labor Cost there are differences between the best performer and large retailers of about 30% and a difference to the mid-sized of 10% to 20%. A significant difference in labor costs of up to 60% is caused by the organization and ownership structure/situation. Direct operating cost and CM3 were previously analyzed. Overall, the Service business is more standardized with precise specifications, which means less variation in contrast to the Parts business. The best performer is Mid Dealer 3.

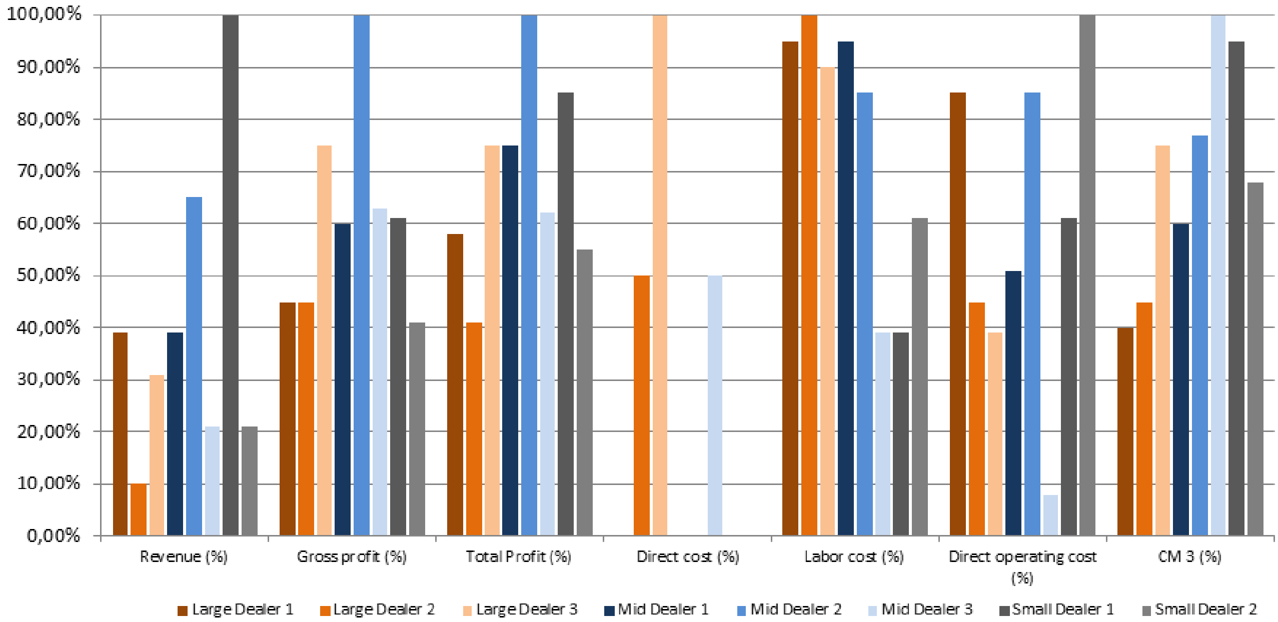


Figure 33: Profitability and costs in the parts business

Parts Revenue shows a fragmented picture. No clear trend in terms of dealer size or geographical location is possible. Gross Profit and Total Profit are around 50% of the best performer, but with fluctuations of about 10% between the other businesses. Labor Cost: Large and medium-sized dealers have about 50% more costs than the best performer. The small dealers have about 30% more because, in small businesses, several functions are carried out by one person. Operating Cost reveals a very fragmented picture. CM 3: the lower the costs the greater the contribution margin. The parts business is a revenue driver with the results depending on the intensity with which the business is practiced.

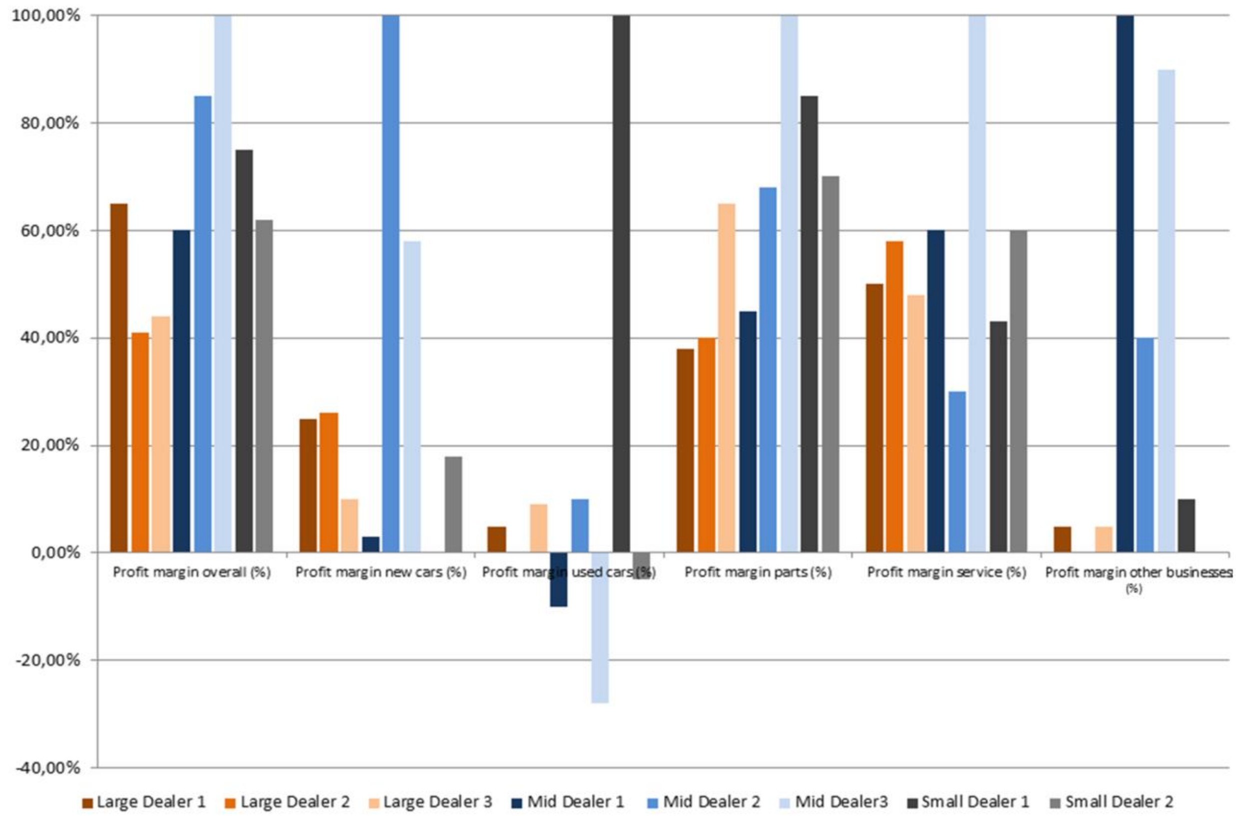


Figure 34: Profit margin per function

Overall Profit Margin: the best performer is mid Dealer 3. The large dealers achieve approximately 50% of the results of the best performer, on average around 50%, and the small dealers have about 30-40% less than the best. Profit Margin in the New Cars and Used Cars businesses is very fragmented, depending on how professionally the business is run. Profit Margin Parts is slightly higher than in service. The large and mid-sized dealers achieve, on average, 50% of the results of the best performer, Mid Dealer 3. The small retailers have 25% lower profit margins than the best performer. The profit margin in Other Businesses is very fragmented with the mid-sized dealers having the best results.

In terms of profit margin the comparison shows that dealers have different strengths. The majority are stronger in the After Sales business. One dealer also has a good profit margin in the used car business.

Annual workshop performance also appears under profitability figures performance, since performance has a direct influence on profitability. The annual performance is further detailed on levels three and four. Without going into details these can be found in the visualization on page 55.

It is also necessary to focus on ratios such as worked hours to hours sold, on target hourly rates to achieved hourly rates, on logistics costs over NORA sales revenue and parts tracking – lead time monitoring.

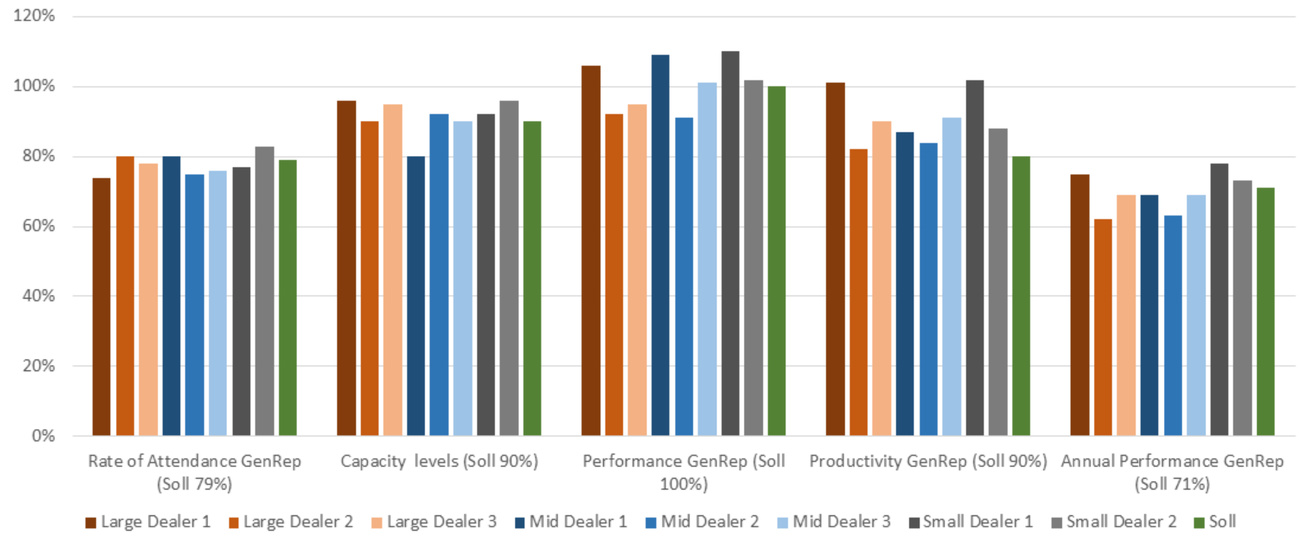


Figure 35: Productivity and performance

Since the dealerships visited had different service offerings and body and paintwork was not provided by all of them, the productivity KPI comparison refers to general repairs, as this is common to all dealerships.

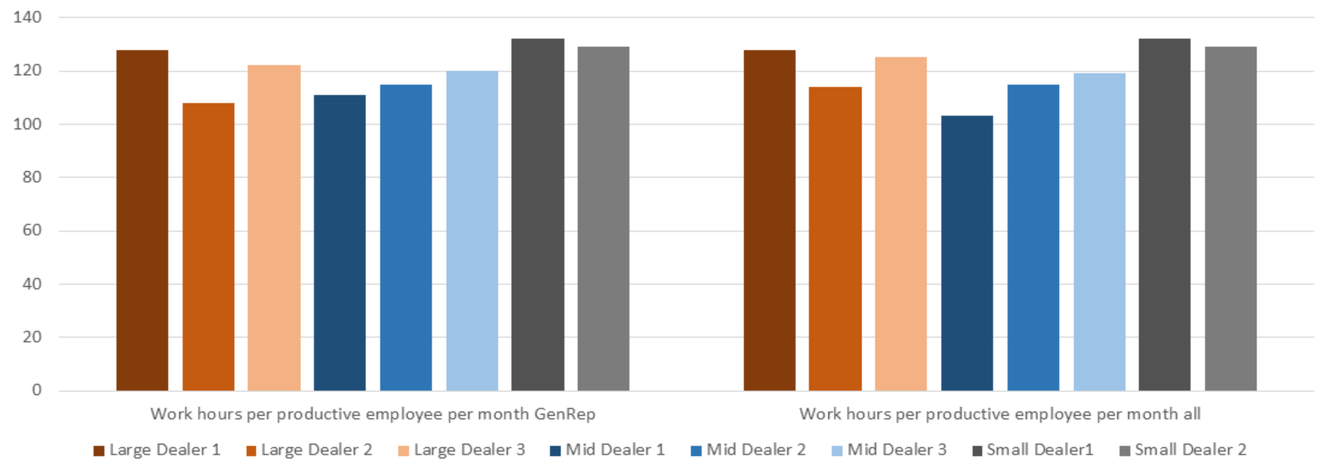


Figure 36: Hours sold

The KPI selection and ranking is validated using a DEA analysis.

Dealers that earn most of their income from other businesses, such as a carwash or a petrol station, were eliminated; this is the case with a smaller dealer (Small Dealer 3). Additionally, the KPIs for Mid Dealer 3 cover all three businesses in two locations because the accounting figures are not kept separately, and staff is flexible and mobile and employed where capacity constraints appear.

Summarizing these findings one single ideal dealer could not be identified although Mid Dealer 3 shows the best performance in many criteria. As the analysis concentrates on After Sales we can note that four other companies also have good processes and KPIs, performing well in many criteria. These are: Mid Dealer 1, Small Dealer 1 and 2 and Large Dealer 3

Good performers had the following relationship between:

Table 18: Correlation between number of car receptions, service advisors, work bays and throughputs

No. of car receptions	No. of Service Advisers	No. of work bays	No. of throughputs
1	1	3	8

The location of the business did not play a major role. Good performers are located both in big cities and in rural areas. Rather, management plays an important role. It is also not surprising that businesses with well qualified people also had good performance and quality output. Other general observations:

- Full time employees usually have 40h / week contracts and part-time employees 20h per week contracts
- In 90% of the cases there is no team-work in the workshop
- 22% of the dealers subcontracted body work
- 66% of the dealers subcontracted paint work
- 10% have introduced the new body technology
- The average number of waiting days for an appointment is 4 days – best 2 days (Mid Dealer 1 and Small Dealer 2) – worst 1-1.5 weeks for engine repairs (Small Dealer 2)
- NORA – almost all (80%) deliver parts for NORA, 50% have a car with recommended CI 66% offer 2 deliveries / day 11% (1) offer 1 delivery / day
- 11% (1) do not deliver to NORA 11% (1) offer 3 deliveries / day.

Here we will analyze the support from wholesalers and OEM/Group. Wholesalers are responsible for retail support. The OEM does not have support functions except in situations which require a lot of expertise. The average time needed to answer a request (wholesale - retail) is 15 min plus the time until it is opened. The average total time until an answer reaches the retailer is 56 min, requiring 3.8 dialogs between wholesale and retail technical support. As technical support is located in one location, differences arise only in the performance and knowledge of the employees. The better qualified they are and the more effectively they work, the faster they are able to answer queries and solve problems.

In an ideal procedure every request would be opened and answered immediately. This would also speed up the process at the retailers and reduce the waiting time for customers.

In complex cases, when the problem cannot otherwise be solved, the OEM is involved. A DISS level 3 message must be sent to the OEM within 2 hours. The average answer time in such cases is 20 min, and 10 hours if every link in the chain is needed to solve the problem: R&D, Quality Assurance and other technical departments in After Sales. The target for writing a PCC is 18 weeks, depending on how fast the problem spread is localized and how many departments have to be involved. Here every process improvement that helps to speed up the procedure is welcome. In the warranty and goodwill process major improvements were achieved by automating claims checks. The speed of claims processing depends on the retailer itself. On average, a retailer needs 7.5 days to submit a claim after repairing a car. The analysis showed that there are also dealers that submit claims daily. The timely submission of a claim by the retailer can shorten the processing time by 6.5 days. On the wholesale side the shortest time needed to process a warranty claim in which a part must be checked is 24 hours – which represents a good time.

The parts logistics has good standards of transparency and speed. The forecast system Autopart calculates parts needed and automatically sends orders to wholesalers. Parts are received within 24h. Express deliveries, if parts are available, are received in 5 to 6 hours. Parts are delivered to retailers twice a day. Some exceptions are made in locations where the distance to the retailer is short; here three deliveries per day are made. **The challenge is to balance the storage costs and transportation costs with parts availability.** Customers, and especially fleets, go to the competition not only because of higher repair costs but also because of the time needed for repairs.

In this chapter best practice examples at retail level were analyzed by considering outputs regarding operations, resources needed, organizational structure and financial and qualitative results. Factors that affect performance were described and relationships between organization, resources and output were disclosed. Best practice in relation to support by wholesalers and OEM is limited since OEM and Group are not involved in operative issues, except when problems cannot be solved at the wholesale level. Further interesting insights can be gained in chapter seven in which Volkswagen is compared to other relevant industries. The comparison at the wholesale level was also limited because some functions are centralized and differences arise mainly from the varying quality and knowledge of the employees performing the operations. The comparison was further limited by the differing processes and operations at different localities, such as in different regions or countries, or as the result of differing degrees of standardization. The next chapter will discuss the findings and results from another perspective by considering further improvements and implementation opportunities.

5.2 Discussion

This section reflects the results described in chapters four and five, discussing effects, opportunities, and feasible scenarios. The aim is to achieve a competitive, sustainable advantage by considering trends, the changing environment, and the current situation.

Dividing the topics into the following five categories, we conclude that:

5.2.1 The Customer

Customer loyalty is crucial, being the foundation for the sustainable economic success of any business.

The target in After Sales is to provide the perfect individualized service to customers. This can vary, depending on customer characteristics and requests. The interviews made clear that the first major task in retail is to correctly identify the needs, spoken and unspoken, of the customer. The overall target is to keep the customer mobile. The retailer must deliver not only good performance by repairing the car in a short period of time but also by managing the customer's expectations. Here, customer service is essential. The OEM can help by providing the retailer with tools that assist in recognizing the customer profile. Considering new technologies and how they can best be used to support business, or create more business, a frequently quoted topic is "Big Data" which has different aspects. Interesting for After Sales is:

A. Social listening, which captures, in real-time, customer opinions and needs and
B. Predictive, personalized marketing promotions according to the state of the vehicle and customer needs (the provision of personalized service offers related to the vehicle such as insurance, financing. Other possible services are hotel or restaurant reservations when a customer drives from one point to the other, making appointments with friends at destinations, etc.)
C. Predict customer evasion
D. The interest of IT companies in developing cars, see Google, or of suppliers of infotainment technology in entering co-operations with OEMs can be explained by the fact that the car is an important medium that provides necessary information to create new business models by matching customer and car data. This leads to the development of new business fields that increase revenue and profit. OEMs must take care not to miss additional business opportunities for potential new customers, such as the younger generation which is more attached to smart phones than to cars. Another example of a lost business field is the oil industry. This industry would never have achieved this development if the most common engine had not worked with mineral oil. The OEMs could have invested in mineral oil exploration, achieving high margins, especially in the past when exploration was concentrated on oil fields easy to exploit.

> Nowadays, OEMs like Audi invest in wind power stations that generate the electricity necessary for electric cars, but this is a very small amount of the whole business share.

Customer loyalty can be increased by providing the perfect service, but also strategically by making the vehicle indispensable to the driver. This implies the development of additional services around the car and customer, mainly by providing value for the customer.

5.2.2 Processes and Organization

The research started with the analysis of four core processes in After Sales. Processes and the business organization are factors that make an important contribution to the economic success of a business. Good performance is achieved when processes are aligned in the value chain from customer to OEM, when interface problems do not exist, operations are efficient and easy to understand for both customer and business employees, and high transparency is achieved. Effective processes lead to higher customer satisfaction and profitability. Good organization process improvements can also be achieved by using new technologies, especially IT and data sources. Nowadays, a service adviser, or the technical employees engaged in the repair process, must correctly identify the extent of the repair after a short diagnosis.

This is one area that has already changed or will change in future. Telematics connect the car to the workshop and relay data about the vehicle's condition, so a diagnosis can be made online and the service specialists decide if the car has to be repaired or not, an appointment proposal is sent to the customer with additional information such as diagnosis result, repair time and estimated costs. The processes in the workshop must be consolidated, freeing up capacity when customers arrive, making tools and equipment and, last but not least, the necessary genuine parts available. Currently, almost half of the interviewed dealers do not have enough parking available because of a location where parking extension possibilities do not exist. Therefore special attention is necessary to enable a smooth and effective process flow in the workshop without long waits because parts, free work bays or technical support for repairs are not immediately available when needed. One solution to capacity problems is to repair the car in a shorter time by increasing staff and dividing the work differently – for example two mechanics work simultaneously on one vehicle. A concept called "three-point-work bay" that splits the tasks of a car service between three technicians was developed more than fifteen years ago by a workshop equipment supplier, Autop. A few years ago Toyota and Hyundai introduced a maintenance process carried out simultaneously by two technicians. At the end of 2012 and the beginning of 2013 a maintenance process called "Team Speed Service" was developed by Group After Sales together with Skoda, which used a similar principle, with Skoda Germany and Wagner Consulting. Here the process is accelerated by using two employees and reducing distances – a well prepared work bay with everything close at hand. The results are promising as the work time required for a service is between 20 and 30 minutes, compared to 50 to 60 minutes when one technician works on the car. Additionally, the process quality was increased because the new work split also allows more quality check steps than previously.

The described processes would also improve, or more precisely reduce, the repeat repair quota which has a direct impact on customer satisfaction. The quality of the back office processes is a permanent issue. The OEM and the wholesalers have to allocate adequate capacities for developing solutions to unknown problems quickly and providing the retailers with information, adequate tools and support.

In analyzing the data from the service analysis reporting we see that the average time for a repair is two hours. This raises the question: if a repair takes on average two hours plus the preparation, reception and delivery time, which is a maximum of one hour, totaling three hours, is it really necessary for a customer to be without his car longer than these few hours? In many cases mobility replacement must be ensured, increasing the costs to be paid by the customer, OEM, retailer or wholesaler. By completing the repairs and administrative tasks within two to three hours and less, these costs can be further reduced.

The effect of a car connected to the existing processes is also worth mentioning: by combining OEM car data and retail customer data, the relationship between the retailer and the customer will continue outside the dealership. The car reception process will change as some diagnoses take place online; the role of the retailer will evolve from a service provider to a consultant for customer problems and a manager of customers' vehicles because Big Data will enable automated service decisions.

Technically, besides online diagnosis, telematics and Big Data will ease recognition of connections, thus enabling preventive maintenance and repair. This can further reduce warranty and goodwill costs not only for the OEM, but also for customers as it can help to avoid consequential damage. The premises for a repair to be completed within a few hours are:

- good capacity planning so that work bay, technicians, tools, and parts are available
- parts availability depends on the IT system forecasts and on the dealer himself as he must accept the parts stock proposed by the system. Parts logistics is transparent and fast since, through Autopart, parts are automatically ordered from the wholesaler. Parts are received within 24h. If parts are available, express deliveries are made within 5 to 6 hours.

An interesting aspect of the next phase of the research is a comparison with other industries in order to gain an insight into whether services such as technical support or parts delivery can be carried out more quickly than in the Volkswagen chain and with better use of resources and assets.

Key questions are:

- How good are other companies in this field of business?
- Do they offer more than two deliveries per day?
- How quickly to they deliver ordered parts?

As with services, the prognosis for customer needs relating to parts can be forecast and customized offers can be made, reducing advertising costs.

Elaborating on the supply chain it was noted that at wholesale and Group level the volume of orders is not constant, but Mondays are always busier than Fridays. At Group level there are problems making reliable forecasts for some customers. It may be interesting to know:

- how other industries deal with such circumstances and what solutions are successful in practical experience,
- the share of cross dock in the supply chain, and how much this speeds up deliveries
- the shortest period, at acceptable costs, for delivering parts from Group to wholesalers or from wholesalers to retailers?
- how has Big Data changed the business models in companies that have applied it?

Current publications write that Amazon and Deutsche Post are testing drones (unmanned aerial vehicles) in the logistics field to deliver packages to customers in 30 minutes or less. Even if the process takes years until it is available it shows the direction in which logistics will develop. The principle can be applied to After Sales in the automotive business too. In an ideal business world the parts stock at retailers is low, the main stocks are kept at the wholesale and OEM level, but necessary orders can be filled in a short time. In terms of sustainability, only what is necessary is produced, based on forecasts.

- A further basic process is the order tracking. Transparency in the ordering and parts delivery process must allow parts tracking until the part is delivered to the dealer.
- Recalling the trend in technical support, the evolution to lifetime technical support, the need to be familiar with a variety of cars and the number of problems to be solved with the same resources, an exchange of experience with other industries would be very interesting.

The warranty and goodwill process at VW differs to that of other brands; the process could be simplified if there were a direct link between parts sold, fitted in cars and warranty claims. A comparison with other industries could reveal feasible solutions. Although the warranty and goodwill process is partially automated and it depends firstly on the retailer how fast the claim is submitted, in cases where the claim and part are checked by wholesalers this processing time takes between 8 and 33.5 days for the retailer to receive the money. Through warranty audits the back office processes must be further improved.

In the parts sales process, besides the already mentioned reliable forecasts and customized and proactive marketing, Big Data can help predict daily turnover based on the historical data, can optimize inventory and better align parts sales with parts inbound. In addition, optimal planning of employee resources can be achieved. From the interviews conducted in logistics at Group level, a deeper analysis of the results of using cross dock at the master depot in Kassel revealed that parts labeling was the critical factor. Therefore, special attention must be given to part identification. QR codes originally designed to track parts in vehicle manufacturing now have many application fields such as:

- item identification,
- time tracking,
- document management,
- general marketing, and much more.

The aim is to identify the best identification technology, allowing rapid product tracking in the parts business, and to align the product supply from OES and other suppliers with the warehouse inbound and storage capacities and sales. At present, approximately 46% of operative employees are engaged in packing and repacking activities. Could an alternative task distribution save costs?

Currently, the cost level in Kassel is, at 37%, still high because of the 50% strategic stocks which amount to only 9.5% of revenue. Following the example of Toyota in the production supply, the question is, could a solution be found to build parts to order in cases where a part that is usually sold only once a year is requested?

5.2.3 Flexibility

Flexibility is understood as the ability to react to changed requirements at every level in the organization. Generally, the closer the organization is to the customer the higher the flexibility. Flexibility is higher at the retail level and lower at OEM level.

The current organization allows a flexibility of 5% in terms of capacity at Group level, and a significant question is whether other industries have found other solutions under comparable conditions? As has been stated, it is difficult to find good employees in the German retail business. The analysis revealed that there are limited career opportunities and the payment of certain functions is low. Some of dealerships analyzed had a variable component integrated into the remuneration, but the question is: are there more effective remuneration models without substantially increasing personnel costs?

Another aspect, when discussing flexibility, is related to the ability of an organization to assimilate new things and to rapidly change its processes due to the new requirements.

In his book The Fifth Discipline (Senge; 2004) the author claims that the most successful corporations have the ability to learn faster than the competitors at all levels in an organization.

Furthermore, whenever there is resistance to change the leaders should be able to discern the hidden cause of the resistance. At the moment, there is no heading "Flexibility" in the KPI reporting system although some KPIs could be reported under this heading.

When considering the Volkswagen organization at OEM level, flexibility also depends on the involvement of the unions in change processes. Ignoring their role and influence can lead to serious implementation problems.

5.2.4 KPIs

The success of every business can be measured by two important sets of KPIs.

<u>Firstly,</u> customer satisfaction KPIs measured by:

- the Customer Satisfaction Survey (CSS),
- the IACS – a classification society that allows comparison with other OEMs,
- ad hoc surveys undertaken as necessary, or retail's own studies
- in the parts business a survey is undertaken once a year measuring managerial satisfaction with the Group.

The subject of the study was the CSS, and the most remarkable observation is that customers show more tolerance of small businesses while mid-sized and large dealerships are judged more critically. This evaluation has not changed for many years despite the substantial effort in retail training and coaching by the OEM. Could a price difference of up to 15% in service hours charged, incline customers to evaluate the business less critically? A comparison with other industries could help to answer this question.

<u>Secondly,</u> the financial success of an operation is crucial to the existence of any business. A comparison of KPIs used in other industries, if such information is available, would be very interesting.

5.2.5 Contractual Relationships

Contractual relationships are part of **a** successful business design. There are several contractual relationships in After Sales. The most important are:

- Between OEM and genuine parts suppliers. Here the Volkswagen organization has to modify its approach from concentrating only on its own organization to taking into consideration the whole chain from supplier to retail. The literature splits the chain in upstream (parts supplier – OEM) and downstream (OEM - wholesale - retail). Until now Volkswagen has concentrated on the logistics in its own master depots and warehouses including the wholesale level. Recently, a new project was initiated with the aim of focusing on the whole chain from supplier to retailer. This implies a good alignment between the interfaces, stock transparency, and new contractual relationships, especially with the supplier.

- Between OEM and wholesale
- Between wholesale and retail
- Between employee and employer. Already mentioned were the problems of recruiting good employees at retail level. Here the career development possibilities, including the financial ones, are limited. Surveys undertaken in the retail organization in seven markets revealed that the financial aspect is important, but not always the deciding factor for employee fluctuation. Soft factors such as management style often play the most important role. A masterpiece of diplomacy is to make clear to the owner of a retail business, who is also the general manager, that the employees quit because of the management style. This is often the case in small and mid-sized dealerships. If, on the other hand, the manager is skillful the retail business is very successful as some owners work with more passion than paid managers, and when facing serious problems do not easily give up because their existence depends on the business.
- Between OEM, wholesale, retail and diverse agencies, service providers and specialists.

The redesigning of contractual relationships can reshape the service level support. This principle was implemented in aerospace and defense, which are known as capital intensive industries.

There are many differences between the automotive industry and aerospace, but there are also similarities. The principle of sharing risks and opportunities can also be applied in the automotive industry. A good example was the warranty parts logistics and parts backorder process, for which VW uses diverse logistics suppliers. The contractual relationship stated that the logistics company was not responsible for transport damages or for losses during transport; since drivers have been made responsible for the goods logistics the costs for goods damaged, destroyed or lost have decreased. The process change has led to an increase in time for the parts receiving process because logistics suppliers now pay attention to the goods received in order to minimize the transport costs.

Having described the main findings of the analysis, identified the areas with the most improvement potential and set priorities, the next step is to contact companies from other industries with best practice examples. According to my literature research, it seems that the most valuable benchmarks will be found at high tech companies, logistic providers, IT companies, and MRO; interviews with the relevant managers and specialists will be organized.

5.3 Conclusion

In the previous sections a short description of the present situation, trends and challenges of the automotive industry in a particular market, Germany, was made. In addition to new product technologies, IT, Internet, intelligent data usage, social media, diverse and changing customer expectations, human resources issues and legal regulations, the competition between automotive companies is a big challenge for every organization. And Volkswagen, the subject of the analysis, due to its dimensions and complex organization on several levels, wholesale, OEM, and Group, faces additional complexity that has to be to be managed efficiently.

To make the analysis more tangible, at the retail level nine dealerships, differing in size, were visited. A third of them were large, one third were mid-sized and the remaining third were small dealerships. All location possibilities were covered: large cities, mid-sized cities and rural areas. In 33% of the businesses all relevant functions from Sales to After Sales were covered. At the wholesale level the interviews were conducted at headquarters and in two regions. This also applied to the logistics function which is bundled in a separate company, owned to 52% by the VW Group, the so called OTLG. At the OEM level all departments that cover the processes analyzed were visited and interviewed. In total one hundred eight interviews were conducted, fifty six at retail level, thirty seven at wholesale level and fifteen at OEM/Group level. The choice fell on the German market because this represents approximately 50% of VWs Europe After Sales business.

Based on the analysis of four major processes in the After Sales business: repair process, warranty & goodwill, parts sales, and reverse service (or parts backorder process) the best dealer practice models regarding organization, process efficiency, quality, steering, customer satisfaction, and financial results were explored.

The investigation revealed that there was no single ideal dealer; instead five businesses achieved good performance in the varying comparisons.

Although cost estimation per process was not possible as dealers work with different KPIs which do not allow process cost estimation, the cost overview was recorded, visualized and further developed.

In a next step the main characteristics of a successful business were identified, and KPIs to control the operations were described in a model, structured on four levels and completed with additional figures.

The material collected in interviews provides valuable information for process, organization, and performance analysis. Findings are:

- Capacity and coordination factors expressed by the numeric relation of: car receptions – work bays – throughputs
- New KPIs were introduced because it was realized that the existing ones are not sufficient or are not consistently applied in the whole value chain from retail to OEM or Group.

Best practice in relation to support by wholesalers and the OEM is limited since the OEM and the Group are not involved in operative issues, except when problems cannot be solved at the wholesale level.

The comparison at the wholesale level was also limited because some functions are centralized and differences arise mainly from the varying quality and knowledge of the employees performing the operations. However, improvement potential exists in the following areas:

- Improved ratio of value to non value steps
- Coordination in parts delivery from supplier to OEM and from OEM to wholesaler
- IT systems and administrative tasks
- Improved resources allocation to enable shorter reaction times to retail queries.

One can conclude that of all challenges mentioned at the beginning of the section, the business digitalization will lead to a steep transformation of the business model.

Therefore the next step in the research will include the benchmark with other industries such as IT, logistics and aircraft service – industries where the digital transformation has so far been successful. The main research questions in that phase will be:

- What new technologies and practices can be used and adapted to the specific needs of automotive service and logistic operations?
- Are there better KPIs to control and guide the operations?
- What does the structure and design of an integrated multi-attribute set of measures at every level of the service supply chain look like?

The reader may ask why this issue is so important right now; it is important because technology developments mean new business models must also be developed. Despite advanced technologies the business model in the automotive business is still traditional. New business models need well-designed and integrated processes. Due to digitalization and the increasing share of electronics in cars it can be expected that the automotive business will reveal similar characteristics to the IT business. The ability to store and process huge amounts of data in a short time and the intelligent use of such data and resources will define the success or failure of a business.

One key success factor will be the usage of the customer data. Previous studies on customer mobility have revealed that human behavior is highly predictable based on the tracks left in digital spatial data. Habits, interests, routines, past experiences and special characteristics shape human beings to such an extent that, upon closer analysis, much of our behavior can be predicted in advance. Until now, without such technological support, predictions were largely based on intuition. Nowadays, the more data related to our personality traits and preferences which we reveal on countless web platforms, the more predictable we become. The quality of predictions depends not only on the quality of the data used, but also on the algorithms used.

The legal regulations related to consumer data usage differ from country to country. In Germany the regulations are particularly strict and can lead to potential competitive disadvantages.

Surprisingly, in the domestic market the commercial usage of the customer data is seen as a bigger risk even than the manipulation of public opinion. Moreover, many Germans are prejudiced against commercially active organizations that want to advertise their products and services, forgetting that the worst thing that can happen is that companies direct their advertising at individuals in situations in which the probability of a purchase, based on previous behavior patterns, is greatest.

What critics overlook is that the difference to marketing activities practiced for decades is in the more precise prediction of actions and individualized offers. The free will of every individual to decide whether or not to make a purchase remains unchanged, although some people probably have little joy in the thought that it is possible to predict their actions so precisely. In order to increase sales offers the legal issues and customer prejudices need to be overcome.

This thesis started with a description of the situation at the beginning of the analysis, and continued with an elaboration on findings based on reporting and direct observation. The next chapter will further analyze the retail businesses by applying another method used to determine the efficiency of those businesses visited. This method is called Dealer Envelopment Analysis (DEA). Of interest is whether the DEA confirms, contradicts and/or introduces new aspects to the analysis of the businesses.

6. About DEA

One of the goals of the research was to determine the efficiency of the retail businesses visited by using a multi-criteria approach and to compare the results of the new method used with the two-criteria method usually used in reporting. Efficiency is understood as the measurement of a proportional change in inputs or outputs.

In this section, the method used to determine the efficiency of the retail businesses interviewed in the first part of the thesis will first be explained. The results achieved will then be described. Finally, a benchmark reference will be provided and the section will be completed with a recommendation for the next steps to be taken. All the subsections are listed below:

6.1. Method description

6.2. Selection of Inputs, Outputs and the number of DMUs

6.3. The input oriented CRS model

6.4. DEA results

6.5. Benchmark reference

6.6. Regression analysis and conclusion

6.7. Recommendation

6.1 Method description

Data envelopment analysis or DEA is a statistical method used in operations research and economics for the estimation of productivity frontiers. It is a non-parametric approach in the sense that it makes no assumptions about the form of the productive operation or productivity function. At the same time it is a powerful benchmarking tool that helps evaluate and compare decision making units (DMUs), in our case dealers, in terms of efficiency and productivity.

The method indicates the DMUs that are using their assets more efficiently and generating more output than others and indicates inefficient businesses.

The references mainly used for the DEA, besides the papers mentioned in the list of references, were: De Leone (2009), Open Source DEA (2016), Pascoe et al. (2003), Golany and Roll (1989).

DEA is a linear programming based technique for measuring the relative performance of decision making units (DMUs). In the presence of multiple inputs and outputs the comparison between different units becomes difficult. A key advantage of DEA over other statistical approaches is that it more easily accommodates both multiple inputs and multiple outputs. Therefore, DEA is commonly used to evaluate the efficiency of a number of DMUs. It allows users to conduct optimization procedures and extended managerial analysis.

DEA is based on a certain number of DMUs and a number of different kinds of corresponding inputs and outputs. The productive process for each DMU is defined as taking a set of inputs and producing a set of outputs. A typical statistical approach is characterized as a central tendency approach and it evaluates productive units relative to an average producer. In contrast, DEA finds the "best" virtual producer or the frontier by enveloping all the observed inputs and outputs**.** It compares each DMU with all other DMUs, and identifies those units that are operating inefficiently compared with other units. In addition, DEA measures the magnitude of inefficiency of the inefficient DMUs compared to the best practice DMUs.

After establishing the frontier, DEA checks if the DMU's performance is worse than the frontier's performance. The meaning behind "worse" performance is that the DMU is either making less output with the same input or making the same output with more input than the frontier. Consequently the DMU is inefficient and DEA assigns an efficiency score of less than one to the DMU. A score below one means that a linear combination of other DMUs from the sample could produce more outputs with the same number of inputs, or produce the same number of outputs by using a smaller number of inputs. On the other hand, if the comparisons of the DMU with other relevant units do not provide evidence of inefficiency and the use of any input or output producer is efficient, then DEA assigns a score of 1 to this producer and the DMU is termed efficient.

In the mathematical sense, the efficiency of each DMU is measured by the distance of its input-output vectors to the frontier.

6.2 Selection of Inputs, Outputs and Number of DMUs

Before performing a DEA we need to determine the number of DMUs and the input and output KPIs that describe the business performance and the assets used. The selection and the number of inputs and outputs and the DMUs will determine how much discrimination exists between efficient and inefficient units. We also need to keep in mind that data, all input and output KPIs of each DMU, are needed to perform a DEA. The input and output variables must reflect the resources used, the outputs obtained and the operating environment of the DMUs compared.

For the purpose of this thesis, due to capacity limitations, eight observations, eight DMUs were used.

The selection of the DMUs is an important step in non-parametric models. In order to obtain meaningful estimations, as many observations as possible should be included. Indeed, the relative nature of a DEA makes it vulnerable to problems with the degrees of freedom. The number of degrees of freedom will increase with the number of DMUs in the sample, and will decrease with the number of input and output measurements. However, there is a rule of thumb on the number of inputs and outputs to select and their relation to the number of

DMUs. Golany and Roll (1989) established a rule of thumb whereby the number of DMUs should be at least twice the number of inputs and outputs considered.

A DEA has a major advantage in that it points to real inefficiencies that are often substantial and generally not identifiable with other techniques.

A DEA assigns weights in order to make each service unit look as efficient as possible. Weights are calculated on the basis of the linear program formulation and have managerial and analytic value.

The mathematical model formulation of a DEA as a generic measure of efficiency which was developed in 1960's:

$$J = number\ of\ service\ inputs, j = 1,2, \dots, J$$
$$I = number\ of\ inputs\ used\ by\ service\ unit\ j, \quad i = 1,2 \dots, I$$
$$R = number\ of\ outputs\ generated\ by\ the\ service\ unit\ j, \quad r = 1,2, \dots, R$$
$$\theta = efficiency\ rating\ of\ the\ service\ unit\ being\ evaluated\ by\ DEA$$
$$su_j = service\ unit\ number\ j$$
$$y_{rj} = amount\ of\ output\ r\ used\ by\ service\ unit\ j$$
$$x_{if} = amount\ of\ input\ i\ used\ by\ service\ unit\ j$$
$$u_r = coefficient\ of\ weight\ assigned\ by\ DEA\ to\ output\ r$$
$$v_i = coefficient\ of\ weight\ assigned\ by\ DEA\ to\ input\ i$$
$$Optimize\ efficiendy\ rating\ for\ service\ unit:$$
$$\theta = \frac{u_1 y_{1\theta} + u_2 y_{2\theta} + \dots + u_r y_{r\theta}}{v_1 x_{1\theta} + v_2 x_{2\theta} + \dots + v_i x_{i\theta}} = \frac{\Sigma_{r=1}^{s} u_r y_{r\theta}}{\Sigma_{i=1}^{m} v_r x_{i\theta}}$$
$$u_1, \dots, u_s > 0$$
$$v_1, \dots, v_m \geq 0$$

A DEA can be conducted under the assumption of constant returns to scale (CRS) or variable returns to scale (VRS). CRS reflects the fact that output will change by the same proportion as inputs are changed (e.g. a doubling of all inputs will double output) and VRS reflects the fact that production technology productivity may exhibit increasing, constant and decreasing returns to scale and is divided into technical and scale efficiency.

For the purposes of this project CRS is used.

Input-oriented DEA: Different DEA models have been developed to measure efficiency and capacity in different ways. Mostly they fall into two categories of being either input-oriented or output-oriented models. Input-oriented models look at the amount by which inputs can be proportionally reduced with fixed outputs. In this case the DEA determines how much input a DMU would need, if it is used efficiently, in order to achieve the same output level. In an output-oriented model an inefficient unit is made efficient through the proportional increase of its outputs, while the inputs remain fixed.

6.3 The input-oriented VRS model

The linear programming technique is used to find the set of coefficients.

Assumptions:

- j … unit
- u… coefficient of weight of output r;
- v… coefficient of weight of input i;
- x… input r by unit j;
- y… output r by unit j;
- k … number of outputs;
- i… number of inputs by j
- r… number of outputs by j;
- s… sum of all units
- X … i x s input matrix;
- Y … r x s output matrix;
- θ … efficiency score, $\theta \in [0,1]$;
- λ … constants

Model (simplified version of generic model adapted for the study):

$$
\begin{aligned}
& min_{\theta,\lambda}\ \theta, \\
& s.t.\ \ -y_i + Y\lambda \geq 0, \\
& \qquad \theta x_i - X\lambda \geq 0, \\
& \qquad \qquad \lambda \geq 0
\end{aligned}
$$

With the help of the DEA we were able to measure the relative performance of organizational units where the presence of multiple inputs and outputs makes comparison difficult and time consuming.

It proved to be an effective approach to measuring the efficiency of retail businesses in cases where traditional approaches provide suboptimal results or are laborious to apply.

Due to the complexity of the available data collected, the challenge, at first, was to find suitable classifications and relationships for the DEAs to be presented. Therefore the following method of analysis was applied. First, the individual data were categorized according to their divisions (Sales, After Sales, Service Parts, Overall) and selected for their classification in the DEAs based on experience. Because of the low number of businesses analyzed in connection with the analytical requirements of the DEA, the number of input- and output-factors was limited in the first twenty-nine runs to 3 aspects each.

Later on an additional eight runs with more than 3 input- or output criteria were conducted.

See the list of both trials on Table 19 and 20.

The goal thereby was to be able to define at least one DEA for each division (Sales, After Sales, Service Parts, Overall) in order to ascertain the applicable efficiency ranking of the business examined and, finally, to be able to depict the related benchmark.

Table 19: List of first set of DEA trials

No. of Trials	Input	Output	Comments	Top / Flop
1	FTE Sales & Other Business New Car Sales Used Car Sales	CM 3 Sales & Other Business Revenue Sales & Other Business	Sales and administrative Staff + Output / Financial Output Sales mainly + Profit Sales	**Top:** LD2, LD3, MD3, SD1, SD2 **Flop:** LD1, MD2
2	FTE After Sales No. of Throughputs	CM 3 After Sales Revenue After Sales	After Sales Staff + After Sales Output / Financial Output After Sales + Profit After Sales	**Top:** LD1, LD2, LD3, MD1, MD3 **Flop:** SD1, MD2
3	FTE After Sales No. of Throughputs	CM 3 After Sales CSS Overall Satisfaction CSS Loyalty	After Sales Staff + After Sales Output / Profit After Sales + Customer Satisfaction & Loyalty	**TOP:** LD2, LD3, MD3, SD2 **Flop:** MD2, SD1
4	Hours sold in units/ FTE overall (New Car Sales + Used Car Sales) / in units	CM 3 overall Revenue overall	Output of Sales and After Sales in units + Staff Sales and After Sales / Total revenue + Total profit	**TOP:** LD2, LD3, MD1, MD3, SD1, SD2 **Flop:** LD1, MD2
5	Hours sold No. of Throughputs FTE After Sales	CM 3 After Sales CM 3 Sales & Other Business Revenue After Sales	After Sales Staff + After Sales Output in units and units financial relevant / Profit Sales & Other Business + Profit After Sales + Revenue After Sales	**TOP:** LD1, LD2, LD3, MD1, MD3 **Flop:** SD1, MD2
6	FTE Sales & Other Business New Car Sales Used Car Sales	CM 3 Sales & Other Business CSS Overall Satisfaction CSS Loyalty	Sales and administrative Staff + Output / Profit Sales mainly + Customer Satisfaction & Loyalty	**TOP:** LD2, MD3, SD1, SD2 **Flop:** LD1, LD3, MD1, MD2
7	Productive FTE No. of Throughputs No. of Work bays	CM 3 Service CM 3 Parts CM 3 Sales & Other Business	Productive After Sales Staff + Output in units + capacity / Profit Service, Parts and Sales & Other Business	**TOP:** LD1, LD2, LD3, MD3 **Flop:** MD2, SD1
8	Productive FTE FTE Sales & Other Business (New Car Sales + Used Car Sales)	CM 3 Service CM 3 Parts CM 3 Sales & Other Business	Productive Staff + All Staff + Sales Output in units / Profitability in all business	**TOP:** all
9	Productive FTE FTE Sales & Other Business (New Car Sales + Used Car Sales)	Revenue Service Revenue Parts Revenue Sales & Other Business	Productive Staff + All Staff + Sales Output in units / Revenue in all business	**TOP:** LD1, LD2, LD3, MD1, MD3, SD1

No. of Trials	Input	Output	Comments	Top / Flop
10	Productive FTE Hours sold No. of Work bays	(CM 3 Service + CM 3 Parts) (Revenue Service+ Revenue Parts) CSS Overall Satisfaction	Productive Staff + Output AS in units financially relevant + Capacity / After Sales Profit + AS Revenue + Customer Satisfaction	**TOP:** LD1, LD2, LD3, SD2 **Flop:** MD2, SD1
11	Productive FTE Hours sold No. of Work bays	(CM 3 Service+ CM 3 Parts) (Revenue Service+ Revenue Parts) CSS Loyalty	Productive Staff + Output AS in units financially relevant + Capacity / After Sales Profit + AS Revenue + Customer Loyalty	**TOP:** LD1, LD2, LD3, SD2 **Flop:** MD2, SD1
12	Revenue (Labor Costs + Direct Costs + Direct Operating Costs)	CM 3	Revenue + Costs / Total profit	**TOP:** SD1 **Flop:** LD1, LD3, LD2, MD2, MD1, SD2, MD3
13	Revenue Labor Costs	CM 3	Revenue + Labor Costs / Total profit	**TOP:** MD3, SD1 **Flop:** LD1, MD1, MD2, LD3, SD2, LD2
14	Revenue Direct Costs	CM 3	Revenue + Direct Costs / Total profit	**TOP:** MD3, SD1 **Flop:** LD2, LD3, LD1,MD1, SD2
15	Revenue Direct Operating Costs	CM 3	Revenue + Direct Operating Costs / Total profit	**TOP:** MD1, MD3 **Flop:** LD3, LD1, SD1 and all other
16	Revenue Service (Labor Costs Service + Direct Costs Service + Direct Operating Costs Service)	CM 3 Service	Revenue Service + Costs Service / Profit Service	TOP: MD3 Flop: MD2, SD1, LD3, LD1 and all other
17	Revenue Service Labor Costs Service	CM 3 Service	Revenue Service + Labor Costs Service / Profit Service	**TOP:** MD3 **Flop:** MD2, SD1, LD3, LD1 and all other
18	Revenue Service Direct Costs Service	CM 3 Service	Revenue Service + Direct Costs Service / Profit Service	**TOP:** MD1, MD3 **Flop:** MD2, LD3 and all other
19	Revenue Service Direct Operating Costs Service	CM 3 Service	Revenue Service + Direct Operating Costs Service / Profit Service	**TOP:** MD3 **Flop:** MD2, SD1, LD3 and all other
20	Revenue Parts (Labor Costs Parts+ Direct Costs Parts+ Direct Operating Costs Parts)	CM 3 Parts	Revenue Parts + Costs Parts / Profit Parts	**TOP:** MD3, SD1 **Flop:** LD1, MD1, LD2 and all other
21	Revenue Parts Labor Costs Parts	CM 3 Parts	Revenue Parts + Labor Costs Parts / Profit Parts	**TOP:** MD3, SD1 **Flop:** LD1, MD1, LD2 and all other
22	Revenue Parts Direct Costs Parts	CM 3 Parts	Revenue Parts + Direct Costs Parts / Profit Parts	**TOP:** MD3, SD1 **Flop:** LD1, MD1, LD2 and all other
23	Revenue Parts	CM 3 Parts	Revenue Parts + Direct	**TOP:** MD3

No. of Trials	Input	Output	Comments	Top / Flop
	Direct Operating Costs Parts		Operating Costs Parts / Profit Parts	**Flop:** LD1, MD1, LD2 and all other
24	Number of Techni-cians Number of Test De-vices Number of Work bays	Number of Throughputs	Capacity expressed by FTEs Service + building + main technique device / After Sales Output (in units)	**TOP:** SD1, SD2 **Flop:** MD2, MD1, LD3
25	Number of Techni-cians Number of Test De-vices Number of Service Advisors	Number of Throughputs	Capacity expressed by FTEs Service + main technique device + Key Service Function / After Sales Output (in units)	**TOP:** LD1, SD1, SD2 **Flop:** MD3
26	Number of Techni-cians Number of Work bays Number of Service Advisors	Number of Throughputs	Capacity expressed by FTEs Service + building + Key Service Function / After Sales Output (in units)	**TOP:** LD1, MD2, SD1, SD2 **Flop:** MD1
27	Number of Test De-vices Number of Work bays Number of Service Advisors	Number of Throughputs	Capacity expressed by main technique device + building + Key Service Function / After Sales Output (in units)	**TOP:** LD1, SD2 **Flop:** LD3
28	Nr. of Throughputs Hourly rate (achieved)	(CM 3 Service+ CM 3 Parts)	After Sales Output (in units) + Hourly rate / Profit Service + Profit Parts	**TOP:** MD3 **Flop:** SD1, MD2, SD2, LD1
29	Number of Direct Reception Work bays Number of Work bays	Number of Throughputs	Capacity expressed by building / After Sales Output (in units)	**TOP:** LD1, SD2 **Flop:** MD2, LD3

Table 20: List of second set of DEA trials

No. of trials	Input	Output	Comments	Top / Flop
2.1.	FTE Sales & Other Business New Car Sales + Used Car Sales	CM 3 Sales & Other Business	Sales and administrative Staff + Sales Output / Profit Sales	**Top:** MD2, MD3, SD2 **Flop:** LD1, LD2, MD1
2.2.	No. of Service Advisors No. of Technicians No. of Work bays CSS Satisfaction Hours sold	CM3 After Sales	Capacity expressed by FTEs Service + building + Customer satisfaction + Performance Service / After Sales Profit	**Top:** LD1, LD2, LD3, MD3 **Flop:** SD1, MD2
2.3.	FTE After Sales No. of Work bays CSS Satisfaction Hours sold	CM3 After Sales	Capacity expressed by FTEs After Sales + building + Customer satisfaction + Performance Service / After Sales Profit	**Top:** LD2, MD3, LD3 **Flop:** SD1, MD2
2.4.	No. of Service Advisors No. of Technicians No. of Work bays CSS Satisfaction	CM3 Overall	Capacity expressed by FTEs Service + building + Customer satisfaction / Profit overall	**Top:** LD2, LD3, MD3 **Flop:** SD1, MD2
2.5.	FTE After Sales No. of Work bays CSS Satisfaction	CM3 Overall	Capacity expressed by FTEs After Sales + building + Customer satisfaction + Performance Service / Profit overall	**Top:** LD2, MD3 **Flop:** SD1, MD2
2.6.	Revenue Service Labor Costs Service Direct Costs Service Direct Operating Costs Service	CM3 Service	Revenue Service + Costs Service / Profit Service	**Top:** MD1, MD3, SD1 **Flop:** MD2, LD3, LD1
2.7.	Revenue Parts Labor Costs Parts Direct Costs Parts Direct Operating Costs Parts	CM3 Parts	Revenue Parts + Costs Service / Profit Parts	**Top:** MD3, SD1 **Flop:** LD1, LD2, MD1
2.8.	Total profit overall Sum of costs overall	CM3 Overall		**Top:** MD3, SD2 **Flop:** SD1

From the total of thirty-seven trials the most relevant, providing the best overview, were integrated in the main section of the thesis in this chapter. The DEA input data remaining trials are visualized in Appendix 10 and 11, respectively.

6.4 DEA Results

The analysis starts with the general picture; in this case the main KPIs that describe the financial results of the DMUs analyzed, including all the primary functions of a retail business, and is then broken down to the After Sales function in general, following which a deeper analysis of the After Sales function is carried out.

The correlation of individual input factors with the performance indicator CM3 was examined in order to consider only correlated input- and output-factors within the framework of the DEAs.

The general KPIs that best describe the economic success of a retail business are, as input, the total profit overall and the sum of costs. As an output, contribution margin three (CM3) overall describes the efficient units that use the assets optimally and manage costs correspondingly.

	Inputs	Outputs
DEA 1	Total Profit Overall	**CM 3 Overall**
	Sum of costs	

Table 21: DEA Results total profit and costs vs. CM3 overall

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	0.60038	0.388	Mid Dealer 3	1.823	Small Dealer 2
2	Large Dealer 2	0.90452	0.143	Mid Dealer 3	6.039	Small Dealer 2
3	Large Dealer 3	0.69076	0.225	Mid Dealer 3	1.829	Small Dealer 2
4	Mid Dealer 1	0.87422	0.096	Mid Dealer 3	2.914	Small Dealer 2
5	Mid Dealer 2	0.82021	0.043	Mid Dealer 3	0.825	Small Dealer 2
6	Mid Dealer 3	1.00000	1.000	Mid Dealer 3		
7	Small Dealer 1	0.36343	0.005	Mid Dealer 3	0.002	Small Dealer 2
8	Small Dealer 2	1.00000	1.000	Small Dealer 2		

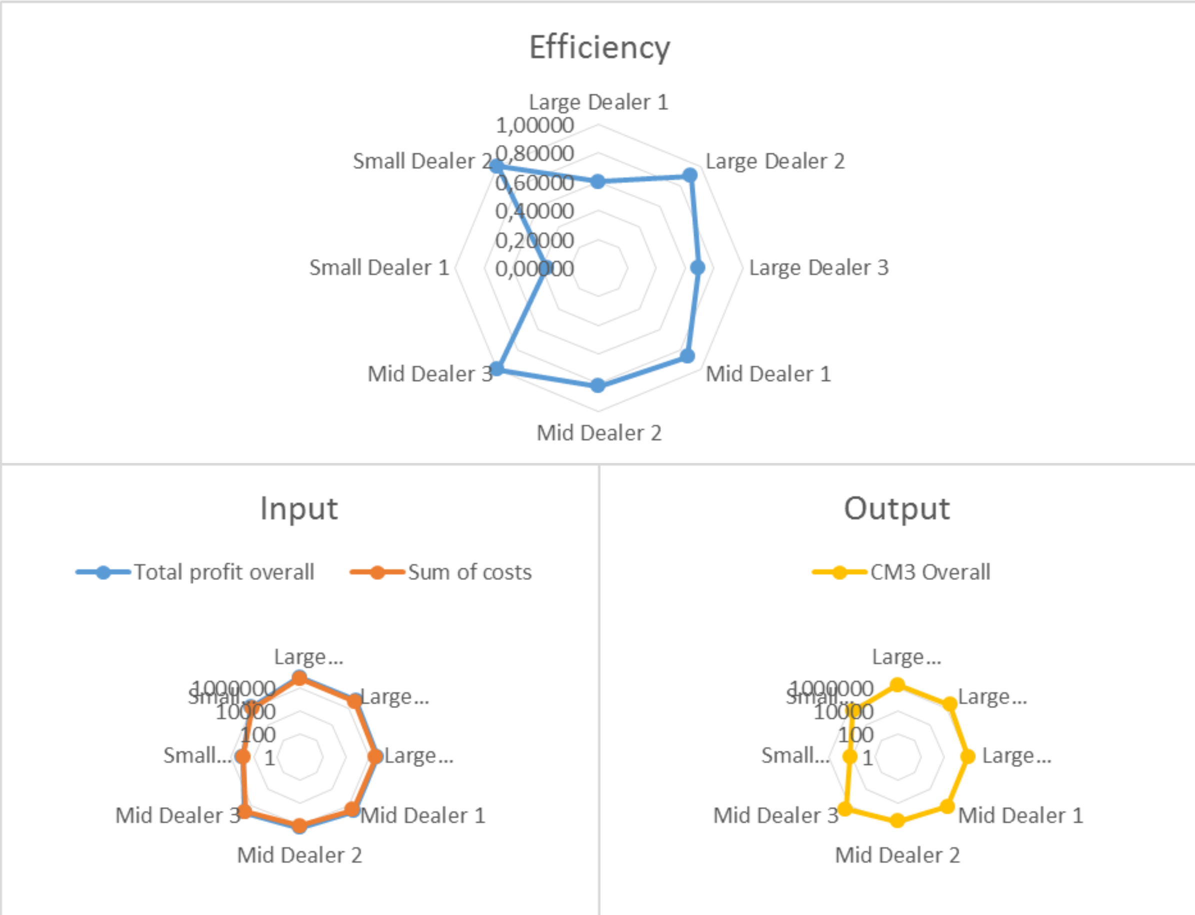


Figure 37: Radar charts overall efficiencies with inputs and outputs for overall profitability

The efficient and dominant dealers are Mid Dealer 3 and Small Dealer 2. The next dealer with good results is Large Dealer 2. On the other hand, we can see that that Small Dealer 1 has the lowest efficiency rates.

The results are illustrated in radar charts: first the efficiency, followed by the inputs and outputs. Because of differences in values, and for a better comparison, the logarithmic scale was used.

As a general observation we see that efficient dealers have lower inputs and achieve the highest outputs. In our case Small Dealer 1 does not have a Volkswagen sales contract. The revenues achieved are agency fees for customers referred to a dealer with a Volkswagen sales contract. As a consequence sales revenue is small and profits are made with After Sales.

In After Sales the retailer is very professional but also limited in terms of capacity. The parts business is modest with only a few regular customers. It is worth mentioning that the business is managed by the owners, three people, who perform the main functions of a retail business but are normally more highly paid than employees. The economic environment is currently good and the prices charged are relatively low for the geographic area where the business is located, but the owners do not intend to enlarge the business, and shy away from the risks of enlargement such as financial loans, more staff and more responsibility.

As stated above, we move one level deeper from the general picture to the After Sales function and its contribution to the overall business success. The KPIs selected for the input are a combination of resources that describe capacity, FTEs and number of workbays, and customer satisfaction values. The output is described by CM3 overall.

The efficient dealers are Large Dealer 2 and Mid Dealer 3. On the other hand, we can see that Small Dealer 1 and Mid Dealer 2 have the lowest efficiency rates.

The results are illustrated in radar charts in Figure 38.

	Inputs	Outputs
DEA 2	FTE After Sales	**CM 3 Overall**
	No. of Work bays	
	CSS Satisfaction	

Table 22: DEA Results capacity plus customer satisfaction vs. CM3 overall

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	0.56113	0.359	Large Dealer 2	0.287	Mid Dealer 3
2	Large Dealer 2	1.00000	1.000	Large Dealer 2		
3	Large Dealer 3	0.60098	0.484	Mid Dealer 3		
4	Mid Dealer 1	0.57777	0.509	Mid Dealer 3		
5	Mid Dealer 2	0.15731	0.160	Mid Dealer 3		
6	Mid Dealer 3	1.00000	1.000	Mid Dealer 3		
7	Small Dealer 1	0.01808	0.005	Mid Dealer 3		
8	Small Dealer 2	0.72571	0.142	Mid Dealer 3		

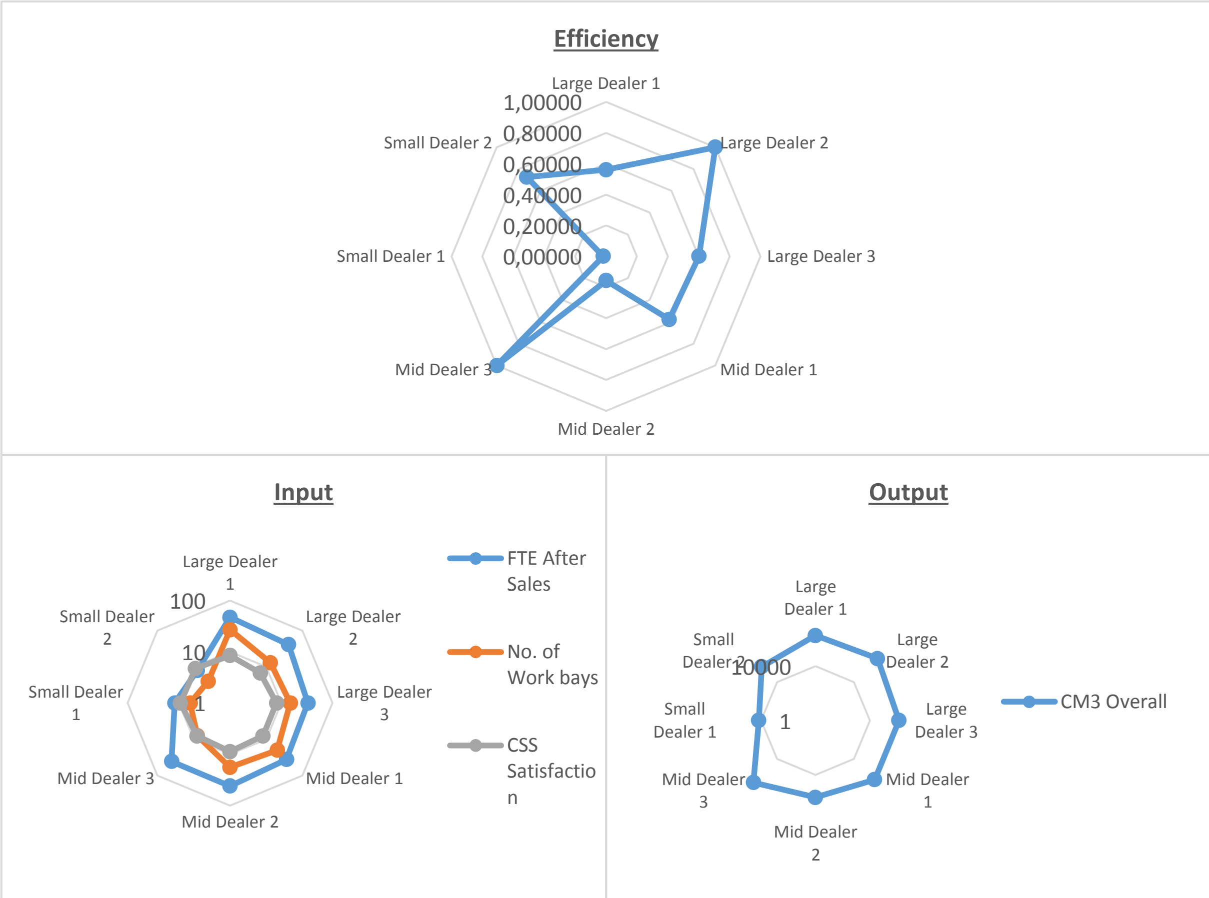


Figure 38: Radar charts overall efficiencies with inputs and outputs for capacity and overall profitability

The least efficient dealer is Small Dealer 1 because he has similar inputs to Small Dealer 2, but less output.

If we continue to deepen the analysis and add to the inputs an additional KPI that describes the service performance, the service hours sold to customers, and, instead of CM3 Overall, we select the CM3 After Sales, we obtain the results below. In this case the rule of thumb was ignored because the results were traceable and verifiable.

We obtain a similar result to the previous one. The efficient dealers are Large Dealer 2 and Mid Dealer 3. On the other hand, we can see that that Small Dealer 1 and Mid Dealer 2 have the lowest efficiency rates.

The results are illustrated in radar charts in Figure 39.

	Inputs	Outputs
DEA 3	FTE After Sales	**CM 3 After Sales**
	No. of Work bays	
	CSS Satisfaction	
	Hours sold	

Table 23: DEA Results capacity plus customer satisfaction plus performance vs. CM3 After Sales

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	0.88075	1.014	Large Dealer 2		
2	Large Dealer 2	1.00000	1.000	Large Dealer 2		
3	Large Dealer 3	0.97930	0.786	Large Dealer 2		
4	Mid Dealer 1	0.87481	0.768	Large Dealer 2		
5	Mid Dealer 2	0.23696	0.238	Large Dealer 2		
6	Mid Dealer 3	1.00000	1.000	Mid Dealer 3		
7	Small Dealer 1	0.08503	0.025	Large Dealer 2		
8	Small Dealer 2	0.86008	0.167	Large Dealer 2		

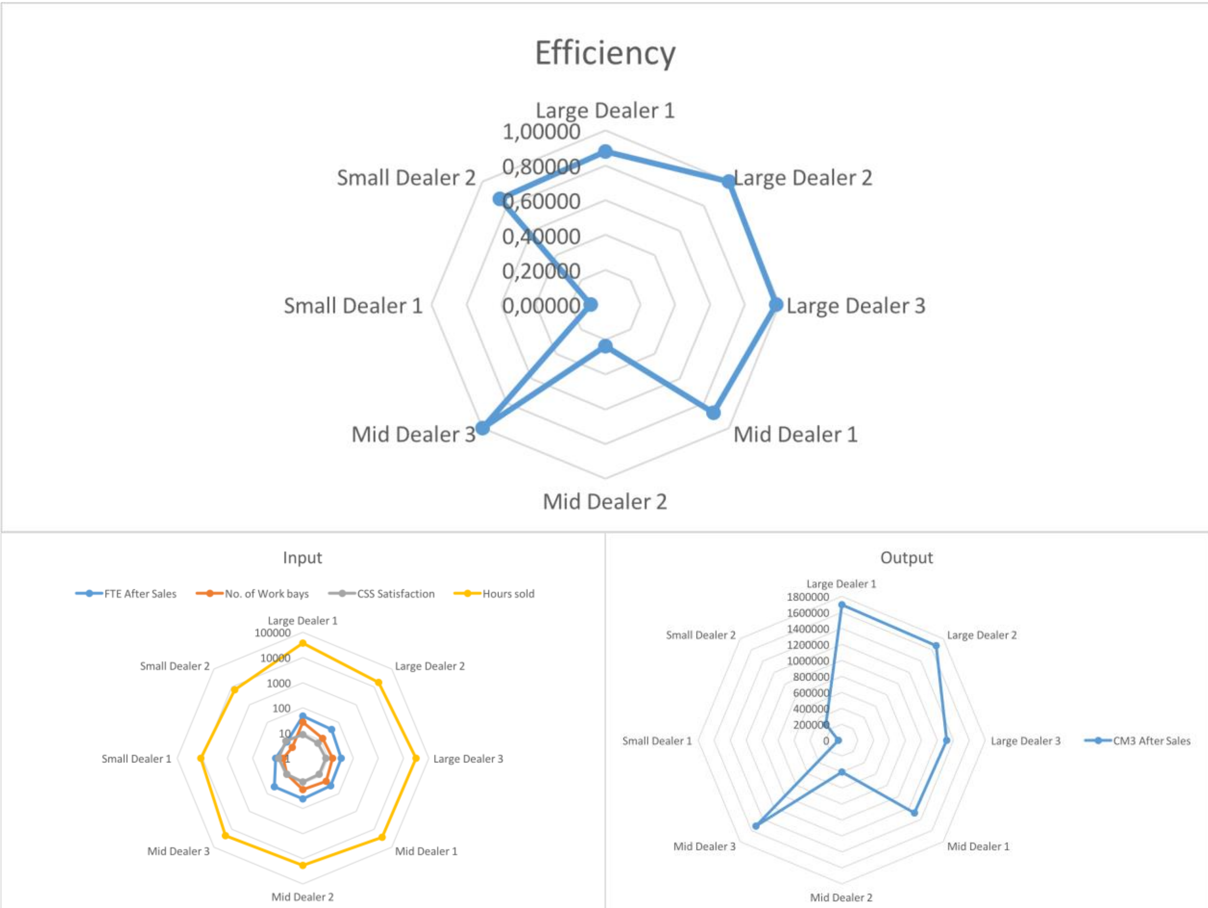


Figure 39: Radar charts overall efficiencies with inputs and outputs for service capacity, performance and profitability

One major difference is the higher labor costs in After Sales at Small Dealer 1. The business is located in a big city where salaries are higher and the key management functions are performed by the three owners.

Following the same methodology in all other trials, the best practice dealer in the most trials was Mid Dealer 3. A good performance was also achieved by Small Dealer 2 and by Large Dealer 2. Finally, by choosing another KPI combination good results were achieved by the other dealers too.

6.5 Benchmark reference

The next step was to take a deeper look at Mid Dealer 3 and the other best performers in the respective categories and to describe the resources and performance of the best practice dealers. The list was completed with other meaningful KPIs and ratios in order to achieve a complete picture of an ideal retail business. The main KPI categories identified were: business performance, financial performance, capacity, human resources and leading costs.

Table 24: List of proposed KPIs

No.	KPI	Value
Category	**Business performance**	
1	Throughputs/Work bay/Year	645
2	Throughputs/Work bay/Week	13
3	Working hours/Throughput (general repair)	2 hours
4	Hours worked/Hours sold	Min. 68% up to 100 %
5	Average Throughput/Service advisor/Day	10
6	Occupancy rate	90%
7	Performance rate	100%
8	Hours worked per productive emp. /month/all	119 hours
9	Yearly performance of productive employee	Min. 69% up to 78%
10	Customer satisfaction	Min. 8.1
11	Customer loyalty	11.2
Category	**Financial performance**	
12	Percentage revenue new car sales	42%
13	Percentage total profit new car sales	24%
14	Percentage CM3 new car sales	40%
15	Percentage revenue used car sales	41%
16	Percentage total profit used car sales	15%
17	Percentage CM3 used car sales	42%
18	Percentage revenue parts	9%
19	Percentage total profit parts	18%
20	Percentage CM3 parts	56%
21	Percentage revenue service	7%
22	Percentage total profit service	31%
23	Percentage CM3 service	76%
24	Percentage revenue outsourced services	40%
25	Percentage of direct receptions from total work bays	Min. 7%

No.	KPI	Value
26	Ratio work bays/Technicians	1.3
27	Ratio service advisor/Technicians	0.4
28	Ratio throughputs/Test devices/Year	645
29	Ratio work bay/Test devices	3.5
Category	**Human resources**	
30	Percentage of technicians	32%
31	Percentage of service advisors	14%
32	Percentage of parts employees	9%
33	Percentage of service employees	47%
34	Percentage of students	21%
35	Percentage of productive employees	70%
Category	**Leading costs**	
36	Percentage of labor intensity degree overall	8.3%, min. 4.6%
37	Percentage of labor intensity degree new car sales	2.7%, min. 2.1%
38	Percentage of labor intensity degree used car sales	1.0%, min. 0.4%
39	Percentage of labor intensity degree parts	9.5%
40	Percentage of labor intensity degree service	49%

6.6 Regression analysis and conclusions

The final step in the analysis was a regression, although it must be pointed out that this procedure is subject to statistical limitations due to the low number of observations. However, the results achieved should still provide an indication as to which variables actually influence the output.

By taking the most relevant DEAs described above, and by listing from the regression the coefficient and the value of the t-test in brackets we conclude that significant correlations exist for the second model between CM3 and CSS satisfaction. If the CSS value increases by one point the CM3 decreases by 850,084 Euro. One explanation for this development can be discounts and goodwill decisions or investments in the organization that increase customer satisfaction but generate costs.

Table 25: Significant correlations between the main business KPIs (1)

	CM3 Overall	CM3 Overall	CM3 After Sales
Total Profit Overall	-0.0800 (-0.4118)		
Sum of Costs Overall	0.4848 (1.9646)		

	CM3 Overall	CM3 Overall	CM3 After Sales
FTE After Sales		5211.9323 (0.2328)	60726.5341 (0.7568)
No. of Work bays		39507.8819 (1.2031)	301280.9833 (1.7555)
CSS Satisfaction		-850083.9791 * (-2.5410)	-1673207.7589 (-1.3671)
Hours Sold			-138.4065 (-0.8338)
Constant	41486.7931 (0.1640)	7550870.0773 * (2.3694)	14083161.4553 (1.2308)
Observations	8	8	8
adj. R^2	0.8581	0.7295	0.7700

In order to identify the most significant variables correlations were made between the different KPIs that best describe the processes. Performance KPIs such as the number of throughputs, hours sold, customer satisfaction and loyalty, or CM3 overall plus KPIs that describe capacity and organization, such as the number of direct reception work bays, test devices, number of work bays, FTE After Sales, technicians and service advisors.

It was established that there is a significant correlation between CM3 overall, the number of service advisors, the number of technicians, FTE After Sales and hours sold. The analysis concentrates on After Sales, but it is worth mentioning that in sales the highest correlation was identified between the sales performance in terms of cars sold and the sales staff.

In the table below a list of correlations between the KPIs mentioned above is provided.

Table 26: Significant correlations between the main business KPIs (2)

	Correlation 1	Correlation 2	Correlation 3
	CM3 Overall	**CM3 After Sales**	**CM3 Sales**
Service Advisor	94%		
Sum of Costs Overall	74%		
Technicians	75%	79%	
No. of Work bays		89%	
FTE After Sales		78%	
Hours Sold		76%	
Service Advisors		86%	
Work bays		89%	
FTE Sales			89%
Cars sold			76%

It must however be pointed out here that this procedure is subject to statistical limitations due to the low number of observations. The advantage of the regressions is that they provide an indication as to which variables actually influence output and to what degree.

The list of relevant regressions is provided in Appendix 12.

The significance is important. Taking into consideration the combination of the following criteria:

a. p-value considered significant between 0.01 and 0.05,
b. t-value high and
c. F-crit value low

we see in the table below, assuming that all other factors are constant and the factor listed is increased by one unit, this results in the dependent variable increasing in value by the amount shown.

Table 27: List of significant variables and influence on output

Significant Variable	Level of Significance[1] (%)	Influence on Output[2] (EUR)
Hours Sold	50	50
FTE After Sales	54	36,050
CSS Satisfaction	57	-691,020
Technicians	56	67,550
Service Advisor	70	275,625
Work bays	76	61,667

[1]The level of Significance gives an indication as to how much of the variance of the dependent variable can be explained by the model
[2] If the significant variable is increased by one unit the variation to the dependent variable, in this case CM3, is shown in Euro.

This procedure should be carried out with more observations in order to fulfil the requirements of sound statistical analysis.

Finally, we can conclude that the methodology employed provides valuable insights by first using the DEA to identify the efficient DMUs and, once the best case has been identified, applying regression provides an indication of the influence of significant inputs and their respective influence on output.

6.7 Recommendation

In addition to the methodology developed above, namely using DEA and regression to identify the effective dealers and the variables that influence output, the development of a balance score card would meaningfully complement the analysis methods.

The advantage of a balance score card is that it complements historical financial KPIs with KPIs that describe drivers of future performance, derived from the vision and strategy of a company. According to Robert S. Kaplan and David P. Norton (1996) in order to achieve maximum benefit, the balance score card must be integrated into the information system at all levels of a company. According to the same authors the primary benefits are:

- it helps to understand the financial consequences of decisions taken by the people responsible and, the drivers of long-time financial success.
- it translates the strategy into tangible objectives and measures and
- the KPIs or measures chosen represent a balance between internal and external measures.

The proposal for a balance score card described below provides a general direction and should be further detailed.

Adopting the proposal of the authors cited above, namely the balance score card, should be multidimensional yet remains manageable. Four dimensions that describe a business's historical, primarily financial KPIs and drivers of further performance are financial, customer, internal and innovation & learning.

The KPIs chosen should reflect short vs. long-term objectives, financial vs. non-financial measures and external vs. internal performance.

The balance score card should also incorporate cause-and-effect relationships and feed-back loops.

The following Financial KPIs can form part of the score card:

Table 28: List of KPIs as part of a score card (1)

No.	Financial
1	ROCE (return on capital employed)
2	Operating income
3	Revenue
4	Total Profit
5	CM3
6	Revenue per FTE per function
7	Hours sold in total and per function
8	Average number of throughputs per day/month/year
9	Throughputs/productive FTE/day/month/year
10	Percentage revenue per function
11	Percentage total profit per function
12	Percentage CM3 per function
13	Parts sales own workshop (absolute, %, day/month/year)
14	Parts sales to NORA (absolute, %, day/month/year)
15	Parts sales counter (absolute, %, day/month/year)
16	Sales revenue accessories (absolute, %)
17	Sales revenue other business (absolute, %)
18	Sales revenue external services (absolute, %)
19	Percentage of labor intensity degree overall and per function (%)
20	Direct costs (absolute, %)
21	Direct operating costs (absolute, %)
22	Labor costs (absolute, %)

No.	Financial
23	Warranty costs (absolute, %)
24	Costs repeat repairs (absolute, %)
25	Costs external services (absolute, %)
26	Quantification of intangible assets
27	Cash flow
28	Market growth

The KPIs describing customer treatment are listed below:

Table 29: List of KPIs as part of a score card (2)

No.	Customer
1	Customer satisfaction and retention (CSS and other studies)
2	New customer acquisition
3	Customer profitability
4	Market share in targeted segments
5	Dealer satisfaction survey (carried out at wholesale level)

Crucial for customer treatment and rating is the detection of the specific segment drivers critical to customer loyalty. These can be short lead times, innovative products & services, value for money etc. The dealer is also a key interface between the OEM/wholesaler and the customer and has a big influence on customer satisfaction as it represents the OEM.

In terms of innovation and learning, most business units reduce the topic to employee training. Investments in training help so that employees can develop long-lasting customer relationships and internal capabilities which enable the development of new ideas leading to future growth.

Employee satisfaction and retention is a prerequisite for developing breakthroughs in new areas – end to end solutions for customers – and for delivering high quality products and services.

In addition to the already defined KPIs that measure employee qualifications, additional KPIs measuring investments in innovative products and services and IT must be defined.

Table 30: List of KPIs as part of a score card (3)

No.	Innovation & Learning
1	Employee training
2	Employee satisfaction
3	Employee retention
4	Investments in innovative products and services
5	IT investments

The impact of Big Data, connectivity and digitalization, with the mass of information available, has a more decisive influence on service organizations than on manufacturing organizations. Finally, the development of a process to deliver new services that target customer value would provide additional stimuli in creating an atmosphere of innovation and learning.

The last dimension of the balance score card, termed internal, describes internal, critical business processes: activities to improve costs, quality (product quality) and cycle time (on-time delivery) and should enhance organizational procedures. To list all process KPIs is beyond the scope of this section and therefore we only briefly address the major points to be considered in addition to the measures to be defined.

Table 31: List of KPIs as part of a score card (4)

No.	Internal
1	Cost reduction activities
2	Product or service quality improvement activities
3	Cycle time improvements
4	Process improvements

It is also important to align organizational procedures and routines, to define and monitor rates of improvement in critical processes and to align employee incentives with overall organizational success factors. Short time-to-market businesses require short cycle times in their internal processes and need high quality, robust internal processes without redundancy. Information must also be available in real-time and employees need to be trained in order to improve their skills.

The goal of the subsection above was to broaden and extend the analysis method proposed, which was based on a DEA and regression analysis. The balance score card briefly described above with its four dimensions – financial, customer, internal and innovation & learning – would be a useful addition to the proposed analysis method and would facilitate the transformation of strategic objectives into a meaningful monitoring and controlling system.

The next chapter will concentrate not only on providing a better answer to the questions raised and described in Section 7.1., but also on finding solutions to the ways in which technological developments and innovations can be used to enlarge the current After Sales business model.

The goal is:

- to broaden customer satisfaction and increase loyalty,
- to increase the market share while simultaneously reducing costs sustainably and by utilizing human and material resources intelligently

by making use of new technologies, by using existing data and the combination, correlation and real time processing possibilities offered by Big Data. Furthermore, the profiles, knowhow and attitudes of the staff are a key success factor that is worth analyzing in more depth. Last but not least, to establish adequate KPIs to effectively control the retail business, the market and, in the long-run, the whole value chain.

7. Benchmarking

This chapter of my thesis describes the benchmarking process, the checklists used, the insights gained and the conclusions reached after a qualitative analysis of the insights. The aim was to achieve a profound understanding of the general business models of companies in industrial sectors complementary to the automotive industry, or in typical service businesses with an additional focus on After Sales.

The businesses analyzed came from the following sectors: IT services and consulting, automated manufacturing and robots, aircraft maintenance and engineering, freight transportation & warehousing and distribution & supply chain solutions, and the high tech industry.

The chapter starts with the methodology used in the benchmark, it continues with the overview of the criteria analyzed. Next, the anonymized results of the interviews for every company are explained. In the last part the results are consolidated and structured according to the key success factors, trends and top business drivers. Commonalities, differences and best practice examples are highlighted. Furthermore, recommendations are made. The section closes with a summary.

7.1 Research Methodology

Is a combination of primary and secondary data, analyzed by following the adequate principles of qualitative research (Mayring, 2015). The first step involved extensive research of the literature resulting in the creation of a checklist containing all the important criteria or factors necessary for the success of a company.

The checklist was adapted after the interview with the first company and again later, due to the differences among the businesses analyzed.

The literature research is regarded as secondary data, while the interviews with the managers of the different benchmark partners delivered the insights and concrete answers to the questions defined and documented in the specific checklists used. The interviews conducted not only provided the answers to specific questions but also strengthened the significance and quality of the research.

As already described in previous chapters a conscious decision was made not to interview businesses from the same industry, although some of the industries have similar characteristics. Benchmarks from the IT sector proved very fruitful as a car contains the equivalent of many personal computers, resulting in a close relationship between the two industries. The automotive industry is becoming increasingly digitized and, with humanity's desire to be continuously online, an increasing interlinking can be observed between the automotive and IT industries. Furthermore, IT connects customers, products and services, allowing a rapid and personalized experience and countless connections and interactions along the value chain between the OEM, the wholesaler, retailer, supplier and customer. Additionally, interviews with high tech companies provided insights into the way in which this industry is solving similar problems, for example, capacity alignment in the supply chain or IT integration. Digitization provides new possibilities for doing business which leads to re-thinking many processes and business models. Since it can be expected that not all customers will adopt digitized processes simultaneously, the first impact is the establishment of new business channels, enlarging the customer base and the business volume, which is sustainable if the product or service is good and professional.

A total of six companies were interviewed. Two were from IT services and consulting and one from each of the other industries mentioned above. All the interviewees were managers from varying departments. In the IT sector a Global Operations Planning Manager and the Volkswagen Key Account Manager were interviewed. At the logistics company two vice presidents were interviewed. One was the Vice President for Customer Solutions and Innovation for Automotive Industry Germany and Customer Management Group for Volkswagen. The second was the Vice President for Solution Delivery in Service Management for all industries worldwide. At the high-tech and robotics company the directors of Parts, Repairs & Used Robots and of Strategic Planning and Service Parts Supply Chain were interviewed. Finally, at the MRO the Managing Director and the Regional Vice President for Australia, New Zealand, the South Pacific and Japan were the respective interview partners.

In the benchmark phase two data sources were used: the interviews, as well as internet research on the companies' websites and official accounting reports in order to reduce the length of the interviews and be better prepared for them. The interviews took between two and five hours and, except for one of the high-tech companies which was visited personally, were conducted via telephone.

The literature research identifies, in the main, three broad interview categories: unstructured, semi-structured and structured (Bryman, 2004). Unstructured interviews are the best choice when the researcher has little knowledge of the topic or subject of analysis. The advantage here is that little preparation is necessary, but it also means the interviewee is able to turn the discussion towards issues that might not be pertinent to the research. The best choice for this research was the semi-structured interview based on a checklist that was then adapted to the respective industries, especially after the first interview. The checklist ensures that the relevant issues are covered in the interview and important points are not forgotten. Furthermore, according to Bryman (2004), the questions in a semi-structured interview do not need to be taken in sequence, but provide an opportunity for systematic analysis. The interviewer can ask further questions if more details are necessary or if the discussion veers in a different direction that might be useful for the research. Moreover, the checklist was provided in advance so that the interviewed partner could prepare for the interview and the duration necessary was shortened. A recording device was used only in one interview. During and after every interview the answers were documented, translated, in the cases where the interview was done in German, and sent to the interviewee for approval. The answers were then assigned to the criteria below.

The structured interview was not used because it has some limitations in terms of flexibility as it does not allow the interviewee to elaborate on the issues raised.

7.2 Overview of the criteria analyzed

Because some of the companies interviewed requested confidentiality the best solution was to anonymize all the interviews. The checklists used are posted in Appendix 13.

In the analysis phase the main criteria for success were identified and grouped in two tables: firstly, general criteria dealing with crosscutting issues such as value proposal, organizational strategies, overall KPIs, procurement or IT and After Sales criteria. Secondly, success factors that are common to all or some of the businesses were identified, meaningful comparisons were made and differences were also established. Finally, the adoption of some of the solutions to the automotive industry was discussed.

The two tables below illustrate the set of criteria compared among the six companies interviewed. The first list compares general criteria and the second, After Sales related criteria. The information provided, and which company was outstanding in which criteria, is also noted and the criteria per company are briefly described. The reasons some information was not provided: the information was confidential, the interviewed partner was not aware of its availability in the company, it was not part of the reporting or it did not apply to the business model of the company analyzed.

A few examples of information that was not provided by most companies were the internal HR strategies, legal regulations, environmental issues, or customer data.

Table 32: Overview general benchmark criteria

	General criteria	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6
1	Industry sector	✓	✓	✓	✓	✓	✓
2	Products, value proposal/strengths	✓	✓	✓	✓	✓	✓
3	Position in industry sector	✓	✓	✓	✓	✓	✓
4	Business trends	✓	✓	✓	✓	✓	✓
5	Top business drivers	✓	✓	✓	✓	✓	✓
6	Number of employees	✓	✓	✓	✓	✓	✓
7	Customer segments	✓	✓	✓	-	✓	✓
8	Product development strategies	✓	✓	✓	✓	✓	✓
9	Organizational strategies	✓	✓	✓	✓	✓	✓
10	Production facilities	-	✓	✓	-	-	✓
11	Forecasts	✓	✓	-	✓	✓	✓
12	HR strategy	✓	-	-	-	-	-
13	Improvement programs / Benchmark	✓	-	✓	-	✓	✓
14	KPIs overall	✓	✓	✓	✓	✓	✓
15	Supplier strategy	-	✓	-	-	-	✓
16	Procurement	✓	✓	✓	-	✓	✓
17	Advanced technology in procurement	-	✓	-	-	✓	-

	General criteria	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6
18	IT	✓	✓	✓	-	✓	✓
19	Business Model	✓	✓	-	-	✓	-
20	Transaction costs	✓	✓	-	-	✓	✓
21	Profit margin (After Sales, Parts)	✓	✓	-	✓	-	-
22	Legal regulations	-	-	-	-	✓	-
23	Environmental issues	-	✓	-	-	-	-

Table 33: Overview after sales benchmark criteria

	After Sales criteria	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6
1	Profit share from After Sales business	✓	-	-	✓	-	✓
2	Supply chain planning	✓	✓	✓	✓	✓	✓
3	Share of employees in After Sales	✓	✓	✓	✓	-	✓
4	After Sales KPIs	-	✓	✓	✓	✓	✓
5	Standardization of supply chain activities	✓	✓	✓	-	✓	✓
6	Supply chain improvement programs	✓	✓	✓	✓	✓	✓
7	Supply base strategy	-	-	-	-	✓	✓
8	Customer demand	✓	-	✓	-	✓	✓
9	Supply network details	✓	✓	✓	-	✓	✓
10	Customer data	-	-	-	-	-	-
11	Availability in service (no. of shifts)	✓	-	-	-	-	✓
12	Preventive maintenance	✓	✓	✓	✓	-	-
13	Bottlenecks vs. risks	✓	✓	✓	✓	✓	✓
14	Parts strategy	✓	✓	✓	✓	-	✓
15	Second parts line	-	-	-	✓	-	-
16	Number of parts codes	-	-	-	-	-	✓
17	Parts ordering process	-	✓	-	✓	-	✓
18	Value of inventory share compared to revenue	✓	-	-	-	-	✓
19	Use of parts kits for repair	-	-	✓	-	-	✓

	After Sales criteria	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6
20	Use of cross dock operations	✓	✓	-	-	✓	✓
21	Delivery quality	-	✓	✓	-	-	✓
22	Inventory turns	-	✓	-	-	-	✓
23	Use of virtual inventory	✓	✓	-	-	-	✓
24	Payment regulation	-	✓	-	-	-	-
25	Service degree	✓	✓	-	✓	✓	✓
26	Technologies used in warehousing	✓	-	-	-	✓	-

7.3 Interview results

Interview details are provided in Appendix 15. The highlights of the interviews and our reflection on the knowledge gained as it affects our case are illustrated below.

All the companies interviewed were multinational or global players and leaders in some of the product segments in which they compete. The subsection is structured after success factors, business trends, top business drivers, comparison, recommendations and summary.

7.3.1 Success factors

Common success factors identified were:

- Firstly, the product portfolio combined with investments in research and innovations. The products were mainly complex or integrated solutions, not easy to replicate consumer goods.
- Secondly, added value services and customized solutions round off the portfolios
- Thirdly, investments were made in end-to-end solutions
- A fourth factor was the central role played by service quality. Quick reaction times, reliability and trustworthiness, to name some of the attributes of service, often resulted in loyal contracts. Service was also provided in-house and not outsourced. This required good communication among the departments involved.
- Other success factors were the ability to connect new technologies with the systems currently running today's enterprises, resulting in integrated solutions and a broad ecosystem of partners and alliances requiring good integration capabilities and social and environmental responsibility.

7.3.2 Main business trends

The main business trends identified relate to the sales of complete, **end-to-end solutions and services**, the ultimate aim being to manage the whole value chain. **Strategic cooperation's and the development of ecosystems** are also a central point. If financial resources are available strategic acquisitions are an alternative or complement, in order to increase agility, efficiency and scalability. All interviewed managers share the view that **digitization is a big trend** that is increasing process efficiency. Aggressive pricing as a way to rapidly gain market share remains unchanged. Suppliers, besides the OEMs, are taking over maintenance activities in the service sector. The trend is towards a **decrease in maintenance and repair costs**. There is a trend towards **reducing inventory level** in the supply chain, and **an effective supply chain** is considered a "must" in order to have a competitive advantage. To quote a supply chain manager from the high-tech industry: "The change was rapid – what was excellence yesterday, is nowadays a must have".

7.3.3 Top business drivers

As far as the top business drivers are concerned, the major focus is on the **product or service portfolios**, their quality, reliability, degree of individualization, and pricing. Focus was also placed on **performance and business efficiency.** Another driver mentioned was **strategic acquisitions in the high-margin segments, and investments in new technologies and cooperation's** were also considered drivers. Leading companies invest up to 8% of their revenue in R&D compared to the average of only 2%. Finally, customers play a central role, especially the ability to develop long-lasting relationships with them.

7.3.4 Comparison

7.3.4.1 Product portfolio IT companies

- In comparing the product development strategies of the companies analyzed, differences were already noted between the two IT companies interviewed. One intends to sell services and not products, more licenses and less hard- and software. In the sales process the line of reasoning concentrates on emphasizing the benefits for the customer and not the features of the products sold. For example, the cloud enables customers to transform their IT and business processes into digital services, thus speeding up processes.
- By contrast, the second IT company interviewed is more concerned with concentrating on not easy to replicate, complex products with higher margins.
- The time to market for consumer products was less than one year and between 2 and 5 years for complex ones.
- One difference was the IT sector's wish to increase standardization up and down the value chain, whereas in the automization sector the aim is to develop individual parts in order to protect profits realized by parts sales.
- Proximity to the customer is important in the service sector. And here it makes sense to cite the slogan of one of the interviewed companies: "We are with you in the right place at the right time".
- A further importance is the minimization of carbon footprints by offering green solutions.
- And finally, a high-tech provider follows the strategy of developing and producing products that can be repaired. The sales margin is deliberately kept low in order to acquire customers so that money can be earned in service. Furthermore, by selling service contracts customer relationships can be further fostered. Service contract penetration for premium

products is higher than for less expensive products and is becoming a constant and stable source of revenue and profit.

7.3.4.2 Organization

Differences were also observed with respect to organization. Some companies are largely decentralized and branches are often located near to customers.

- Functions such as sales, service, training and administration are not combined, but are organized in centers distributed across the country.
- By contrast, in other companies service is integrated in many other business units and decentralized.
- Back office functions are often centralized.
- Future business is organized independently.
- Some companies are organized by functions, others according to the main product lines.
- Global solutions are sought for bottlenecks and this process is aided by high transparency.
- Functions such as logistics and warehousing are often outsourced.
- Forecasting is decentralized, but procurement is generally centralized. Other centralized functions, in order to ensure global consistency and efficiency are: Procurement, Legal Services and HR.
- Other services are outsourced, when financially feasible.
- The share of employees in After Sales differs from one industry sector to another. For example, in the IT sector it ranges between 25 % and 44%, between 2% and more than 5% in the high-tech sector, attains 100% in the MRO business and is 0% at the logistics provider.
- Subsidiaries are independent businesses with their own CEOs.
- Company headquarters are often responsible for the global strategic focus.
- Common concerns are also efficient resource utilization, continuous process improvement, reduction of employee stress and minimizing the environmental footprint.
- To speed up processes and minimize the amount of paperwork, documentation is carried out using hand-scan-devices and tablet PCs.
- Decisions to invest in own assets are financially driven. Where there is high, constant business volume and stability in terms of costs, companies invest in own assets. By contrast, when, because of volatile volumes, flexibility and adaptability, are necessary, operations are subcontracted.
- The branding process is controlled by the company in all cases in which products are sold under its label.
- Although there are differences regarding the outsourcing degree of production facilities, from zero to 80%, it was observed that, more often, high-tech products are produced by the companies themselves.

There were differences in the organization between centralized and decentralized forms.

7.3.4.3 Processes

The degree to which forecasting is used varies greatly and in some companies forecasts are used extensively (including big data analytics) while others follow more simple methods, but are looking for improvements.

Continuous improvement initiatives begin with optimization processes in general, with the goal of finding the best solution suitable for the needs of the system, as these are subject to various constraints. They continue with process simulations, benchmarks, process digitalization and, very often, IT standardization or integration programs. Other areas undergoing improvement are the impact of the companies' business activities on the environment and their own carbon efficiency, as well as that of their subcontractors. It is worth mentioning the initiative of one high-tech supplier whose goal is to achieve the "perfect customer order" whereby service and parts delivery is only one aspect that must be perfectly integrated with the other customer interactions.

7.3.4.4 Human resources

Besides the ability to attract well qualified employees and the importance of regular training, not much information regarding HR strategies was provided.

7.3.4.5 KPIs

KPIs are of great importance for the management of any company. If the KPIs accurately record the complexity of the business model, management can easily work on areas to be improved. By contrast, if the KPI system fails to record important criteria, problems, which are often difficult to solve, arise and, in the worst cases, lead to insolvency. The quality of the data collected is a key factor as conclusions might otherwise be false as they are based on incorrect figures.

The majority of the companies analyzed is listed on the stock exchange and therefore discloses all financial KPIs required by the international accounting reporting standards. In addition, the following KPIs are also used to monitor business:

Financial KPIs: revenue, profit, free cash flow generated, margins, average EBIT, warehouse/inventory value obsolescence, net inventory as a percentage of sales and supply chain aging (duration of parts in the supply chain measured in days)

Transaction costs were important for one third of the companies interviewed and are tracked punctually, with the focus on total costs and the number of transactions, but they are seldom used in regular reporting

- Market share per product
- Net promoter score (NPS), a customer loyalty metric
- The lead time for producing and/or delivering products
- Service contract fulfillment depending on the service level bought by the customer
- Incoming orders
- Stock turnover

- Delivery performance, service degree of 92-95%, fill rate, delivery time, adherence to schedule, on-time-delivery (for suppliers), stock-out for critical parts
- Compliance KPIs
- Downtime of the product
- The reaction time of service staff when a product is defective
- Up-time of the system.

7.3.4.6 Supplier strategy

All the companies interviewed have realized the importance of sound supplier strategy and industry collaboration. Positive effects are achieved through sharing expertise and best practices, and through striving to improve suppliers' capabilities. Further benefits of working with diverse suppliers include strengthening the ability to more effectively reach diverse marketplaces, creating positive change. The primary concern is to foster partnerships, close long-term contracts and build ecosystems.

7.3.4.7 IT

A discerning factor in competition is the IT technology in use with respect to performance, user friendliness and degree of integration. The companies not originating in the IT industry sector use, in the main, commercial solutions without voice recognition and are striving to create a more open, standardized and, consequently, more cost-effective IT landscape.

One of the solutions most often implemented for the supply channel is SAP software. The RFID technology is not often used in the service field, only at the request of customers in logistics. The SAP applications are diverse, ranging from parts ordering to warehousing, to scheduling service appointments based on service contracts, or process modeling provided by the Business Objects module. The Oracle database is also often implemented, in combination with own developments.

The companies use their own developments for forecasting, except the IT companies which sell this product to clients. The level of standardization in high-tech is high as this is seen as the first step necessary before moving to the next level. It also implies a comprehensive approach as it requires cooperation with suppliers. In IT processes and customer support are standardized worldwide. Generally, more service is offered than agreed in the service contract, and the strategy is to have standardized service contracts for private customers up to mid-sized companies and larger companies. At the request of a customer it is possible to deviate from the standardized processes and utilize the customer's operating procedures.

All the companies interviewed are facing the challenge of integrating new software in order to incorporate acquired companies, or to ensure the compatibility with the client's or supplier's software solutions. The best practice solution identified was that of an IT company which drafts processes and systems onto the existing ones to ensure consistency, and develops interfaces to the software that is the primary product of the acquired company. In businesses where many IT Systems are in use, such as IBM, Oracle, etc., the IT backbone is standard, but this does not limit flexibility. A broad use of voice recognition software was not found, except in one company. However, strong IT interfaces to the main suppliers or service providers are installed. Finally, augmented reality (in the form of Google glasses) is used for selection in warehouses.

7.3.4.8 Business model

Only half of the companies interviewed provided information regarding their business model. The goal is to be asset light and investments in own assets are only made if it makes sense financially. Sometimes there is a combination, such as joint ventures or contractual partners dedicated to the company which adopt the company's branding. The trend is to provide service solutions and not to sell individual products; to sell licenses not software. Therefore the franchise concept has been revised and cloud services, analytics and mobile services are offered by building platforms that are used by competitors. An ecosystem has been developed in relation to own technologies in order to reduce costs. And cash-pooling agreements are used internally to ensure the financing of projects. In the field of consumer products the majority of customer issues are solved using social media platforms and online communities. Another trend is the increase in the volume of the leasing business since the Euro has lost value against the US $ in all companies in which pricing is in US $.

The managers interviewed were quite reluctant when the question regarding profit share from the After Sales business arose. Only half of them gave answers to this question. In the IT sector the gross margin in service is 38.3%. In the high tech companies this is even better, up to approximately 50%. In the aircraft industry profits of up to 30% are made with parts and components and the average profit margin in maintenance is 7%.

7.3.4.9 Risks

There are differences in terms of bottlenecks vs. risks among the different companies, even among those in the same industry sector. While in one company the primary constraint is the availability of financial resources, others see the innovation-to-market processes and a global increase in IT security threats as the main risks. However, most nominations relate to exact forecasting, especially for parts.

7.3.4.10 Supply chain

Of great interest for the analysis were the details relating to supply chain planning. The goals were more or less the same: to deliver the right parts or products, quickly and in time, in the right quality and cost effectively to the customer. Therefore the design of the supply chain is a key factor; it must be lean and efficient and the result of team work in different disciplines which must be considered and orchestrated, correctly located, synchronized and managed, resulting in a continuous flow.

Possibilities were found in many organizations, ranging from partially centralized supply chain planning to a centralized planning department that plans and organizes the warehouses: network of warehouses, the warehouse and the stock/inventory, even though subsidiaries/markets have paid for the parts in stock. In this case a central department controls the inventory worldwide. Virtual Global Supply Chain Management is implemented at the best performer.

Common to all industries interviewed is the fact that the customers do not own the parts in stock in the way the dealers in the automotive business do. Generally, more service levels are provided depending on the customer's requirements and willingness to pay. In order to avoid stagnation capacity alignment is important; forecasts are periodically communicated to suppliers so that they can align capacities (human resources, materials etc.). Monthly meetings are held with critical suppliers to discuss forecasts and capacities, changes in road maps or the life cycles of parts, and any additional topics that can influence capacity. In cases of same-day-delivery parts are stored close to customers; the warehouses are small within a dense network. Process and information transparency must be ensured and a continuous flow in inbound logistics can be achieved if planning simulations are carried out on a monthly basis and if forecasts are good. If exceptions occur the plan must be changed. In order to balance workload and capacity and control stock levels inventory plans are released and communicated once/week. Spare parts procurement, sales, and logistics are partially centralized. Global solutions are sought for bottlenecks; international teams are formed to solve the problem. This is called "Transparent Supply Chain". The same applies to software problems, in which case virtual teams are formed using telephone conferences and social media functions to solve the problems. Inventory planning is carried out extensively with adequate software in which supply chain algorithms are used. Real-time transportation monitoring is at least partially implemented; truck drivers have cell phones and geo-fencing, and GPS technology also allows for good tracking and information flow. The hub structure proved to be the best solution in respect of business volume vs. costs. Contingency planning for any possible disruptions determines the flexibility of the supply chain. Temporary staff provides flexibility and the opportunity to adapt to peaks, and enables contingency planning in routing. Processes are monitored and deviations are subject to review meetings and supplier meetings.

Generally, all the companies have started supply chain improvement programs; these vary from the continuous use of process optimization programs and simulations, IT integration initiatives, RFID introduction and predictive maintenance. The most impressive approach was that of the logistics provider which runs an innovation center and invests in trending research and solution development. The innovation center provides a central platform from which customers and business stakeholders can engage with company experts on innovation-related topics and issues, and where every new technology can be tested.

Different approaches already exist in the IT sector. Due to advanced forecasting methods, customer demand can be planned and supply chain visibility is very high; all parts stocks are visible. There is more fluctuation in the After Sales business of the other companies where the strategy is long-term planning based on good prognoses so that products are bought and sold at economically acceptable prices and logistics is not expensive. If flexibility is requested the customer has to pay a premium.

Availability of service in the IT sector is high and hotlines with 3 levels are available worldwide 24/7. In order to solve problems immediately, global players utilize their position to pass the processing from a hotline in one time zone to a hotline in a different time zone. Service is organized locally and capacity problems are otherwise solved using matrix organization and shared services. Storage capacity is compensated for by the use of air freight.

The goal in the high-tech sector is to create a leaner supply base with fewer suppliers, while maintaining, where possible, dual / multiple sourcing strategies. This strategy requires close cooperation with suppliers to enhance, among other things, time to market and quality. In addition, the company is continuing its initiatives to reduce assets through outsourcing. Availability of service is lower than in the IT sector – resulting in 24/5 availability. Weekend work is only done in warehouses in the USA. In the logistics sector one high-tech company uses VMI (vendor management inventory) for cheaper, standardized parts, by means of which the supplier can see the stock required and deliver independently. All shipping methods, air, road, rail and sea, are used for transportation. The companies tend to rationalize the way in which inventories are carried out. The tendency is to regular, planned shipments for stability in the supply chain; express shipments are part of planning and are used mainly for slow movers that are not stored locally and must be delivered punctually. A summary of all shipments for a customer, both in-transit and historically, can be provided by means of Active Tracing.

7.3.4.11 Parts strategy

The parts strategy pursued by the interviewees is very different. In the high-tech sector there are opposing views; some are attempting standardization and the use of common parts, or fewer individualized configurations as these are expensive while others are developing individual parts in order to protect their margins. It is difficult to find the right balance or an optimum between standardization and customization vs. individualization. The problem with catalogue parts – often electronic parts which can be obtained through the manufacturers' catalogues – is that the validity periods are shorter and it often happens that the parts break during storage or are defective. Parts and service are available for 10 years and there are "Best Effort Service" contracts that allow the company to refund a customer for the remaining time contracted if the company is unable to deliver and/or service a product. Obsolescence is a permanent issue in this industry.

The availability of parts for older products in the IT sector is shorter, for PCs it is 5 years and for servers it can be up to 7 years. A certain number of parts are stored, but they are relatively expensive due to warehousing costs, or because they are disassembled from products not sold. The obsolescence rate is not a major problem as cross border parts delivery is possible or sophisticated and highly developed forecasting algorithms are used.

Spare parts obsolescence is also not a problem in aircraft maintenance and engineering as the lifetime of an airplane is about 20 years and the parts have a similar lifetime. A major difference to the automotive industry is that parts are sold directly by the component producers and not exclusively by Boeing or Airbus.

Unfortunately not all companies provided information regarding the number and structure of parts codes. In the high-tech sector the ratio of active parts to total parts is 20/80. One fifth of total parts codes stored are active; the company does not count slow moving parts as active.

Very little information regarding the value of inventory share compared to revenue was provided. Only two answers were received – in IT the share is 5% and in the high-tech sector it is about 21%.

A second parts line is not in use as it is thought to decrease the genuine parts margin.

Parts kits for repair are used in the high-tech sector. In robotics, the sets consist of a main component and attachment parts; a set does not consist of several main components, and a logistics supplier compiles parts sets for repairs as this is more economically feasible. Another company uses kits for clients that have 24h contracts. This company compiles the kits at factory level in order to speed up the entire repair process.

Two thirds of the companies use cross docking in the logistic operations.

The question regarding delivery quality was answered by half of the companies interviewed and lies between 1% and 2.1% for physical parts and is based on the number of software errors, stand still periods and the precision and speed of the robot.

Information relating to inventory turns was only provided by two companies. Either way, the spread is considerable, as in IT it was 30.7 inventory turns/p.a. whereas in high-tech it was approximately 5 inventory turns/p.a. One third of the companies, the IT businesses, declared the use of virtual inventory. The opinion in the high-tech sector was that a dense distribution network allows planning flexibility and does not require the back- up collaboration of distribution locations.

The question regarding the technology used in warehousing was answered by only three of the companies as the other half have outsourced their logistics and warehousing. One company has introduced RFID, one planned to introduce this technology and the logistics company uses whichever technology the customer requests and is prepared to pay for.

The average service degree of the shelves for most of the companies was 95%, with the range between 90% and 100%. They have agreements stating the speed at which a part has to be available, depending on the service level requested by the customer. 100% is achieved when parts are stored locally at the client.

7.4 Recommendations

In this section of the chapter, the possible adaptation to the automotive industry of any good solutions from the analyzed industries will be addressed and discussed.

7.4.1 Product and service portfolio

The product and service portfolio is crucial, but is not the principal subject of this thesis. The interesting observation in the high-tech sector was the efforts to invest in end-to-end solutions, to develop a B2C interface, and to control the whole value chain. Digitization and networking, search engines and social media are increasingly becoming intermediaries between the automotive industry and its customers. There is a danger of losing the direct, valuable contact to customers and of becoming a B2B supplier for Apple, Google, etc. which then instead represent the new interface to the customer. These days, due to data protection and security laws, especially in Germany, it is very difficult for an OEM to obtain a 360 degree view of the end-customer. If the automotive industry does not make efforts to change this and to invest heavily in convincing customers of the advantages of providing necessary data, we will find ourselves in a situation in which Google, Amazon, etc are doing the business and making the profits instead of the automotive industry because these companies are asset light, and the automotive industry will be unable to invest in research as previously. It is now up to the automotive industry to meet this challenge and to fight for and defend its direct interface with the end-customer, or abandon it to Google and co.

In order to defend the direct interface with the end-customer the industry must invest in digitization, in different communication channels, in new marketing approaches. The preference of media-conscious people to be always online and the possibility of transforming a car into a communication center as a result of the increased electrics, electronics and software installed in cars, is leading to a convergence of the automotive and IT sectors. As a consequence, the foremost characteristics of both industries will contend with one another, leading in some cases to conflicts. One example is the time to market for new products which is shorter in the IT sector, or the multi-media features in a car which often use Google services, but must be kept separate from the car systems which manage the driving safety of the vehicle.

In contrast to the businesses that were the subject of the analysis the share of service contracts sold in the automotive industry is lower. The service contract is the most powerful instrument available to increase service loyalty, also in the automotive industry. In the private customer segment the penetration rate is still low. The efforts in this industry must be intensified.

7.4.2 Service quality

Service quality played a central role in all the businesses analyzed. The same applies to the automotive industry in which quick reaction time, reliability and trustworthiness are some of the attributes of service often offered.

7.4.3 Connections, integrations and investments in new technologies

Another success factor was the ability to connect new technologies with the systems currently running today’s enterprises, resulting in integrated solutions, a broad ecosystem of partners and alliances which require good integration capabilities and social and environmental responsibility. The ability to connect to new technologies can be improved at VW. The best and, in the short-term, most expensive approach is to standardize the major, common IT systems and develop interfaces to software products that cannot be integrated. In other words, the backbone of the system should be standard but flexible enough to connect to newly introduced IT applications.

Investments in new technologies and cooperation are considered business drivers. This can be enhanced in the After Sales business at VW. Firstly, the construction of a laboratory is necessary in which all possible new technologies, that could be used and adapted in After Sales, are set up and tested.

7.4.4 Cost management in retail and supply chain

The trend towards a reduction in maintenance and repair costs is also being observed in the automotive industry. One possible effect, if this is not considered by the OEM, will be a decrease in loyalty. VW has already reacted to this trend by introducing second line parts for older cars. The introduction of such programs is difficult and can take time because of the diverging interests of the retailer, wholesaler and OEM. The stakeholders in the value chain have different interests, for example, the retailer is interested in higher margins from the sales of genuine parts. The margin in sales of economy parts is much lower. Thus, a dealer needs more business in order to compensate for his losses in selling parts with lower margins. Additional measures which can be taken include increasing the automation in the service operations in workshops, increasing efficiency by speeding up processes and increasing the number of throughputs. An effective supply channel means reducing inventory levels and providing necessary parts quickly and without additional costs. Here, good forecasting can help in aligning requirements with the parts in stock. It is possible these days to have prediction models for the maximum output in capacity in order to know in real time how much margin is generated in every depot, for every part, for every customer. It is also possible to monitor the status of the order-line level, inventories and mobile assets. Cross-retail and cross-border collaboration can increase the flexibility of the supply chain, and virtual inventory will lead to increased transparency in the supply chain.

7.4.5 Customer satisfaction

The customer also plays a central role in the automotive industry. The ability to develop long-lasting relationships with customers secures business profitability in the long term. A 360 degree view of the customer is not available in the automotive industry. It is easier to realize this in the high-tech and IT sectors and some have already achieved this ability. Fleets provide the higher share of customers in the automotive business. In such cases the private end-customer is the user of the mobility service, and fleet managers have a major influence. The OEMs must intensify their efforts to obtain a clear picture of the customer and not lose their direct link to them. Developments such as the connected car, preventive maintenance and big data forecasts will positively influence this process. In the future, the OEMs and retailers will sell more mobility services and manage customers' mobility needs instead of selling and servicing cars – mobility where and when you need it. Car sharing is only one potential solution. The mobility solutions developed also need to minimize carbon footprints by offering green solutions. The important observations made in the benchmarks of the service sector fully apply to the automotive industry too. The proximity to customer is vital, or to cite the slogan of one of the interviewed companies: "We are with you in the right place at the right time". This applies perfectly to future network development.

7.4.6 Business model

The observation made in the IT sector, of increasing standardization up and down the value chain, is partially implemented in the automotive sector and can be further enhanced. The strategy of a high-tech provider to develop and produce products that can be repaired, and to keep the sales margin deliberately low in order to acquire customers and earn money in service, might not be the best strategy. In the retail sector of the automotive industry After Sales already provides compensation, especially in the used car business. A better strategy would be to make all retail functions profitable as the density of sales contracts is generally lower than service. Nonetheless, customer relationships can certainly be fostered further by selling service contracts, leading to a constant and stable source of revenue and profit for all players along the value chain.

7.4.7 Organization

Clear advantages regarding centralized vs. decentralized organizations and functions were not identified in all cases. Both organizational forms have advantages as well as disadvantages. There are clearly advantages when future business is organized independently.

Something not used in the VW organization are global virtual teams which could provide global solutions in solving bottlenecks. Technical support also does not take advantage of different time zones in which specialists are globally available.

Efficient resource utilization, continuous process improvement, reductions in employee stress levels and the environmental footprint are nothing new for the automotive business as these are perennial issues. VW has been engaged in improvement programs for years. The example of the aviation industry – of accelerating processes by carrying out documentation using hand-scan-devices and tablet PCs in order to minimize the amount of paperwork – can be followed. Process simulations, benchmarks, process digitization and continual IT standardization or integration programs should be on the agenda of the VW brand. It is worth mentioning the initiative in After Sales of a high-tech supplier with the goal of achieving the "perfect customer order" in which service and parts delivery is only one aspect that must be perfectly integrated with all other customer interactions. Another good example from one IT company is internal cash-pooling agreements to finance projects.

The branding process example from the high-tech sector in which businesses sell products under its label could only be conditionally accepted / followed. In the case of accessories it would be beneficial as the branding is directly linked to the primary product sold, the car. However, if the branding becomes a source of income and the significance of such products containing the VW brand is high and without any logical connection to the car, brand values might be diluted.

7.4.8 Processes

Forecasts are definitely beneficial for the planning of the necessary resources and smooth management of unplanned situations. VW has started employing big data analytics to replace more conventional planning methods based on experience and some historical data, but this ought to be generalized and used extensively.

7.4.9 Supply chain

Of great interest is the supply chain planning. The design of the supply chain plays a key role in delivering the right part or product, quickly and punctually, in good quality and cost effectively to the customer. It must be lean and efficient and the result of team work in different disciplines which must be considered and orchestrated, correctly located, synchronized and managed, resulting in a continuous flow. Virtual Global Supply Chain Management is implemented at the best performer and this example should also be implemented at VW, certainly in all business units owned by the Group and, in a second phase, in the entire organization. An initiative of the high-tech sector to use vendor management inventory for standardized parts is also interesting. Furthermore, process and information transparency must be ensured. A continuous flow in inbound logistics can be achieved if planning simulations are carried out on a monthly basis and if forecasts are good. Real-time transportation monitoring is not implemented at all at VW. The best practice examples, such as geo-fencing, GPS technology, and communication via cell phone with truck drivers allow for good tracking and information flow. Processes should be monitored regularly and deviations should become subject to review meetings and supplier meetings. Obsolescence is currently an issue at VW, but good initiatives which have already been started will reduce this problem. However, the company could also apply additional solutions. If material and warehousing costs exceed the benefits an example from the high-tech sector – the “Best Effort Service” contracts which allow a company to refund a customer for the remainder of the contract if it is unable to deliver and/or service a product – could be considered.

The total repair process could be expedited by using parts kits compiled at the factory or the supplier level. Logistics operations could be accelerated by the use of cross docking. The introduction of RFID in warehousing would be a technological benefit for VW.

7.4.10 Human resources

The ability to attract well qualified employees and the importance of regular training are key issues at VW too. At both Group and brand level there is no problem finding good people. It is also no problem in the wholesale business in developed countries, with the exception of the USA, which is characterized by a higher level of fluctuation. Most problems in hiring good employees arise in the retail business in developed countries. Various local and one centralized initiative were, or are, carried out. The HR issue should be a permanent focus of top management as it is one of the leading criteria discerning the company from the competition.

7.4.11 Supplier strategy, ecosystem

It is also highly recommended that VW develop a sound supplier strategy in After Sales, including cross industry collaboration with other mobility providers and cooperation’s with city planners. Positive effects can be achieved by sharing expertise and best practices, and striving to improve capabilities. Further benefits of working with diverse companies include strengthening the ability to more effectively reach diverse marketplaces, creating positive change. The fostering of partnerships, the closing of long-term contracts and the building of ecosystems are a primary concern. The development of an ecosystem based on the company's own technology will reduce costs. In order to ensure the financing of projects, cash-pooling agreements are used internally.

7.4.12 KPIs

A list of existing and meaningful KPIs was provided in previous chapters describing the situation in the retail and wholesale businesses. This list can be completed with the following KPIs considered significant for the management of any company in order to capture the complexity of the business model. These are:

- Free cash flow as a financial KPI to ensure the business remains fluid
- Transaction costs, at least for primary services and processes
- Market share per service and, if possible, per product
- Downtime of a defective customer car

7.5 Summary

In conclusion, to sum up the knowledge gained from the benchmarks of other industry sectors and what makes sense to adapt to the automotive industry in general and to VW in particular: The customer and his purchasing habits ought to be central to the business. Communication and sales channels ought to be verified to ensure they are still compatible with customer communication and purchasing habits. Services and products and the necessary infrastructure must be adapted to the needs of the customer while the OEM must seek solutions that will allow the transformation of the business while remaining the epicenter of revenue generation in the automotive industry.

Besides establishing digital capabilities, improving internal processes and enabling the efficient planning of processes, two key elements are differentiation and agility. Finally, all these various initiatives must be coordinated, integrated and orchestrated.

8. The Roadmap

The future of retail and After Sales is fraught with challenges. The merger of real and digital worlds means OEMs and the retail business will have to review their processes, the time-to-market of their products and their business models. Processes must be accelerated as more and more products from the consumer electronics industry have to be connected to cars or integrated in workshop processes. In comparison, the average time for product changes in consumer electronics is two to three years, whereas the lifetime of a car is five to seven years. The connectivity/the merger of these two products is a game changer. As products, processes and services become more digitalized the transition and coexistence between the digital and real worlds has to be optimal.

The main question is whether the traditional OEMs will have the flexibility to learn quickly and to rapidly develop or adopt and integrate innovations?

All the relevant topics concerning this question will be addressed in the last part of this thesis, beginning with topics that describe customer expectations regarding service in 2020-2025, and the product/service portfolio, including added value services, all summarized under the heading of customer intimacy. In order to implement the service of the future, a strategic repositioning of After Sales is necessary. This strategic positioning is described in an illustration with two dimensions: customer relationships and operational excellence. The main blocks of activities are then described. The chapter closes with a summary.

8.1 Future strategic positioning of After Sales

A comprehensive holistic strategic view includes the short, middle, and long term activities necessary to achieve the vision and the measurable targets on the path to the final goal. Therefore the most innovative proposed activities are recommended according to the implementation timeline – the so-called wave. Four waves were identified: the first wave is short term; two and three are middle-term activities, and the activities proposed for the fourth wave ought to be implemented in the future. The other activities mentioned are not allocated to a point in time because they are carried out consistently. Here the dissertation addresses the innovative aspects that can be put into practice according to the availability of the necessary resources. The main strategic activities will be illustrated before the chapter is summarized.

As with every other mobility provider, VW has the vision of becoming the most attractive mobility provider in the future.

This vision cannot be achieved by VW alone as mobility has many different aspects. The Oxford dictionary defines mobility as “The ability to move or be moved freely and easily”. One of the three explanations provided by dictionary.com, and the most appropriate, is “the ability to move physically: mobility is part of physical education”. According to dictionary.com the word **mobility** was originally known in the early 15th century as "capacity for motion" from Old French mobilité meaning "changeableness, inconsistency, fickleness," and from Latin mobilitatem (nominative mobilitas) meaning "activity, speed," and figuratively: "changeableness, fickleness, inconstancy," from mobilis (see mobile (adj.)).

An OEM in general, and VW in particular, as a producer of passenger cars or LCVs, cannot cover all the mobility needs of its customers in terms of speed, infrastructure, advanced IT capabilities, environmental, regulatory restrictions and economical aspects.

Therefore this chapter will focus on the mobility solutions provided by passenger car producers and on the necessary service. Future vehicles will be part of a dynamic and flexible mobility system. Furthermore, digitalization and the Internet of Things (IoT) require the transformation into a producer company with advanced IT capabilities and a large service portfolio.

8.2 Customer intimacy

This section is structured in the following subsections:

8.2.1 Service 2020-2025 for the customer

8.2.2 Product/service portfolio

8.2.3 Added value services, management of customers' mobility needs

8.2.4 Customer segmentation

8.2.1 Service 2020-2025 for the customer

The service process currently practiced was described in chapter four in Section 4.1.

The first hypothesis that we make is that there will be a variety of ways in which service is provided depending on customer preferences and the vehicle's technological restrictions. Without going into depth, customer preferences depend on a willingness to pay either more or less for a service and its media affinity, whereas an example for a vehicle's technological restrictions could be the age of a car; seven-year old cars do not have the latest electric and electronic devices for sophisticated assistance features installed, such as car to car or car to workshop communications, allowing online diagnosis activities.

Starting with the traditional customer service order, we can expect that digitalization will simplify and expedite the appointment determination process. If the connectivity of a car to the workshop is technologically feasible, and the customer agrees to the online transfer of data, a diagnosis can be made. On-board diagnostics (OBD) means that a vehicle has self-diagnostic and reporting capabilities. If a problem can be solved via software updates this can be carried out with the customer's agreement. On the other hand, if a technician in the workshop decides that a car needs to be repaired in the workshop a service appointment must be suggested to the customer and capacity, in terms of work bays and technicians, including necessary tools and spare parts, must be available for a smooth process flow.

See illustration in Figure 40:

Figure 40: Service 2020

Besides information regarding faults, repair suggestions, appointment times and repair duration, a customer also receives the estimated costs by way of the vehicle display, a PC or other mobile devices. If the customer agrees to the conditions the car is repaired as planned. The car reception process is more effective if it is paperless, using a tablet PC connected with the workshop IT systems. The diagnosis data and vehicle history are available to the service adviser before the customer arrives at the workshop. The moment the customer arrives at the dealership an automatic number plate recognition camera sends data to reception and the driver is guided to a parking place. In addition to the diagnosis a vehicle check can be carried out on reception of the car in order to avoid overlooking any other defects. If any additional repairs need to be carried out this is first agreed with the customer. The technician doing the repairs can be assisted by Augmented Reality (AR) visualizations and a remote expert.

During repairs a customer can either wait in the dealership or receive information on the status of the repairs on a PC or other mobile device. In the dealership a dashboard can provide information regarding the repair progress to customers. It might not be possible to have PC or mobile device cameras inside the workshop in every case, but repair status as information by email or phone is always possible. Once repairs are finished the vehicle history must be updated. When the car is returned to the customer the service adviser can explain on his tablet PC, with AR assistance, the repairs carried out, and the billing.

The final step, payment, can also be organized to be comfortable and easy for the customer. Invoices can be sent, confirmed and paid electronically.

Depending on the duration of the service alternative mobility can be provided, or a customer could be given the option of having the workshop pick the car up from home and return it after the service.

Once the existing open questions regarding autonomous driving, such as who is responsible in case of an accident, have been resolved, and the necessary changes to the infrastructure have been completed, a car could drive itself to the workshop for the repairs or service.

See illustration in Figure 41:

Figure 41: Service 2020 (Cont. 1)

For predictive maintenance purposes information on the vehicle, driving performance, mileage and similar relevant parameters can be transmitted to Volkswagen so that the car can be re-paired before any damage occurs.

In the case of older cars maintenance predictions can be made using big data forecasting methods.

In another scenario a service employee could go to the customer to pick up the car. Once the car has been picked up at the agreed time the customer receives a video call on the website. The service advisor greets the customer and carries out the reception, which the customer can follow on his tablet. Service/repairs suggestions, including duration and costs are provided to the customer. The customer can accept or reject these online and ask questions by way of vid-eo chat.

In a further scenario the service comes to the customer and could be called the mobile truck. In such cases the service advisor drives to the customer with a Mobile Service Unit and receives on his mobile end-device, all relevant information regarding the vehicle and the customer. Thus equipped, the service advisor carries out a mobile car reception at the customer. With the permission of the customer he then activates the OBD data transfer. The data are evaluated in real time at the back end and transferred directly to the service advisor's mobile end-device. A software update can be carried out immediately on location. In order to solve a problem the service advisor can make use of the remote support possibilities provided by tablet, smartphone or data glasses. Should spare parts be required, these can be ordered immediately using the mobile end-device, and swiftly delivered. Subsequently, the service advisor reminds the customer of the next required service and arranges an appointment with him directly then and there. The corresponding data entries made on the mobile end-device are automatically updated in the back end system.

Thus, it is apparent that future market growth will be driven by digitalization, software and services.

8.2.2 Product/service portfolio

In the chapter 4 the core service process was described. It is necessary as a mobility provider to have a more extensive product portfolio. In addition to the services offered today, from services to quick services to various repair operations, preventive maintenance provides additional sales business opportunities. Dividing the customer type into new car and used car buyers, these can be further divided into two major categories: private and business customers. Whichever category is chosen, the goal is always to maximize the retention of customers. In the case of used car customers the task is more demanding because if the customer has bought the car outside the Volkswagen organization, dealers and service partners have to find a way to attract these customers, who have never before experienced the branded network, in order to retain them.

Regardless of category, customers appreciate consistent service and a rapid response to their requests. Digitalization and big data analytics allow individualization and personalized marketing under economically feasible conditions. The goal is to offer end-to-end solutions and to manage customer mobility needs by managing trust and complexity throughout the entire customer life-cycle. It is crucial for every business to have direct access to the customer. Intermediaries, such as the platform providers, have the potential to disrupt today's existing business models, and pose a danger.

The service portfolio must satisfy customer requirements. There are differences between private and business customers.

Due to urbanization a higher share of private customers will, in future, not own cars, but they will pay for mobility: an electric car during the week to drive in and around the city and other cars with all types of power trains on weekends and for vacations, depending on requirements. Perhaps an SUV for skiing or a convertible vehicle in the summer, or a stylish sedan with a driver for going to the opera in the evening etc.

In the case of business customers, depending on the size of the fleet, additional stakeholders have to be taken into consideration. Firstly, the person responsible for the fleet purchasing process and secondly, the fleet manager, if the functions are separated. The user of the car has limited or no influence at all in the case of fleets. In the fleet purchasing process four elements are important: the product, the sales price, the TCO costs and the service and finally, financing conditions. For the fleet manager, in addition to the product characteristics, the TCO and service processes are important. Besides costs, user friendly processes and product characteristics, an automatic fleet management provides:

- Location and tracking of the vehicle
- Display of vehicle data, trip data, vehicle status / service status and reporting
- Geofencing (definition of permitted areas, routes or periods of time for use).

Additional support for the car user could be provided by: automatic keeping of a driver's log-book according to tax office standards and the recording of journeys which, if saved and differentiated, increases convenience.

The following services can be provided for all customers, independent of category, providing customers and users agree to the data security conditions:

- Based on information relating to the vehicle, driving performance, mileage and similar relevant parameters which are transmitted to the Volkswagen back end, most probably to the dealer, predictive maintenance and planned repairs can be proposed and planned
- Recommendations for action based on the information relating to driving performance can be communicated to the customer (e.g. tips for lowering fuel consumption / offers for safety or economy training)
- Demand-activated leasing and insurance offers are prepared and transmitted electronically to the customer
- To protect against theft and for rapid first aid in case of accidents, the vehicle can be located and, if necessary, disabled by means of GPS tracking and tracing
- The search for, administration and individualization of, points of interest such as parking spaces, sights, fuel stations, incl. fuel prices, can be provided.

Added value services are described in more detail in Section 8.2.3.

To sum up, preventive diagnosis opens up new dynamic service possibilities:

- Conversion of sudden/surprising vehicle breakdowns into plannable maintenance events and
- Dynamic service deployment.

There are also several benefits for the dealer:

- Enhanced customer satisfaction/retention
- Service contracts with optimized inspection intervals can be provided
- Optimized logistics
- Adaptation of diagnosis to field behavior.

The benefits for the vehicle owner or driver are:

- Plannable downtimes
- Enhanced vehicle availability (shorter maintenance time)
- Optimization of maintenance intervals.

A further business boost can be expected from autonomous driving cars if current issues can be solved. Due to the current improvements in the research of autonomous driving technology regarding functions, speed and a reduction in price, as more and more consumer electronic technology is used, it can be expected that autonomous driving will be introduced. The biggest current obstacle in the growth of autonomous driving is the lack of the regulation of liability in case of accidents. As OEMs, or in combination with OESs, risk financial bankruptcy they are reluctant to introduce the technology. If liability were to be divided among several parties involved, such as OEMs, OESs, customers, insurance companies and the state, the introduction and growth of the technology would be faster.

8.2.3 Added value services

As we have seen a connected car is a rich source of data if we have the systems to analyze that data; 98-99% of data is not even exploited today. The function of a car must be extended so that it becomes an indispensable mobile device. Depending on the type of car, it could be used as a mobile office or living room according to the needs of the driver and passengers. It is furthermore necessary for industry to develop from a linear process to life-cycle thinking by using simulations to make better decisions. The goal is to design products and services for the entire product life-cycle. It is becoming increasingly necessary for After Sales to take advantage of this, to think out of the box and enlarge its business model in order to become a service provider as well as providing technical service for cars.

In addition to the basic service of a car, further services, particularly for private customers, can be provided:

- QR-Codes can be used to compile complete customer profiles and to actively design offers
- The customer could, for example, take a photograph of a part with his smartphone and this will be directly transmitted to the original parts website. Thus the customer is able to buy parts online.
- If he decides to do so, the workshop will immediately submit an appointment for the assembly and calculate the costs incurred. The payment process will also be digitalized. The service will then be provided once the order is confirmed by the customer.
- The customer can log into the OEM/wholesaler or dealer's website from home or elsewhere using a mobile device. He can order an accessory part following which the customer can be offered a vehicle check-up, including an individual service package, based on the data provided by the OBD interface.
- Information regarding weather can be transmitted depending on the destination and route entered in the navigation system
- If the car is connected to a smart home, the driver can remotely control the energy consumption, heating, connected devices such as a refrigerator, coffee machine, television set, plant watering systems, lights and blinds etc. while sitting in the car
- Another valuable function is car parking. This includes the identification of free parking places when traveling to a certain part of the city. In cases of autonomous driving cars,

the car is able to look for a parking space without a driver. Robot parking garages already exist in Japan.

- A wider integration between a connected car and the internet of things (IoT) in order to better connect the car to the outside world – booking restaurants along a route, providing data to doctors and health insurance companies – is another convenient service
- If there is a promotion in a supermarket or store where the driver regularly shops, information regarding such an offer can be relayed to the car cockpit whenever the driver passes near the respective store.
- If the customer is looking for a new residence and passes near such a location, again, such information can be displayed in the cockpit. Many other such cases, too numerous to mention in this thesis, and all following the same principle, are possible.
- One very important function is eCall. ECall is an automatic emergency call system in case of accidents that reports a number of important data, such as vehicle type, time of the accident, vehicle position and number of occupants, to the European emergency center. If the information mentioned above is enhanced with data regarding the conditions of the occupants and the car this can considerably enable the preparation of emergency teams. Connected Mobility can assist in saving many lives if rescue services can take action within the first 40 minutes of an accident. The information can also be transferred to insurance companies and retailers so that in cases of accidents in which only the car is damaged replacement mobility is immediately available and the formalities with the insurance company are automatically commenced.

The trend regarding the provision of mobility and the convenience of end-to-end solutions for customers in addition to the servicing of cars is confirmed by the regular research done by DAT. In its annual report the German Automobil Treuhand GmbH (DAT), a company founded on February 28, 1931 in Germany and globally active for the automotive industry, revealed that 80% of German car owners declared that the main reason for car ownership is individual mobility and freedom. In second place, at 64%, is the dependence on a vehicle due to the location of residence and workplace. The third main reason, at 48%, is the time-saving factor that a vehicle provides when getting from A to B. It is also important to mention that the last two reasons mentioned were, at 9%, the simple pleasure of driving and a car as a status symbol. Several customer groups no longer look for horse power in a car. Entertainment is more important and therefore the integration of all customer devices such as smartphones or tablet PCs in the car system is a basic requirement. As such, the first step is to establish exactly what kind of mobility the customer wants: a safe trip from A to B, or a truly unique driving experience.

Findings related to another mobility service, car sharing, are partially contradictory. Whereas the Fraunhofer Research Organization, which has developed scenarios for the approach to mobility in 2035, assumes that E-mobility and car sharing will increase as ecological lifestyles become more common, the DAT has revealed the opposite trend. The Fraunhofer scenarios claim that sharing and experience will be more important than ownership, and whoever is jointly mobile will be more fashionable. Another reason for sharing is the trend of consciously renouncing a part of ones income in order to enjoy more free time or take sabbaticals. In consequence people have less money available for buying cars or undertaking expensive repairs.

By contrast, according to the annual DAT survey in Germany, car sharing is no alternative to private automobile ownership. For 88% of the surveyed car holders car sharing would not be viable as an alternative to car ownership. The top 3 reasons given were the effort to determine the location of each car, the lack of appropriate offers near their own place of residence and the discomfort of sharing a vehicle with someone else. But this might change in future as urbanization expands and if a nationwide supply and better processes are implemented.

Another challenge is the smooth transition from one mobility provider to the next. Here, cooperation is the key. Cooperation's must be set up with other established mobility providers such as airlines, railways, shipping lines, bus companies, public transport companies and city administrations, to name the most important ones. The alternative is to invest in another mobility provider, like Daimler, which is extending the car sharing business of Car 2 Go, its own business model, to the taxi business. A boost could come with autonomous driving, and Uber has announced that it will buy autonomous driving cars from Tesla in order to augment its service offers.

Today we have partial automation, but this will further develop to high automation and then to full automation in further logical evolutionary steps. The trend in logistics is against trucks in urban areas and towards sharing/pooling as the new model. In the future, there will be a higher circulation frequency and smaller batches with self-driving trucks and trains. In this sector LCV producers need to keep an eye on the trendsetter, Uber Cargo, and platforms are also important. The wagon or truck container has no intelligence but does have a high potential for sensors to monitor brakes, track & trace, for cargo monitoring, wheel monitoring etc. The temperature when transporting food is also important for trucks – asset monitoring logistics – and the sensor developed for example by Bosch is ideal since, as an RFID, it does not need energy and can last for 6 years.

In order to shape the mobility of tomorrow sufficient and correct data is necessary to provide a service. To be successful OEMs and retailers need to add new channels of connection to their traditional points of contact with their customers by matching the contact expectations of the customers. Data will improve the functional asset performance, automation will increase and workflow will become more collaborative. A change in values is being observed; a status update is ongoing: YESTERDAY-OWNERSHIP, TODAY-ACCESS; and technology is taking a back seat.

To provide a mobility experience to customers companies need to be open to partnerships and must monitor the competition. The usability of cars must to be extended, such as in the case of Uber where, while the car owner works, his car can become a taxi, it can be rented. For the mobility experience the different points of contact must be brought together: parking, rides, biking, public transportation, fuel stations etc.

More and different points of contact with customers will develop and OEMs need to try out different possibilities and to find, or permanently establish, their position in the mobility and service environment.

8.2.4 Customer segmentation

Although the focus of this thesis is not on customer segmentation it is important to mention the ongoing development of customer segmentation at Volkswagen. Four to five years ago the main segmentations criteria were the commercial point of view and the social milieus according to SIGMA Sensor Research.

From the commercial point of view Volkswagen distinguishes between private and business customers.

The private customer is characterized as an essentialist, rational buyer, married with two children on average and in need of a qualitativ, reliable product.

Business customers are generally small to mid-sized fleets, highly price sensitive, looking for discounts and in need of cars with a low total cost of ownership. Both customer segments, private and business, demonstrate high involvement due to high costs.

Private customers

The segmentation based on social milieus according to SIGMA Sensor Research applies value orientation, from traditional, through modern, to post-modern, and social status (lower middle, middle middle, upper middle, upper class) as the basis to plot the milieus. These "social milieus" reflect the psychological predisposition of customers and link them to the acceptance or rejection of our products.

The analysis starts by classifying the products according to technical criteria in different product segments and allocating vehicles to the varying customer requirements, actively designing cars according to those requirements and marketing them respectively. A social milieu relates to people with similar values and consumer patterns. As this approach is not yet automotive specific it is combined with other data (e.g. media milieu studies, online milieu data gathering, micro-geographical market segmenting, automotive clinics, online panels etc.) in order to obtain an all-round view of each relative customer segment. Two dimensional segmenting of milieus can depict social status.

The first dimension is the Price – Premium – Divider where the segmenting is carried out according to the willingness to pay high / premium prices across all vehicle classes. According to this dimension we can identify three main categories:

- The up-market – target groups with an above average demand, backed by purchasing power, in the luxury segment or with a demand for premium products, regardless of the vehicle class

- The mid-market – target groups leaning towards middle of the range price segments / with average demand for premium products and
- The down-market – target groups with a preference for the lower price segments, due to lack of purchasing power / low interest in premium products in general.

The second dimension is the Aesthetics Divider where the segmenting of the market is carried out according to key automotive attitudes, values, lifestyle and taste. Based on this dimension we can also identify three main categories:

- Brand loyal, traditional “no experiments” – target groups with a preference for conventional concepts, traditional taste and design, and an above average trust in established European brands
- Brand, model and car concept express identity “this is me” – target groups who want to express their socio-cultural identity through their choice of concepts, brands and models: e.g. status, joie de vivre, sportiness, environmental consciousness etc.
- Openness for innovations “I am me” – target groups who reject any kind of brand loyalty and mainstream trends in favor of purchasing decisions based solely on subjectivity and taste.

Combining the two dimensions above we obtain the automotive lead segments in Europe which are:

- Distinction and Classic Taste: Conservative elite milieus leading a traditional way of life. The leadership role in society is taken for granted as is the focus on achievement. Appreciate a sense of style, connoisseurship, good manners. Clear overrepresentation of "50 plus" age groups and higher education. High proportion of business proprietors, senior executives / managers, independent professionals and retirees with higher to highest income levels.

Important for this group are: Family tradition, property and financial independence, a distinguished lifestyle, understatement and discretion. Refined elegance, a high level of comfort, long-standing tradition regarding the make, and a respectable overall appearance is what they appreciate in a car.

- Trust and Comfort: Mainstream conservative milieus which cling to traditional values, morals, social customs and conventions. Strong liking for traditional tastes and ordered family life. Usually older people (often 60 plus) with lower to medium level of education. Above-average representation of homemakers, retirees.

Important for this group are traditional family values and gender roles, financial security, middle class standard of living, a lifestyle conforming to established rules. First and foremost, they want to feel comfortable, well and secure in their car, and they want to be seen driving the car.

- Power and Superiority: The "upper class’" standard of living as a measure of success. Very prestige-/outward- oriented lifestyle; like to display what has been achieved. Broad age distribution up to 50 years. Typically freelancers, self-employed, company owners, managers, with medium to higher level of education. Often with high standard of living, but many of them crisis-stricken too.

Important for this milieu are status and prestige, belonging to the "rich and beautiful", luxury consumption. They drive the latest luxury vehicles from renowned brands and do not see why successful people should settle for less.

- Functional Aesthetics and Active Lifestyle: Cosmopolitan urban elite milieus. Goals in life comprise career (for both sexes), "art de vivre", and sustainable lifestyles. Usually with academic educational background. Broad range of age groups. Often highly qualified employees, managing directors, freelancers, professionals, senior officials, students.

Important for them are a high standard of living, good taste, art and culture, but also: humanism, tolerance, open-mindedness. In a car they value safety, practicality, and ecological responsibility. Additionally, they value intelligent technology and superior design.

- Responsibility and Ecology: Socio-critical, politically often leftist milieus. Many ‘68 / post-‘68 intellectuals with a blend of traditional left, new green and communitarian values. Rejection of consumerism, economic globalization and post-modern I-am-me philosophy of life. Among the core values: ecology, (global) social justice, human rights. Typically highly educated academics in nearly all age groups.

Important are for them: Education, self-realization, ecological and political correctness, (global) social justice, human rights. Their opinion in terms of cars: the lesser evil, one cannot do without a car these days. Generally, they drive a small and economical car.

- Authenticity and Smart Mobility: Young, mostly highly educated, urban avant-garde milieus in metropolitan areas. Lifestyle trendsetters, in some cases living contradictory ways of life. Age focus up to 40 years, often living as singles. Typically well-educated young professionals in creative jobs, artists, media people, freelancers, students.

Important for this group: Career, self-determination, autonomy, creativity, art and culture, intuitive consumption regardless of conventional prestige patterns.

- High Tech – High Touch: Progressive mainstream milieu often adopting new / postmodern trends. Mostly well-educated white- and no-collar workers, or still studying, up to 40 years of age, often in the IT and modern service industries. High proportion of singles and young couples. Technology-oriented (early adopters of high tech-products) consumers, open to new experiences, ways of life and consumption.

Important for them are career, fun, mobility, outdoor activities and individualized consumption. They like creative, sporty, sensual, modern cars.

- Tough and Cool: Mostly young-generation milieus, including youth subcultures and drop-outs, often leading unconventional or purely hedonistic lifestyles. Escapism and aesthetic provocation as a means to gaining identity. Breeding ground for new fashions and tastes. Typically singles up to 35 years, either frequently changing jobs or unemployed. Usually, without higher educational skills.

Important for them are the "gang", indulgence, coolness, fashion, fun and action, big kicks.

- Affordability and Joie de Vivre: Modern mainstream milieus, usually the offspring of the Trust and Comfort / Practicality and Economy segments. Under growing economic pressure they tend to spend less on consumption in cases of decreasing household incomes. Typical: married couples with children. Mostly educated up to intermediate level. Usually middle aged, blue-, white- and no-collar workers with a blend of traditional and modern values.

Important for this group are family-life, security, roots, but also individuality, experiences, joie de vivre. Regarding cars they need a versatile, child-suitable and inexpensive car, but preferably including driving excitement.

- Practicality and Economy: Working class milieus, strong materialism, with a distinct philosophy of life. Often with socially and politically authoritarian attitudes. Often manual workers/retirees/homemakers with lower education in the 50 plus age groups.

They value as important: Satisfactory standard of living, social security, values based in solidarity and community. A car should be affordable, economical and robust.

- Big Demands - Small Pocketbook: Economically and socially marginalized milieus with few chances of making it in the post-industrial labor force. Usually the most affected victims in an economic downturn: long-term as well as recent poverty, immigrants, socially uprooted. High share of unemployed/unskilled, semiskilled workers. Usually with low incomes.

Important for the group is social and economic survival, and keeping up with the consumption level of the mainstream. They want everything at the lowest possible price.

- In terms of volume most of Volkswagen's customers are, and will continue in the next ten years to be, in the "Trust and Comfort", "Affordability and joie de vivre" and "High Tech – High Touch" segments. Volkswagen wants to retain these segments and, in order to increase market share, it will try to attract other milieus / segments too by focusing in the modern and postmodern world on the value orientation scale as these milieus show higher volume and are less traditional and more modern.

In After Sales the private customer group relies primarily on the marketing segmentation explained above, but it is then again consolidated in terms of the offerings because a large customer group can be covered with few offerings.

We have a few extreme customer profiles, such as the price insensitive, comfort oriented customer. Managers, for example, don't want too much contact with the workshops because they don't have time and they expect 100% mobility, so an adequate replacement car must always be available. In the same category there is another subgroup that is also price insensitive, but needs a lot of customer care – in general, retired people who spend hours in the workshop. At the other extreme are the price sensitive customers who want basic service and exact information regarding repairs. They require a clear explanation of the bill and also want to give their approval if more repairs than initially agreed are necessary.

All other customer profiles lie between the above described extremes.

The business customer is very different to the private customer. The process is easier to understand because the service is fixed according to the contract/service package that they have bought. Here the challenge is to define easy, lean processes supported by IT and, of course, price competitiveness.

In terms of technical repair standards there is no differentiation between customers, but in terms of soft facts, especially customer treatment, the differentiation is crucial.

In recent years other segmentation approaches have arisen, supported by statistic algorithms, Big Data and IT. Customer loyalty can be one segmentation criteria. Thanks to business analytics we are able to predict customer loyalty; here segmentation into the most loyal 30% or 50% and the least loyal 30% or 50% is conceivable. An additional segmentation can be developed based on a customer's value to the company over the whole life-cycle of a car. The goal is to identify highly valuable customers for up-sell, cross-sell and conquest efforts. Based on the historical purchase data, including the car, repairs, services, financing, leasing, etc. predictions for future sales and profits can be made. This marketing is more targeted to the needs and preferences of the individual customer; moreover the goodwill can be based on the customer life time value.

Fleet customers
In addition to segmentation according to fleet size, in B2B there are two major groups which influence the fleet business which might have contrary interests, viz. fleet management & the car user.
Fleet management emphasizes: car price, TCO costs, CO^2 taxes, financing costs, process simplicity and IT compatibility (e.g. the billing process).
The car user wants: maximum service, a dense retail network, short-term availability and mobility.
Another segmentation criterion usually related to size is the product portfolio, such as in the case of fleets, where the customer usually purchases a package. The most common product portfolios are:

- Fleet sales
- Fleet sales and financing
- Full operational leasing that includes service and
- Leasing.

Best business opportunities for an OEM lie within the "full operational leasing" which includes financing by the OEM.
The further development of segmentation can be implemented based on a product portfolio combined with customer needs. An appropriate concept should be developed.

Summing up, customer segmentation based on commercial status or on social milieus according to SIGMA Sensor Research retains its validity and can be enriched by more dynamic segmentation approaches supported by business analytics. The new segmentation approaches described above have the potential to improve the customer experience, reduce marketing costs and help dealers to understand behavior in their regions as well as lifetime value in order to improve sales and service.

8.3 Areas of focus in After Sales

As mentioned in the introduction to the chapter, the strategic positioning of After Sales is necessary.

Customer satisfaction and loyalty and operational excellence form the basis of sustainable economic success in a business. The primary areas of focus to be developed and managed and their contribution to strengthening customer relationships and operational excellence are illustrated below in Figure 42.

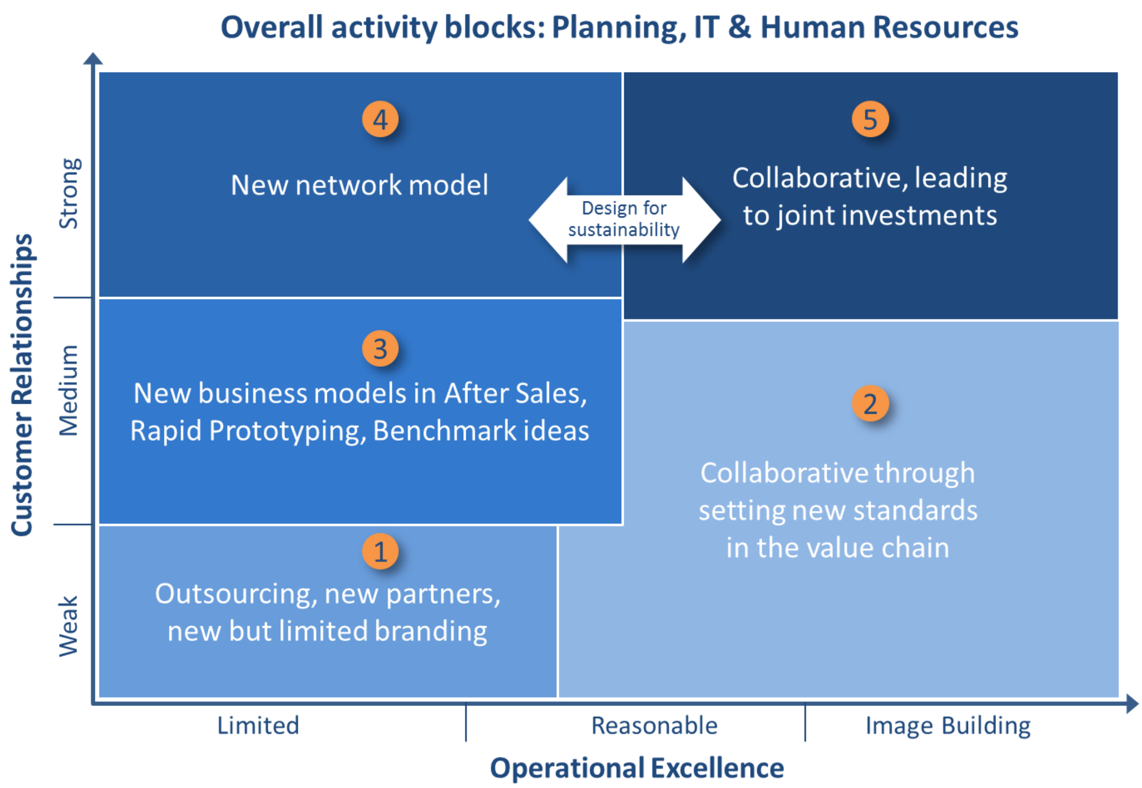


Figure 42: Future strategic positioning of After Sales

Ordinary activities such as those illustrated in the first area of focus will not be described here. Those activities which have limited impact will be addressed briefly and topics which need to be tackled in more than one area of focus will be described only once. Activities such as planning, human resources and IT need to be considered in every area of focus and will also only be addressed once.

We will first address the activities common to all areas of focus: planning, IT and human resources.

<u>**Planning**</u>

Topics to be addressed:

- Good forecasting by using big data algorithms as often as possible; service and parts sales prediction; impact of diverse influence factors such as weather (IBM bought a weather channel), customer evasion prediction, car defects prediction, network capacity prediction and planning etc.
- Digitalize process planning, introduce process modeling and simulation
- Increase the efficiency of supply chain planning through digitalization, the aim being to achieve continuous flow
- Use cash and resources (staff) pooling.

IT

The challenge is to link new developments to legacy systems. It would be best to develop a standard IT backbone that can be connected to other software by means of cloud computing instead of legacy systems. The time needed for development and implementation must be substantially reduced.

Process acceleration due to digitalization:

It is important to have IT solutions between the retailer and the OEM that enable good data gathering and organization in order to better serve the customer and prepare dealership visits. To better understand customer preferences and choose the best communication channels and make appropriate offers, data is necessary. Data gathered from the different customer points of contact with dealerships and the OEM must be collected, consolidated and connected with the OEM IT systems and other retailers' IT systems. Data should even be collected from WhatsApp, Facebook and email and electronic documents employing the necessary algorithms.

In the long term, machine learning and artificial intelligence can be introduced in the working environment in the wholesale, service and distribution chain to enhance human expertise. If economically feasible, especially at the retail level, the technology can help service advisors and technicians as a knowledge provider. In the long term it can also raise service quality and reduce personnel costs. For example, the IBM Watson machine is a cognitive computing system with voice recognition that that can gain knowledge by reading texts and can interpret unstructured data. It is currently in use in medicine and helps doctors keep pace with new developments in research. It ought to be assessed whether Watson could be introduced in the technical support hotline.

Human Resources

The managers and employees in the entire value chain have a direct and major impact on customer satisfaction and the economic success of a business. As it is not the purpose of this thesis to go into depth on this topic, the major points to be considered will only be briefly mentioned. Furthermore, concentration will be on the retail level where most problems finding sufficient qualified staff are to be found.

The work principles in teams and business units, which function like a start up, differ and contradict the standard work principles contained in employee work contracts under the "old economy". They do not conform to the strictly regulated working hours per week and per day passionately defended by unions. A working environment full of creativity and energy does not conform to bureaucratic regulations and control. It needs trust and motivation and the acceptance of a different approach to solving tasks.

The profile of ideal management also differs from the norm today. Charismatic personalities, not entertainers, are required. Charismatic managers have very precise and clear ideas and know how to realize them and are accordingly able to communicate their ideas so that a team knows how to proceed.

The education and training must also be reconsidered. Instead of proclaiming absolute truths to students, more relativity ought to be integrated into the training concepts. Continuous learning is the future. Integrate communication at various levels as a discipline in training concepts.

The example of Airbus can also be followed and extended in the automotive industry. In order to enhance creativity in its own organization and to support employees who have innovative ideas, Airbus created the Idea Space network with 5,000-8,000 engineers in which anybody with a problem needing a solution posts this in the system and anyone who has a solution can join a virtual team so that the problem is quickly solved and can be rapidly implemented. The network offers the possibility of quickly linking people with ideas. Questions are asked in the network and hundreds of answers are often received.

The activity system in Figure 43 shows the most important points to be considered.

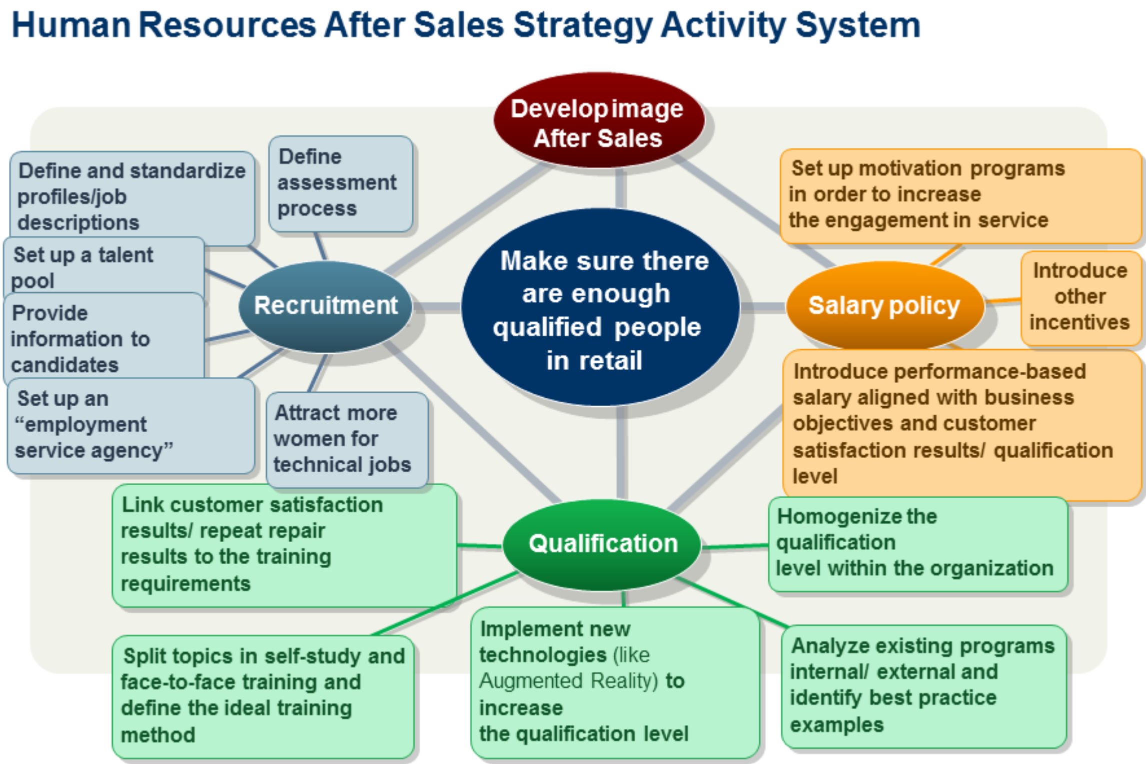


Figure 43: Human resources activity system

In addition to the principal topics mentioned above the following aspects will increase the quality of the several foremost steps.

Recruitment:

- Shift from technically oriented to service oriented
- Give more attention to customer orientation and social skills in job descriptions
- Set up an International Employee Exchange Program at retail level
- Integrate social media in the search process

Qualification:

- Strengthen cultural aspects
- Ensure long-term effects in training
- More on the job coaching instead of classroom training
- Make use of advanced technology in qualifications

Image:

- Organize motivational events, build a community using new media
- Establish a strong service culture with 100% customer focus: the staff need
- to be able to see the world through the eyes of internal and external customers

Globalization and digitalization are changing the rules of the game and role models are more important than ever. Managers need to set a good example and not only show their employees respect, but also give them recognition and provide them with more responsibility. The problems and issues are becoming more and more complicated and one individual employee will not always be able to solve these alone. Team work is therefore in demand.

Bosses need to know their employees as well as they do their customers, and they need to motivate them, because when people are enthusiastic about their work they can perform amazing things.

Failure and calculated risk taking must also be allowed, as only when one knows exactly why something doesn't work, can one do anything to improve it.

A culture of continuous learning will enhance the innovative capacity and flexibility of the company, as only top companies are able to re-invent themselves when it becomes necessary.

The **second area of focus** has a positive influence on image building whereas the influence on customer relationships is medium. Key activities here are collaboration in the value chain, branding and controlling with appropriate KPIs and transparency.

Collaboration in the value chain

The problems and tasks to be solved and set up regarding digitalization, autonomous driving vehicles and the internet of things are so complex and diverse that no one company alone can solve them and no one company has the financial resources to cover all the necessary issues. In this case collaboration in the value chain and outside the industry, a so called ecosystem, is vital. The meaning and role of an ecosystem will be dealt with in the fourth area of focus.

Starting with the OEM, virtual teams can be formed to solve problems. The example of Airbus described in section before should be followed, not only internally at the Volkswagen brand, but also between the several Group brands, wholesalers and, if necessary, including retailers.

On the retail level collaboration between dealers in order to share capacity, inventories, specialists, print shops etc. would be desirable. If arbitration from wholesalers is necessary this should also be planned and developed with the necessary resources.

Outside the industry a broad ecosystem of partners and strategic alliances ought to be set up based on the topics addressed. This subsection will address the primary strategic partners necessary in After Sales.

Branding marketing

The branding marketing can be strengthened. Following the example of a high-tech company interviewed during the benchmark study the branding process should be controlled by the company. The core element is the development of products that are not produced by the company itself but by suppliers under the brand of the developer. The advantage is that the company can offer a large range of products without the need to invest in production facilities and staff, which is cost intensive. Additionally, R&D continually extends its capabilities and capacity utilization is assured.

The next best practice example from the benchmark study that can be followed comes from a logistics provider. All its logistics subcontractors have branded their assets with the logo of their contractual partner, even though they own the assets themselves. The advantage is a consistent sight for customers who are assured that the service quality is high. The message to the logistics provider is that they are dedicated suppliers who fully identify with the values of the contractual partners.

KPIs and Transparency

KPIs are basic requisites for control and transparency. The thesis addressed this topic in depth in the section "Dealer Best Practice Model" on pages 39-41. Therefore no further details will be provided in this section except to say that the monitoring system needs to be supported by an effective IT system and that transaction costs should be constantly monitored.

The above topic concentrated on the internal monitoring in the value chain, but in order to get a clear understanding of the strengths and topics to be improved, benchmarks with competitors within the industry as well as outside the automotive industry are necessary. The best example is chapter 6 in the thesis. The benchmarks should be carried out repeatedly, also with other companies, as the business environment changes rapidly.

Activities in **the third area of focus** address topics such as new business models in After Sales based on new technologies and business ideas from other industries adapted to the automotive industry. The technology analyzed to a certain depth is rapid prototyping.

Incentives

There are various incentive opportunities that the OEM or Group can utilize in order to promote the implementation of initiatives or projects. This can be simple cost absorption for strategic projects, grants for advertising, discounts, or even complex combined bonus programs for performance, quality, customer satisfaction or investments, or any combination of these.

Incentive programs can have different goals, ranging from increasing market share, increasing sales, customer satisfaction, and service quality, to network investments in capacity.

The most successful incentive programs in the organization have been the Combined Bonus Programs.

Incentive programs must be part of the annual targets and in many cases market research into the activities of the competition can be significant. Depending on the content of the incentive program an alignment with all other divisions must be carried out before the program can begin. For example, if the introduction of intelligent tools for the connected workshop is incentivized the department concerned must ensure that the respective tools are available. The steering KPIs should generally be linked to the incentive schemes.

Key success factors for incentive schemes:

- content and scope are clearly defined. These can be: increasing turnover, increasing margin, decreasing costs, resolving complaints, etc.

- the target/goal must be clear, what must those incentivized accomplish. The steering process must be based on KPIs. All targets must be measurable, challenging but achievable
- the existence of an opening clause if the incentivized is unable to reach the agreed goal; otherwise introduce multiple levels of incentives for various levels of performance
- the start and duration of the program must be clearly defined
- easy to implement
- high degree of transparency; the performance system should be totally transparent so staff can see others' performance
- supported by IT
- easy and convenient billing process
- it must include incentives for all key players involved in the value chain
- it must include benchmark elements with the competition
- communication by means of various communication methods
- training in how to achieve the desired results
- program tracking based on the agreed KPIs; the most effective plans were based on the results of no more than 3 to 4 KPIs.

The least successful incentive programs were bonuses for newly installed or improved processes because they did not consider results. Finally, once the incentive scheme has been completed, participants will be eager to see the overall results. This provides an opportunity to reinforce the value and purpose of the incentive scheme as well as recognizing the best performances. Recognition before one's peers is highly motivational and award events are a popular way of thanking the participants for their contribution and encouraging similar behavior in future incentive programs.

The strategic organization

This subchapter will briefly address some key issues relating to the Volkswagen Organization. The Volkswagen Group and Brand are large, having a complex structure and complicated relationships with both unions and shareholders.

A major challenge for the Group and at wholesale level is to balance the independence of the various brands and wholesale units responsible for financial results and to utilize synergies in areas not visible to the customer, such as common IT, financial services, or human resources management.

The subchapter concentrates primarily on the organization of the Volkswagen Brand, the German market and the retail business in the German market. As the Volkswagen Brand is part of a Group some references to Group activities in the strategic organization are pertinent.

One possibility for managing markets and dealers is **a minimum influence model**. It concentrates on the agreement and monitoring of performance targets, approval of major capital expenditures and selection vs. replacement of the business unit chief executives. This model works well if the legal contract allows it and the business unit is performing well. From a legal point of view the business units involved must generally belong to the Group or Brand in order to be able to make decisions on all major investments. It is up to the parent company to extend the competence of a business unit to provide it with such management powers. For example, a business unit can make decisions regarding additional investments and on the recruitment of the chief executive.

The benefit of this model is that business units managed in this way maintain their individuality and autonomy. However, there is a danger of repeating tasks, wasting resources and synergies. In the case of a multi-brand dealer the costs of the contractual agreements increase exponentially.

At the other extreme is a totally centralized organization, which involves the stringent management of business units and, generally, the ownership of those business units. Centrally managed organizations often lose their flexibility and agility. The wholesale business of the Volkswagen Brand in the German market is partially a part of the brand and partially owned by the brand and large Volkswagen dealership chains. In terms of management it can be compared with a centralized organization, but with many degrees of freedom. Most wholesale partnerships in the Group and in the brands are based on standardized contracts.

In our opinion **the best solution** for the relationship between the Group, the brands and the wholesale business is a combination of centralized activities and brand and market individual initiatives in order to maintain brand individuality and utilize synergies.

Central Functions and Services

Competence centers for back office functions. At Group level, in cases of common platforms, responsibility and expertise can be bundled to become a **"Competence Center"**. Examples: research competence in terms of visualization techniques, technological expertise in a certain field or the Internet of Things in the connected workshop center. Here the Group can develop all kinds of prototypes for the interested brands as well as doing basic research in that area. Other examples are: synergies relating to product development, purchasing, and After Sales services and programs.

Government relations. Another example of necessary centralized functions is in government relations, in order to align market and brand activities.

Network. We propose setting up an international distribution system, developing synergies in service, i.e. using the same dealer networks and implementing the same technical standards, thus reducing complexity for everyone. Central functions, such as investor relations, compliance, internal and external communication, purchasing, etc., can, in time, be reduced locally and can profit from the Group's expertise, developed in recent decades, and can use its leverage to achieve greater influence. The Volkswagen Group, consisting of an international team, has its own expertise and can therefore assist other brands and businesses more and more by including their positioning and wishes, instead of just telling them what to do.

Information Technology. We suggest developing IT systems and setting up common platforms, especially for mobile services and the digitalization of processes. The investments in technology in this area are significant.

Human resources. In terms of human resources development, the individual Group brands and business units are totally independent. Each brand or business unit has its own recruitment process and these are not aligned with one another. There is a pragmatic approach to recognizing bilateral assessment procedures, but this is all. There are also some drawbacks as quality levels vary. The Volkswagen retail business in the German market is currently in the process of deciding in favor of a centralized recruitment process in order to procure better staff and better amortize the cost generated by a professionally organized process. As in many markets, there are problems finding good personnel and setting up a centralized recruitment process for all functions in retail and, if necessary, also in wholesale is a good solution. Furthermore, an organization at a national, or even an international, level which acts as an employment agency can be installed in order to quickly help dealers that need staff. The Group can also help by encouraging the formation of communities in order to strengthen the cooperation and motivation of the retail employees.

A further aspect is job rotation. The brands and Group are familiar with each other and it is common and encouraged to move from brand to brand or, in recent years, good wholesale managers have been appointed for Group or brand functions abroad. The benefit here is that the organization is becoming more international and better able to face challenges in the future.
Strategic investments. The best example is the strategic investment undertaken by Volkswagen in China.

Ecosystem. The Group seeks to create value primarily by fostering cooperation and synergy between its businesses and suppliers in technical areas of development, in production, purchasing, IT etc., primarily with those which invest heavily.

Cultural aspects. The Group can add value if it enhances the cultural aspects of the distribution organization – the traditional love for cars and engineering. A strong culture will help facilitate a better use of synergies and increase the openness and transparency of the processes. The creation of silos must be avoided. In almost all divisions the Group can enhance cooperation with the brands and wholesalers and better communicate best practice or innovations and therefore improve the learning process in the organization. It can also reduce the rigidity in organizational boundaries by encouraging networking and cross-company linkages. The foundation therefore is one of common values – “Together” – not one against the other. A culture of cooperation and partnership between management and employee representatives across all business units, environmentally and socially responsible business practices, including in the collaboration with suppliers, must be the ultimate goal.

Unifying a wide variety of brands and companies with all their individual characteristics and focuses under one umbrella is an enormous challenge, especially as the Group is committed to maintaining the individual identities of the brands. There are also areas where the activities interfere with one another and in such cases it is very challenging to monetize synergies and enhance collaboration between the brands and the wholesale business. However, the fact is, good parent companies can create substantial value by having unusual insights of opportunities, skills and resources, and by focusing their influence and activities on creating value from these insights. Back office synergies can be implemented step by step where necessary, required and wanted. Efforts are necessary to continually align the several business units, to align processes and products in the Group.

New business models

The automotive industry needs to develop innovations for which customers are prepared to pay. If not, the costs will have to be lowered and more money will have to be made from the distribution channel.

By contrast, the largest technology companies, with their extensive ecosystems and capital reserves, are able to develop business models that are disruptive to the traditional business of OEMs. An example would be the collaboration between Google and Uber which could start a free taxi service for customers in cities, with self-driving cars, fully financed by advertising.

OEMs have to find new sources from which to generate revenue and profit along the value chain. A good approach would be to learn from Google and Apple, which were able to discover revenue sources at the interface between the digital and real worlds. The current profitable business models in the digital business are driven by advertising data. According to Spiegel Online magazine, Google generated revenue of $ 31 billion in 2014 from advertising on Android devices. According to the same source, which was citing a Google lawyer in court, 70% of this was profit. Other digital business models charge fees for providing services. Another common model used by many companies offers free Wi-Fi, but analyzes the behavior of users. Another source of revenue in the B2B business between Google and Apple was disclosed by a Bloomberg report; according to it, Google pays Apple a huge amount of money to remain the preferred search engine on the iPhone. The amount paid in 2014 was approximately € 920 million.

Service based Business Models (BM) will, in future, need the cooperation of service platforms. Experts estimate that profits will, in future, be generated by services achieved with comfortable platforms, not by producing and selling physical devices. Successful IT companies such as Apple and Google, and more recently Alibaba, do not invest in assets, they do not produce things. Production is outsourced to suppliers. These companies have introduced new values in the business practice that will lead to the transformation of business models. Proof that business success does not imply ownership of or investments in assets can be easily verified when we compare the value of companies on the stock exchange. Apple is valued at approximately $ 760 b., whereas Volkswagen, which owns many assets, is valued at only $ 60 b. The reason for this difference is that the financial world values Apple's access to customers more highly than Volkswagen's. If we take a closer look at how Apple further developed its business model we realize that it also started with products, such as the PC, and also developed and sold products which were compatible with the PC and then introduced services later on: iTunes, Apple music and the iCloud. Apple has built an ecosystem around its products to minimize competition. We can now observe the same strategy being practiced by Amazon which has built up a platform on which Apple products are not sold. Another recent example is Alibaba, a Chinese e-commerce company founded in 1999, which provides consumer-to-consumer, business-to-consumer and business-to-business sales services via web portals. Other services include electronic payments, a shopping search engine and data-centric cloud computing services. Alibaba sells vehicles over a platform and also provides comparative values of other manufacturers' vehicles. Vehicles are sold by means of digital presentation; a physical showroom is not necessary as Alibaba has access to customers. Here the strategic position and role of After Sales must be utilized. As car sales become more digitalized and the personal contact to customers disappears, a major opportunity will arise in service to gain direct access to customers when cars need servicing or repairs. OEMs must be smart enough to retain access to customers and not lose it to intermediaries. The risk will be higher once autonomous driving vehicles enter the market as such vehicles can drive themselves to a workshop for a service.

Connected-car service providers make money by selling car data acquired through OBD2 plugged-in devices, selling crash data and driver behavior data to insurance companies. Navigation and traffic information are delivered for free and this is compensated for by in-car advertising. Dynamic real-time geo-information, granular map data, is a critical enabler of autonomous driving.

Other examples for generating revenue are based on selling data in the right context:

- charge a fee to direct drivers to a service center for repairs,
- sell information regarding traffic flow to authorities,
- sell parking information at a sports event or conference,
- sell information regarding weather conditions or concerning road conditions, or
- generate income by giving advice on how to run and optimize the car in real time,
- simulate the performance of the car etc.

This business model will generate revenue by offering both free digital services and chargeable digital services. Fees could be charged for historic data. For example, Tesla charges fees for digital services and add-ons. Another example is Konecranes which, since digital monitoring has been possible, also leases cranes, generating a revenue stream from services. Another example is the SMOKE DETECTOR: A sensor that costs 99 cents; a monitoring service is provided by means of the iPhone. By making the information available to others, for example to insurance companies, at a fee, the risk curve is altered. A further example from Formula 1 racing: teams are monitored by way of biometric data, and as a number of sensors are installed in every car these can measure the biometric data of the drivers and send the information to the team doctors.

A final example that will be described in detail is Rapid Prototyping or Additive Manufacturing technologies or 3-D-Printing. For simplicity the term 3-D-Printing (3DP) will be used. To research this topic interviews were conducted with Volkswagen specialists in 3DP plastics and metal, specialists in data modeling for 3DP, and the manager responsible for innovation at Airbus was also interviewed. The technology and the objects that can be produced will first be described after which the advantages and disadvantages will be listed and finally, a proposal for a business case will be described.

Definition of 3DP and the main technologies in use

The term 3DP includes several methods. It is a branch of additive manufacturing, in which a three dimensional object is created by applying the advanced concept of inkjet technology. The object is printed by adding layer after layer of different materials (plastics, ceramics, metals, wood, food-ingredients…). Additive manufacturing is distinguished from other traditional processes, especially from subtractive manufacturing (an object is cut from the raw material to achieve a desired shape or function) or injection molding (liquefied material is injected into a mold).

In most cases plastics or metals are the materials used. Objects are built up in layers, since it is an additive method. The structure is computer controlled and made from one or more liquid or solid materials according to predetermined sizes and shapes (CAD data). In order to be able to print an object CATIA design data must be adjusted as a KVS file. While printing, physical or chemical curing, or melting processes take place. Typical materials for the 3D printing are plastics, resins, ceramics and metals.

The primary techniques of 3D printing currently in use are:

- Selective laser melting and electric ray melting for metals
- Selective laser sintering of polymers, ceramics and metals
- Stereolithography and Digital Light Processing for liquid resins
- Polyjet Modeling and Fused Deposition Modeling for plastics and partially synthetic resins.

The industry leader in 3DP is Airbus, but several other companies from other industries are working in this field. To date, Airbus has qualified 500 materials and certified the printing of 1,000 parts, mainly for cockpits and aircraft. Airbus has, in the last 10 years, prepared the use of these methods in series production. Further examples:

- Houses are printed by ALM
- A Steel bridge was printed in the Netherlands
- Jewelry
- Functional parts are printed in machines in areas that cannot otherwise be reached thus improving the throughput times of the machines
- EDAG has printed a car prototype
- DIVERGENT3D also printed a car called “The Blade”
- Maersk prints parts for its fleets
- NASA printed an engine part on the ISS and the whole system now consists of 2 parts instead of 114; NASA is also doing research into the reuse of materials

- Rolls Royce has also printed engine parts etc.

The list of examples could be expanded further, but this not the main purpose of this section. According to the Wohlers Report 2015, 3DP is about to make a breakthrough. Prototypes from 3D printers are particularly advantageous when the planned manufacturing process is not suitable for batch size 1, for example, when casting. However, there is no limit to its applications. 3DP offers a potential that also makes it very interesting for the production of end products. For example, geometrical shapes, such as hollow or delicate structures, or bionic structures, which can't be produced using conventional techniques, can be printed. In such cases prices do not rise with complexity, but only with material consumption. Additive manufacturing is even beneficial for highly individual products.

With 3D printing more lightweight and compact devices can be produced. The results achieved by Airbus have proven the potential of this technology:

- Weight saving 30-55%
- Non Routine Card (NRC, savings in maintenance due to less complexity) up to 90%
- Lead time reduction up to 75%
- "Green" technology energy reduction up to 90%
- Reduction of material costs 5-10%
- Reduction of costs for printed tools 10%
- Reduction of process steps vs. manufacturing 50%.

The following forecasts have been made by Airbus specialists regarding the development of 3DP technology in the next ten years:

- the printing speed will be 250x faster
- the materials used will have the same price as conventional materials
- weight will be further reduced
- degree of individualization will increase
- CO2 emissions will be further reduced
- all parts used to build the plane will also be available for maintenance purposes
- more parts will be produced from metal
- standardization will decrease, tolerance systems will lose their meaning.

However, this development could also affect logistics. Many companies currently produce abroad because of cheaper wages. With 3DP production supply chains will change and in-sourcing and the re-allocation of internal resources will occur.

At Volkswagen the technology is known as Rapid Prototyping and has been used for ten years to build prototypes. The materials used in this field are mainly plastics. In principle, you can only print all the plastic parts which are not in sight as the surface quality is not good enough. No safety relevant parts in metal or parts which influence the stability of the vehicle should be printed. The quality of plastic printed parts also still varies significantly. Although the parts produced fulfill geometrical data specifications, the material properties do not meet the requirements of the conventional materials used to produce serial parts. Should these parts be used in practice it will also be necessary to involve the quality assurance department to qualify and certify the 3DP process. The limit to the dimensions of parts printed is 400 x 400 x 200 cm.

Another important consideration is the printing speed. There has been major development in this regard as in 1997 it was 5 cm^3 per hour, in 2016 it is 200 cm^3 per hour and the forecast for 2019 is 5,000 cm^3 per hour.

The method is suitable for small series of special models such as the Phaeton, EOS, Sharan or Golf and Passat; special editions for a certain percentage of parts. The method is also well suited for countries with a large variety of models and small numbers of cars such as the USA where a minor facelift is performed annually. The batch size of 50 is the limit in terms of capacity, if the parts need to be produced in a short period of time. It is often not enough to print a single part; instead an entire module must be replaced.

The ability to reproduce digital forms has led to discussions regarding future solutions for the copyright on 3DP objects. In order to prevent the copying of parts, the components can be provided with chips so that fakes can be easily distinguished from originals. A chip can be injected into a part and provided with a unique identification stamp which cannot be copied. A further point being discussed is the price development. Although material prices have risen moderately in the last 20 years; for example 1 kg of polyamides cost 80 DM twenty years ago and today costs 55 EUR, the costs of materials and printers are still high.

The conclusions reached after the interviews with the Volkswagen 3DP experts was that it would be a good idea to carry out a deeper analysis and prepare a business case for implementing 3DP technology in After Sales. Should VW not do so other companies will, and fakes that can be produced in China or Turkey could be especially dangerous. Besides defining the quality criteria for parts and for the printing procedure, the unique identification of parts, protection against data theft, traceability and legal issues relating to any cooperation with the 3DP equipment / machinery manufacturers would be useful. A possible business model could see Volkswagen either owning the data models and selling data to replace parts or investing in print shops.

3DP Advantages and Disadvantages

In addition to the points made in the previous section, a more detailed list and description of the advantages and disadvantages of 3DP technology is included in this section.

Advantages:

- The technology enhances in-sourcing initiatives
- The manufacturing supply chain is shortened, as manufacturing only needs a supplier for materials
- The level of lean manufacturing is high
- Less labor is involved in the manufacturing process
- The ability to build complex shapes that are difficult or impossible to produce with existing machines

- The inventory level is minimal
- The lead time is short
- Waste level is either low or zero
- The methods are more favorable regarding energy consumption because material is constructed only once in the required size and mass
- The transportation costs up- and downstream in the supply chain are low
- The level of agility and flexibility is high
- Due to the short supply chain the OEM is able to respond quickly to demand changes; this is beneficial if demand becomes volatile
- 3DP minimizes inventory risks as parts are produced on demand, and improves working capital requirements and management, an important factor of supply chain effectiveness seen as a lean manufacturing principle
- Transaction costs decrease
- No obsolescence and scrapping costs
- Lower capital costs as parts are produced on demand and not kept in stock. This is a solution for the automotive industry as the capital intensity is a structural weakness of this industry.
- The decentralization offers opportunities to increase sustainability
- Product customization on-demand under economic aspects
- The technology supports R&D with prototyping and product development
- The materials can be recycled so there is no longer any need for constant material supply and the brand can be associated with sustainability and environmental friendliness
- There is a good trade-off between low volume batches which, although more customized, are less harmful to the environment. Some customer groups might prefer these products rather than the low cost of economy of scale or mass produced products
- New jobs created as a network of 3DP shops is established.

Disadvantages:

- Limited production volume
- 3DP printers and materials are still expensive
- There is a shortage of supply due to the limited number of suppliers who are qualified material providers
- The accuracy and aesthetics of 3DP products still has room for improvement
- It is geometrically possible to produce all parts with this technology. Parts from several different materials can also be made, but these parts cannot withstand temperatures above 40 degrees Celsius and may not be dropped
- There are still many technologies related to the 3DP industry which are not very well developed. FDM (Fused Deposition Modeling) is currently considered a relatively low quality product, but is expected to develop better in the coming years

- The existing 3DP technologies are not particularly ideal for industrial or higher volume manufacturing, or are not geared for mass-production. One batch can be produced and the machine needs to be reset, which takes additional time
- Still existing or new patents increase costs.

The application of 3DP manufacturing tremendously transforms the way companies, in general, and OEMs in particular do business. Therefore adequate business models must be developed and applied. The details are described in the section below.

Proposal for a 3DP Business Case

Following a short description of how other companies deal with the issue of revenue and profitability a proposal for a business case for Volkswagen, based on assumptions, is made.

Due to digitalization and 3DP technology a redistribution of profits relating to the car ownership lifecycle is ongoing. The digitalization hotspots are the platforms because a platform can freely control prices and conditions and cannot be bypassed.

Divergent3D is a USA based company that has developed the NODE™ connectors which, in conjunction with carbon fiber structural materials, are the key components in building a car chassis. With their approach, the company was able to build a very strong and very light chassis, and do so while saving energy and generating less pollution. Their business model in the field of 3DP is to standardize the platform and sell licenses.

Lego is also a good example of adapting to the new business environment, especially as, with the 3DP boom, anyone with 3DP can now print each and every single brick and character originally made by Lego. To proactively respond to this growing trend, Lego has now reinvented its business model to start selling their designs, similar to franchising contracts which allow any commercial purpose with Lego properties. Lego has now started to establish its new market segment – franchising its designs all over the world. (3D Printing Industry, Sher, 2013)

The approaches cited above are two examples of business cases. The proposal for Volkswagen concentrates on compiling an overview of how current costs are incurred, describing and estimating the 3DP costs and finding the break-even point at which it is feasible to use the technology in After Sales.

The calculation was made based on an example. The part illustrated in Figure 44 is a wheel carrier. The wheel carrier is part of the chassis and has the role of optimising wheel control. This part was chosen because the annual installation rates of 5,000/p.a. makes it suitable for 3DP.

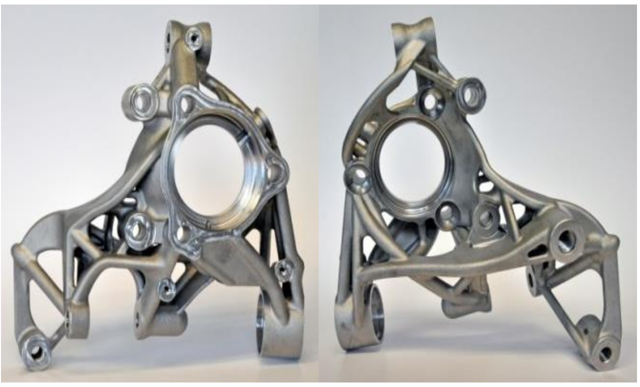


Figure 44: Wheel carrier

3DP Manufacturing Process

• Production time in a 500T EUR facility	32-36 Hrs.
• Preparation and follow-up / part	60 minutes
• Material costs	2 EUR/cm2
• Print speed	20 cm3/Hr.
• Price of part produced by means of AD Manufacturing process	100 €/piece
• Weight	1,4 Kg/ piece

Prognosis is a 75% cost reduction for the part

Conventional Process

Price of part produced by means of the conventional process	10-15 EUR/piece
Manufacturing costs per part	included in part price
Costs of tools	included in part price
Retrofitting costs	included in part price

A cost differential was calculated on the basis of a comparison of both methods (traditional and 3DP) and their respective costs. We then distinguished between the unit-deltas and line-deltas:

- Unit differences occur for each part produced (partly pro-rata) – for the same kind of part in the same amount
- Line differences apply to a type of part. Thus, for example, tools need only be acquired once for one type of part

The illustration in Figure 45 shows all cost categories in a comparison between the traditional approach and 3DP.

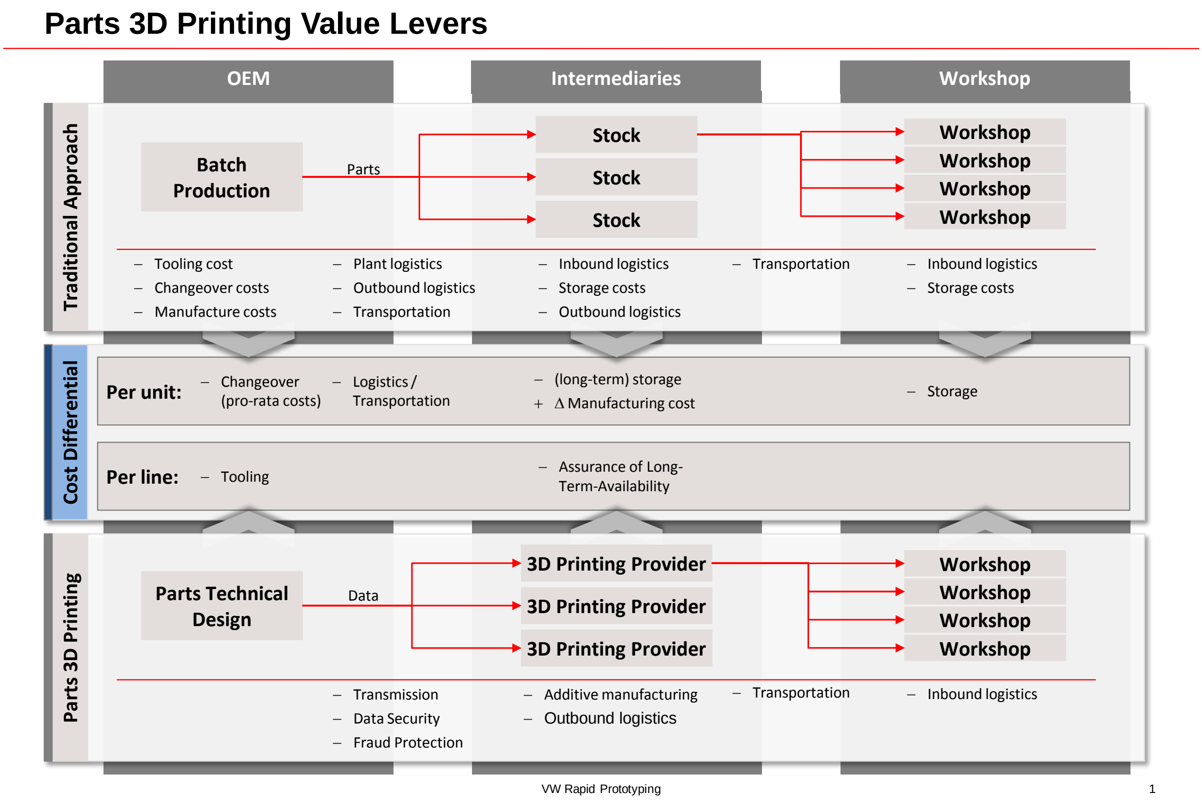


Figure 45: Overview value levers traditional approach vs. 3DP

The calculation made for the part described above, the wheel carrier, revealed that, even taking a worst case approach in terms of costs for 3DP, the method is interesting for volumes between 500 and 2,000 pieces per year at the present manufacturing costs and time required for this new technology.

Although the manufacturing costs for a 3DP part is 2.2 times more expensive than for conventional production, with zero tooling and changeover costs, zero or minimal logistic costs and zero overproduction costs, a business case analysis over a ten year period, including an average stock period of only two years for this rarely needed part, reveals that 3DP is more profitable.

The details of the calculation are explained in Appendix 15.

As mentioned at the beginning of the chapter, the foremost strategic activities are illustrated in Figure 42. For implementation the general work split between the OEM, wholesalers and retailers is that the OEM develops most concepts and implements the rollout at the wholesale level. The wholesale level adapts the concept to the local needs of a market and implements the rollout at the retail level. The retail level then adapts the concept to its needs. Monitoring is carried out at every level in the value chain and consolidated at the wholesale or OEM level respectively. More rarely is the concept development undertaken at the wholesale or retail level. The best practice information exchange between the different retail and wholesale businesses is desired and supported by the OEM.

New Business Models in After Sales and sustainable business models adopted by IT companies that generate revenue and profit in the digital business were first discussed in this section.

Then the 3DP method that could be applied to producing spare parts was analyzed in more detail. According to Wohlers Report 2015, 3DP technology saw significant growth in 2014, an increase of 38.9% from 2013. The report forecasts that this industry has the potential to capture 5% of the global manufacturing market and beyond, with product and system upgrades / sales and AM services. The basis of this forecast is Wohler's observation that it took the 3DP industry ~20 years to gain its first billion in revenue, but only five years to produce its second billion.

In the next subsection the advantages and disadvantages of 3DP were described and, finally, a breakdown of the costs of traditional and 3DP technology and a cost estimation for breaking even, based on a concrete example, a wheel carrier, was made.

In conclusion, the benefits of 3DP manufacturing technology are production on demand, short lead times, lower capital costs and the impact on the environment. There are also further improvements necessary, such as lower costs for machines and materials, higher geometrical precision and technical characteristics of materials.

Nevertheless, various parts can be produced with this technology. The recommendation for Volkswagen is to begin the implementation of this technology by using the example of the wheel carrier to identify further parts that can be printed once the procedure is qualified, and to set up a process and the business requirements for such a printing shop network.

Benchmark ideas from other industries

Topics to be addressed:

- Introduce real-time transportation monitoring
- Use geo-fencing
- Consider contingency planning
- Introduce RFID or Bosch low energy Bluetooth sensors
- Use AR/VR glasses in warehouses, and perhaps also in workshops to assist technicians in repairs
- Reduce parts availability from 15 to 10 years; a detailed quantification is necessary
- Logistics processes must be planned by means of workstations and time management methods beginning with the supplier when the order is placed, to the production at the supplier and ending with the logistics to the destination point. The timing of the logistics, a higher level of automation and control of the individual components increase the efficiency.

The activities described in **the third area of focus** address topics such as new business models in After Sales based on new technologies that have disruptive potential and business ideas from other industries that can be adapted to the automotive industry.

Activities with moderate influence on operational excellence but strong influence on customer relationships are described **in the fourth area of focus** – namely, issues related to network model, design and including a proposal for more precise capacity estimation. Pricing and the topic of revenue management will also be addressed.

<u>New network model</u>

Network design

This section will concentrate on the proposal for a new approach to the design of the After Sales network after briefly mentioning the general current situation at a global level. In order to reveal the importance of the business for the organization we will first cite some key After Sales indicators for the Volkswagen Group at the global level from 2015:

- Revenue: € 6.2 billion
- Sales to dealers: > € 16 billion
- Parts stock value OEM/NSC: € 1,5 billion
- Employees OEM / NSC Level: 15,000
- Approximate number of retailers: 20,000
- Approximate number of retail employees: 280,000
- Vehicle car park: > 90 million
- Average daily throughputs: 200,000.

Apart from the key operating figures cited above the After Sales business is characterized by stable operating earnings and good profit margins, even although the OEM has to provide a full-range supply, and 15 years availability, of parts.

The Group parts supply organization currently offers 1.6 million parts range positions produced by 6,000 suppliers. The warehousing is carried out in 19 master depots and 141 regional depots and at importers with a 96% service level to retail. One strength of the organization is the global presence of its logistical infrastructure. Hardly any other OEM, except Toyota and GM, has a similar car park and service network size. Furthermore, Volkswagen After Sales includes both the passenger car and truck businesses. We can therefore conclude that the service network is large, diverse and complex. The network planning principles are not the same worldwide as the organization consists of different independent importers or wholesalers and twelve brands. Additionally, even at Group level, there are further companies recommended by the OEM that carry out network planning according to some common agreed principles. But, until now, no concept using big data and business analytics has been developed. Car connectivity and the impact of digitalization on the distribution channels and network have also not been analyzed. Further improvement potential lies in exploring cross-brand and cross-dealer synergies as network density varies today, leading regionally to lower market exploitation. Another big difference in network planning exists between EU countries and those outside the EU. In the service business in the EU only a qualitative selection of service partners based on qualitative standards is possible because of the large market share of the Volkswagen Group. In all other countries the OEM and the wholesalers can carry out quantitative planning for nationwide coverage with the retailers.

Independent of the network planning provider there are always two big steps in network planning: firstly, the theoretical rough planning carried out according to generally agreed principles with or without an IT system, and at a later date the detailed planning at regional level.

The main objective of any service network planning is to recommend the service network capable of covering the repair necessities of a region and country, achieving the maximum service revenue coverage under economic aspects. It is about finding a balance between coverage and the number of service partners by evaluating the difference between the existing service capacity and the future capacity needs that depend primarily on the car sales, customer requirements, car technologies and repair methodologies. A customer's main criterion for choosing a service business or dealer, besides the convenience aspects such as distance and satisfaction with the quality and price of the service, is the communication aspect at the interface with the retail staff. There are differences between countries; for example, if we compare Germany with the Netherlands, in the Netherlands customers are ready to pay higher prices for service if they are satisfied with their treatment by the retailers. Important for the Group and the OEM, besides fulfillment of legal regulations related to warranty and repair of the products sold, are the obligations of product observation, customer satisfaction and loyalty, network coverage under economical aspects, distribution efficiency, stability, predictability, market exploitation and image projection.

Network planning is long-term oriented because in order to increase capacity substantial investments in infrastructure are often necessary. Service capacity must be adjusted regularly to both the current and long-term future potential customer requirements. Retailers will invest in infrastructure only if profitability and sustainability are ensured. The OEM and wholesalers must evaluate constellations based on economic requirements, inter-brand competition and multi-brand scenarios.

The result of the planning is a mix of preferred retailers, including own retailers, strategies for retail development in mega cities, and on how to deal with large dealer groups, multi-brands or exclusive distribution channels.

<u>The first step</u> of the network planning will be to analyze, per brand and per country, the current situation in terms of dealer and service businesses, their size, location, performance and portfolio. Market peculiarities and brand objectives and strategies should also be considered. Challenges are historical, geo-demographic or economic constraints, strategic locations, open points, bad dealer performances, succession problems and competition, to name but a few.

The service network planning is always based on the prognosis of car sales. In the EU sales, service and parts contracts are separated. The reason for this lies in customer behavior. Cars are changed on average every 4 to 6 years, so customers shop more rarely for cars than for repairs or other services. In consequence a customer is prepared to travel longer distances to buy a car than to service a car. This is why a service network has to be denser than a sales network.

Every network planning approach starts with a market and network analysis. The primary steps are:

- Define market areas for sales and theoretical areas for service in EU countries. Areas for service outside the EU market can be defined too

- Collect customer data, anonymized for the OEM if both the customer and the dealer do not agree to supplying the OEM with full information
- Business portfolio analysis: what contracts does the retailer have, the service portfolio analysis, KPIs including sales figures and sales forecasts for the next three to five years, customer satisfaction survey results, drive-time for service customers, waiting time for an appointment, capacity information, technical competence availability etc.
- Information regarding competition: Brand network, independent workshops, fast-fitters, parts wholesalers.
- This analysis is carried out at retail, regional, market and Group level.

The points mentioned above are those taken into consideration today. In future the data collection will be more accurate as connected cars will enable tracking of the movement profiles of customers. Thus the location of a service operation can be determined very accurately. If all the information is available the detailed planning can be done by the OEM in advance. Even more precise planning can be done if parts sold can also be tracked. It is recommended that the network planning be reviewed every five years. In future, once digitalization and big data have accelerated processes, managers will have to make decisions very quickly and, with the necessary data being available, the network planning can be reviewed at least every second year. Furthermore, self-learning computers can process huge amounts of data in real-time, constantly monitor changes and propose measures.

<u>The second step</u> in the traditional service network planning is to estimate the repair potential. Therefore the following data must be collected:

- labor revenues per vehicle segment
- labor revenues per repair type
- determine service hours per vehicle per repair type
- determine additional service capacity.

The following categorization of order types has proved meaningful: warranty, goodwill, normal customer orders, customer orders with modified prices, external services (e.g. paint), internal orders and redeliveries. Counter and trade sales are excluded. The categorization of repair types must be correlated and distinguished according to vehicle age and, until now, the following categorization has proved useful and practicable: body & paint, inspection & maintenance, power unit, running gear, power transmission, electrical system, heating & ventilation & air conditioning. This categorization needs to be reviewed with the introduction of new technologies e.g. BEV vehicles.

From the categorization above insights regarding the average hours per segment, per vehicle, per year can be gained. For example, a vehicle in segment 1a, which is at most two years old, needs 2.95 hours of repair per year. If the total number of hours is broken down according to the repair type this appears as follows: body & paint 1.33 hrs, inspection & maintenance 0.59 hrs, power unit 0.44 hrs, running gear 0.24 hrs, power transmission 0.09 hrs, electrical system 0.18 hrs, heating & ventilation & air conditioning 0.09 hrs. This is then completed with additional service types: wheels & tires, accessories fitting, glass replacement, breakdown and recovery. Revenue figures can then also be added.

The total hours within a territory are calculated using the formula below:

Total theoretical hours that can be sold = Total hours sold per vehicle x car park

The real number of hours that can be sold = Total hours segment 1a x loyalty factor segment 1a

+Total hours segment 1b x loyalty factor segment 1b

+Total hours segment 2 x loyalty factor segment 2

+Total hours segment 3 x loyalty factor segment 3.

The number of scrapped vehicles is also taken into consideration.

In future, connected cars, big data and business analytics will enable a more precise estimation of the number of hours sold by monitoring key car parameters and by using predictive algorithms for predictive maintenance.

In step three the number of work bays, technicians and service advisors necessary need to be determined. The traditional calculation begins with the real number of hours that can be sold and the customer loyalty per segment is already included.

Number of necessary technicians = real number of hours that can be sold / 8 hrs

as it is assumed that, on average, one technician works 8 hrs/day, 220 days/year at 80% efficiency

Number of necessary service advisors = number of necessary technicians / 5

as it is assumed that, on average, one service advisor coordinates 5 technicians.

Number of work bays = number of necessary technicians x 1.3.

The estimation of capacity can be calculated more precisely in future using big data and business analytics.

Finally, the fourth step would be to compare the current situation with the target situation in three to five years and to define the necessary steps to reach that goal.

Apart from capacity estimations at regional and market level, it must be decided whether the network structure should be one tier or two tier, whether to have specialized dealers or generalists and one-brand or multi-brand locations. The next decision to be made regards the service format: body, paint, service factory, full service workshops of different sizes, service only workshops, direct express service etc.

If there are specialized competence centers logistic links between service points need to be considered. At the wholesale level the network development team needs to categorize retailers in preferred partners, development partners and critical partners based on their market attractiveness and dealer performance. A development approach must be determined and regularly monitored for each category. Critical factors could be the necessity of support formats e.g.

strategic locations when investors cannot be found, successor problems, open points, investments on hold, retailers going bankrupt etc.

Before elaborating on future trends, a few points regarding the multi-brand network issues are worth mentioning. As the Volkswagen Group has twelve brands, network planning needs to address additional points. The service network planning is carried out for each brand based on the new vehicle sales figures for each brand. It is preferable to have fully-operational sales & service dealers as in order to achieve market coverage for service only, locations need to be planned. The best indicator for market coverage is the average travel time or distance accepted by the customers. Finally, the business case for the service center must be positive. A simulation is carried out by taking into consideration the economic impact of varying parameters such as market coverage and multi-brand locations.

Forecast parameters for repairs potential and the exploitation thereof are changing rates of loyalty and the technical service potential per vehicle in terms of hours and money.

We can conclude that the competition is no longer industry bound, the penetration of segments 2 and 3 remains challenging, the After Sales profit in retail will decline if nothing changes at the retail level, standardized initiatives do not work consistently and connectivity and digitalization are not consistent across dealers, markets, and, from the Group perspective, across the brands.

The points to take into consideration for network planning for 2020/2025 are illustrated in Figure 46.

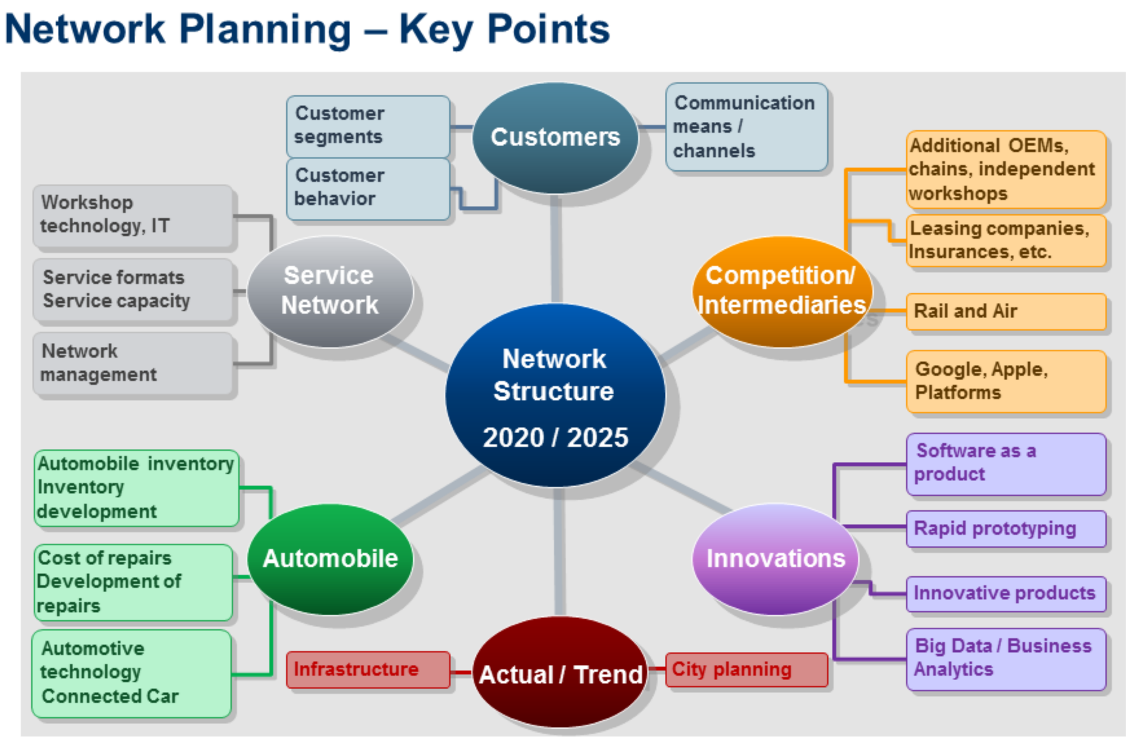


Figure 46: Network planning activity system

Apart from the future developments mentioned in the network planning steps one to four, the new points to be addressed will be described briefly in this section. New and capital rich competitors from IT are entering the market. Google and Apple, for example, have the cash reserves to buy OEMs and are the primary competitors because they have a direct interface to the customer. Unfortunately, due to business analytics and less rigid or more liberal interpretations of data privacy laws, the IT companies mentioned above know the customers better than OEMs. The After Sales organization will have to learn to cope with the change in customer structure which will include new media and digitally savvy customer segments in addition to the well known customer segments. It will be challenging to maintain the same high standard of quality with all groups.

With respect to new technologies it is estimated that the BEV technology will result in a 33% reduction of service sales potential per vehicle in comparison with conventional technology. Due to connectivity and car-to-car communication it is estimated that the probability of accidents is falling, leading to additional risks in revenue per vehicle of another 20%. The consequence is lower revenue and profitability if the capacity utilization decreases and customer loyalty cannot be increased.

The extensive use of big data and business analytics will have to include forecasts regarding maintenance and repair, the parts that need replacing, customer evasion prediction, individualized marketing actions, further sales predictions and end-to-end solutions.

The communication and customer points of contact must be enhanced with the highest possible number of digital channels and points of contact providing, for example, online diagnostics, software updates etc. The use of 3D printing technology to optimize inventory and transportation costs, described in detail in the previous area of focus, will also have to be integrated into the network planning.

Digitalization and connectivity will also include the service formats and the building itself. It is estimated that there is a 35% waste in the construction of buildings in general, and of dealerships in particular, due to information asymmetry and misunderstandings. It is also believed that digitalization will increase productivity, reduce the costs of assets by 20% and maintenance costs by 80%. If a building is poorly planned the loss in social performance is estimated to be –approximately 300% of the value of the building. The challenges in the coming years include adding infrastructure and cities that outgrow rural areas.

Another strategic decision could be the reduction in parts availability from 15 years to the 10 required by law. The benefits are lower logistics and obsolescence costs in the whole value chain and a reorganization of the depot and warehouse structure and capacity at all levels. A detailed analysis must first be carried out.

In summary, we can conclude that digitalization has also changed customer behavior in After Sales. Before visiting a dealership for a service or repairs customers first do their research online and then decide on a dealership. Customers are also better informed when coming into a dealership, thanks to the internet.

The big challenge is to ensure a smooth transition between the first virtual (or digital) contact with a customer, when the appointment is made online, and the actual visit to the physical dealership and to provide a good after-sales experience for the customer. Furthermore, the future will be fast, mobile and multi-channeled. Customers will be constantly connected and will want and expect retailers and the OEM to work to accommodate them. More and more often retailers, wholesalers and the OEM will have to engage with customers online, harnessing data from these contacts and from customer traveling.

Variable pricing vs. revenue management

Revenue management and pricing are the cornerstones of an economic strategy and must therefore be closely linked. The basic idea is to establish how much the individual customer is prepared to pay for a service or a part, and the fact that revenue can be increased if different prices are charged, or, in other words, charge more for some products in order to increase revenue (see illustration in Figure 47).

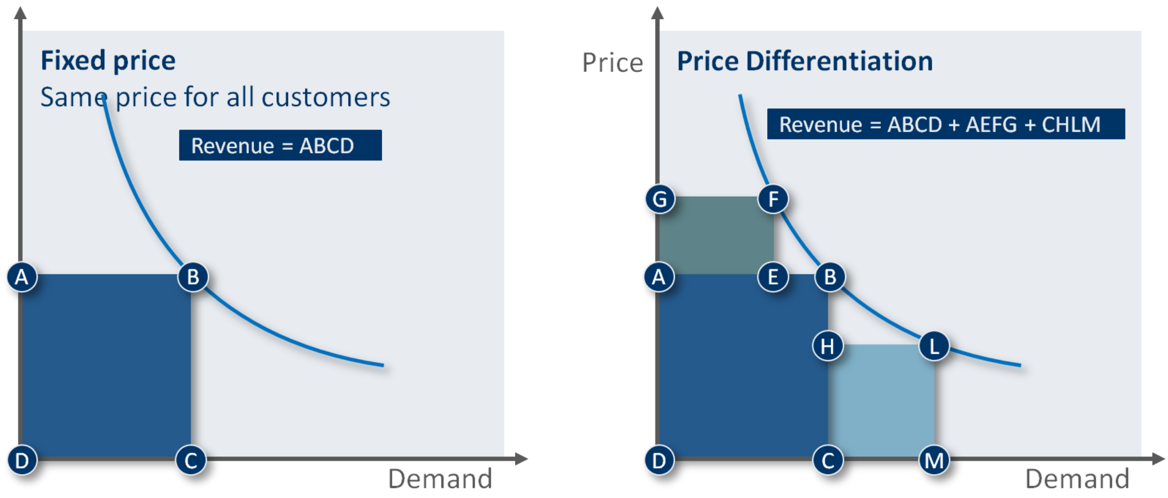


Figure 47: Revenue management

This method is widely used by airlines or in the hotel business. As an example we have used the airlines because, as a mobility provider, the industry bears a resemblance to the automotive business. Airlines manage passenger demand, pricing, booking class assignment, seat inventory control, spoilage management, and group management. The other topics considered are scheduling and capacity adjustments, performance monitoring and product distribution. Each airline has a complex computer system based on algorithms that can maximize the profit on each flight based on the types of fares offered on that specific flight. On one flight, there could be two dozen different fares based on different factors such as advance purchase or the number of days spent at a destination. The computer knows that by releasing, for example, 5 seats at a very low price, 10 seats at a slightly higher price and 20 seats at a slightly higher price, it can maximize revenue as the flight fills up. The computer adjusts fares continually until departure. On routes with significant competition airlines may have sales of seats at the last minute to fill the plane if it's not particularly full. It also depends on the day of the week. Tuesday, Wednesday and Saturday are often the cheapest days to fly because airlines carry fewer business passengers on these days.

A popular 6 p.m. flight may not have any seats on sale as people are willing to pay full price for it, whereas the early bird 5 a.m. flight is more likely to have seats on sale. If a flight is not filling up as expected, award availability can be opened as the departure date approaches. With relatively fixed capacities and costs, many of today's airlines assign groups of customers to market segments with different prices that demand elasticity.

The business principle used by airlines, and described briefly above, can also be applied in the automotive business to After Sales. Currently, besides different hourly rates for different types of repairs and differences in price for new and older cars, plus offers on economy parts, there is no revenue management approach known in the organization. The system currently used is based on historical price data and is rather inelastic. It is unable to generate real time recommendations and also does not consider a slew of other external data sources such as competitor pricing, special events or weather data. The application of economic models of demand, pricing, costs and supply to the After Sales business in different markets and networks can lead to increased revenue in the organization.

For the implementation of revenue management the following steps, illustrated in Figure 48, need to be considered.

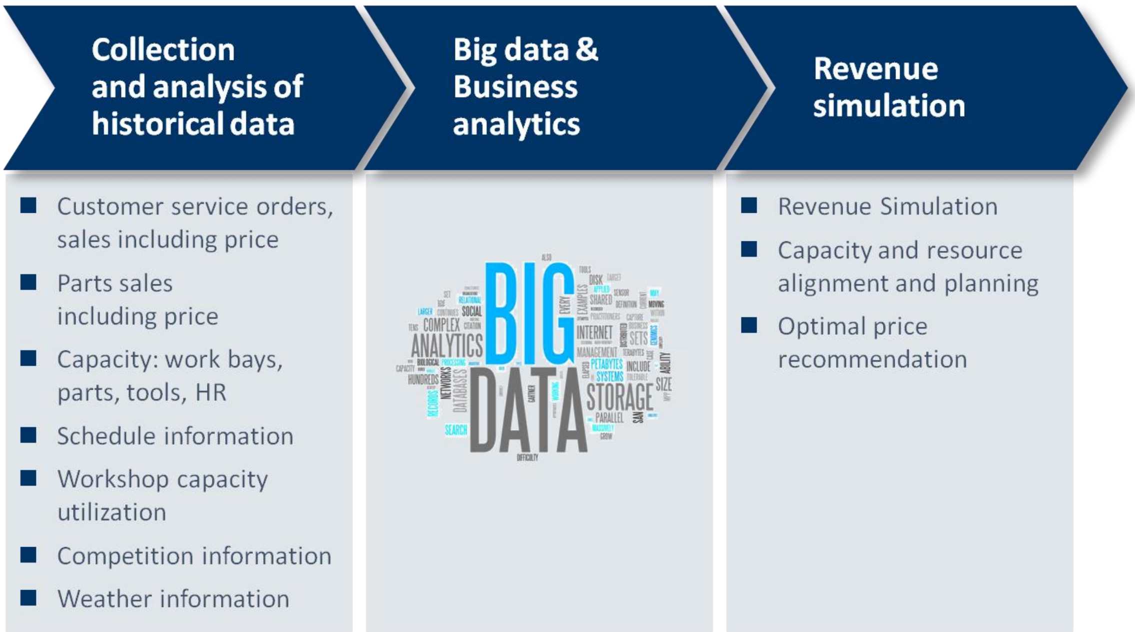


Figure 48: Steps implementation of revenue management

The first step is the collection and analysis of historical data. Information regarding customer service orders, what was sold when, at what price going back 5 to 10 years if possible, would provide precise insight. The same applies to parts sold at the retail level. The analysis could be conducted at a dealer or a dealer group, at the level of a region or the country. Information as a capacity of work bays, parts, technicians, service advisors and special tools must then be correlated with the service sales figures. Scheduling information regarding busy months and days of the week plus workshop capacity utilization must also be considered. If possible, offers being made by the competition and pricing information should enhance the analysis and, finally, weather information should also be included.

Optimal Pricing can be achieved by means of predictive analytics. Accurate historic data processing will aid in reacting to dynamic market demands by offering every service at the right price. An effective revenue management system can also offer further benefits, such as management information and customer forecasts, for use in network capacity planning, investments in infrastructure, workshop equipment, parts and human resources, to mention only the most important ones.

In order to implement a variable pricing structure by performing a comprehensive analysis of the current pricing and fare structure based on criteria such as costs, capacities available, competitors, product value and maximizing revenue the following must be taken into consideration:

- Service capacity needs to be optimally utilized especially in regions where tough competition prevails.
- The basis for a good prediction of customer demand in terms of repairs and parts sold. The more accurate the forecast the better the availability and the shorter the waiting time for customers; higher revenue and better network control are logic consequences
- A comprehensive pricing system, ideally at national level, is reasonable. The generation of competitive prices requires an extensive understanding of regional and national prices and their underlying structure.
- A system solution must support a short-term response to market changes. Simulations must be possible.

One scenario could be the introduction of competitive revenue management in order to be able to recommend inventory control changes based on the lowest competitor sales price in the marketplace.

In order to generate optimal revenues from the existing operations and customer base, OEMs require advanced systems based on big data analytics to analyze market behavior and cash in on revenue opportunities. It is necessary to develop a solution that uses the pricing recommendations generated by the revenue management systems, supported by data analytics, to generate optimal service and parts selling prices. Retail, wholesale and OEM After Sales departments will need to develop increasingly intelligent services by unifying the on- and offline customer experience. This means continuously adapting the physical size and form of the network, attracting, selecting and qualifying the right network partners, developing a profitable multi-format channel that combines online and offline strengths, coping with disruptors in the digital aftermarket, building advanced IT knowledge into the whole value chain and attracting and retaining the right people.

The fifth and final area of focus, which contributes to strong customer relationships as well as operational excellence, addresses the topic of collaboration leading to joint investments, to the establishment of an ecosystem. Demand generation activities will then be addressed briefly, followed by a discussion of processes and organization issues. Topics such as KPIs and transparency will not be elaborated on in this part of the thesis as the second area of focus contains a comprehensive proposal. Finally, before summarizing the main findings and recommendations, the importance of design for sustainability will be discussed.

The problems and tasks to be solved and set up regarding digitalization, autonomous driving vehicles and the internet of things are so complex and diverse that no one company alone can solve them and no one company has the financial resources to cover all the necessary topics. In this case collaboration in the value chain and outside the industry, a so called ecosystem, is vital.

I would first like to elaborate on the meaning of the word ecosystem. The best definition that we could find was provided by Accenture. According to them the ecosystem is “a company's competitiveness network: an increasingly global, foresight-driven, multi-industry nexus of partners (suppliers, institutions, customers) and stakeholders through which business problems are solved and outcomes are shaped”. Ecosystems are considered new engines for growth, and competitiveness in the digital age is considered high performance. The products developed in an ecosystem have the potential to become the industry standard.

The After Sales ecosystem partners are: suppliers of parts, workshop equipment, IT, Big Data Analytics, logistic providers, lighting companies (traffic can be controlled with traffic lights), city planners, other mobility providers, and … the list continues.

A visualization of the most important ecosystem partners in After Sales is provided below. It covers new technologies and business models for the strategic positioning of After Sales and is divided into four main groups: universities, 3D printing, cloud and consulting. Only the current most important companies are listed.

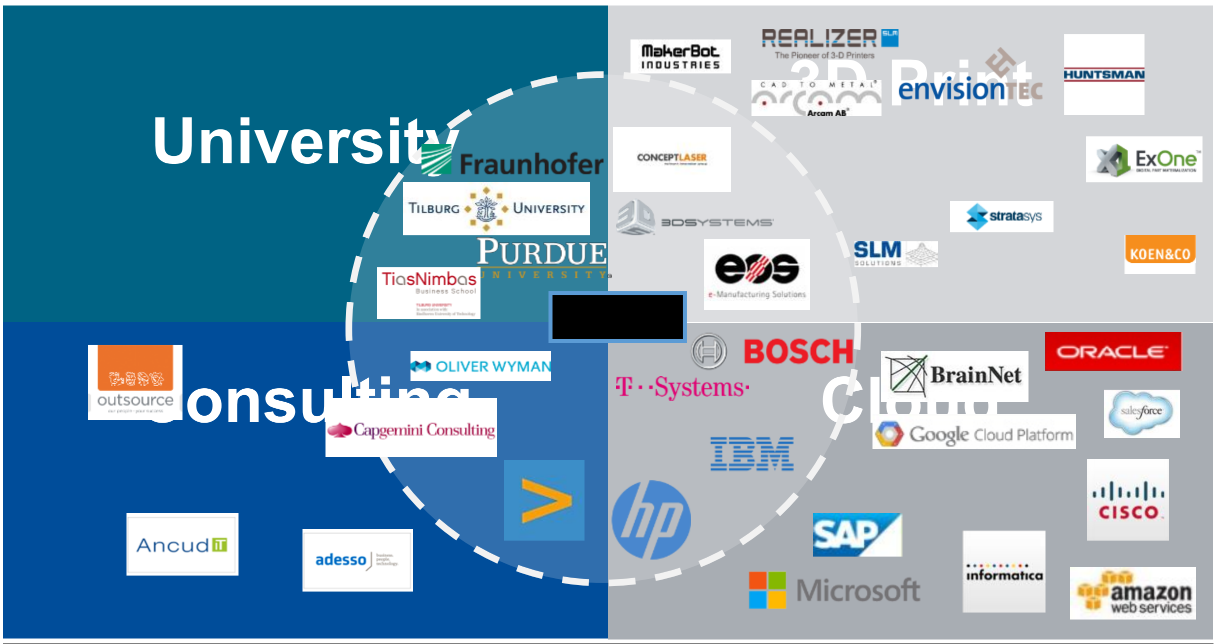


Figure 49: Ecosystem for future oriented After Sales

Not mentioned in the illustration above, but important for the Group, is Multi Brand Management.

A sound example is SEB Group GMBH, a large French consortium that produces small appliances. Notable brand names associated with Group SEB include All-Clad, Krups, Moulinex, Rowenta and Tefal. According to SEB, they have faced considerable competition from low-price Chinese competitors, but have managed to maintain a constant level of sales. A large proportion of its product lines are now manufactured in China. Its headquarters are in Ecully, a suburb of Lyon. SEB successfully manages 25,000 products from several brands.

In order to grow and compete, the organization must be ecosystem-ready. Therefore a sound supplier strategy must be developed; it should foster partnerships, close long-term contracts, provide transparency and good communication.

Even though the primary role of cooperation in the context of an ecosystem is value creation, attention must be paid to the benefits that ecosystem partners have from the cooperation. For example, business analytics companies are often interested in the data base of a company and can use this knowledge to the detriment of their clients.

Such cooperations must be periodically and carefully reevaluated in order to avoid competitive disadvantages or intellectual fraud.

Demand generation activities

Demand generation activities are closely linked to innovation. In order for an OEM to avoid the danger of becoming a simple “hardware” provider, automotive companies must become more knowledgeable of IT and acquire the lacking IT competence as quickly as possible. The company needs to develop further as a mobility and service provider, to understand customer needs and to think in solutions for customers. The value provided by such services is more leisure time for customers and better quality of life.

Services provided to customers need not be limited to cars although, of course, the car is the starting point. Apart from the preventive maintenance activities already described in previous sections, the connected car, IoT and digitalization provide many service opportunities.

The current generation of connected cars offers navigation with real-time traffic data, telephony, entertainment (that is often individualized) and assistance systems such as parking sensors and cruise control. In the premium segment, primarily, these functions are connected. Route planning and traffic information is currently offered in real time, as is the use of social networks, streaming of music and movies, a concierge service and simple driver assistance systems. Internet in vehicles has only recently become available. At present, the integration of various components takes precedence and as vehicles possibly have their own wireless network and internet access wifi-enabled devices can be connected to the vehicle.

Moreover, significantly enhanced driver assist systems based on radar and sensor technology that are in direct communication with the vehicle’s environment are being integrated. The final stage of this development is the autonomous driving car.

Apart from the technical tests of all the systems mentioned above, OEMs can generate end-to-end service offers for customers by entering into cooperations with energy suppliers, building administration companies, stores and supermarkets, entertainment providers etc. The list is long and the selection criteria should be based on the customer group needs per market. Investments should be made according to priorities in all possible directions in order not to miss any opportunities. The basic idea is simple, add service to a product and generate new business models.

Process & Organization

This section addresses the following topics based primarily on the findings of the benchmark interviews: design, planning, execution, human resources and IT. These points will not be elaborated on in depth as this is beyond the scope of this thesis.

Important topics to be addressed:

- The foremost task is to design the perfect customer order. Details were described in depth in Subsections 8.2.1, 8.2.2. and 8.2.3. The changing customer needs and expectations must also be continually monitored and the competition observed, and service offers adapted accordingly.
- The workshop must also be connected and digitalized to deal with connected car operations. Utilizing the data regarding a vehicle’s state/condition the necessary parts for the repairs can be ordered automatically. The most frequently used tools in the workshop can be provided with sensors and by linking these tools to a monitoring system mistakes can be avoided and operations can be recorded automatically. The sensors could also send a signal if a tool is defective. Transparency can be achieved by consolidating all connected cars and tools in an active cockpit shop-floor. The current work progress can be constantly visualized and, if necessary, capacity can be adapted to the available resources.
- Automation of operations by means of robots and an automated guided vehicle – a mobile robot that is used in shop floor logistics – should be introduced. Second generation robots are at a developmental stage that make them economically interesting for smaller companies and businesses too. These cognitive robots can work hand in hand with humans. Apart from heavy, repetitive and boring tasks robots can also be introduced in office work. Some administrative and book-keeping tasks can be automated. The use of an autonomous transportation system would reduce the distance a technician has to walk to fetch the tools or parts needed in the work bay. The problem is that many managers and employees are reluctant to take these technological leaps.
- Parallel processing of operations also speeds up processes and enhances the quality of repairs as, depending on task allocation, technicians can check the work done by others without losing time. A good example is the inspection process developed by the Group for the Skoda brand, called Team Speed Service
- Process digitalization, availability of remote experts to help with complex diagnosis and repairs when needed, the use of augmented reality/virtual reality (AR/VR) technology to

visualize repair steps for technicians and the status of the vehicle and repairs done for the customer should also be implemented

- Accelerate processes by getting rid of documentation, using hand-scan-devices, tablet PCs etc.
- Create parts kits to accelerate processes in cases of repairs
- Introduce virtual management inventory, firstly at the level of the master depot, then at the regional depot level and finally at retail level, if the retailer agrees
- Introduce vendor management inventory for standardized parts
- Rework the technical literature system by describing common principles and the details depending on vehicle configuration and Group brand in separate points

Design for sustainability

A sustainable trend for years has been the ecological impact and carbon footprint generated by physical products. The go-green strategy must be comprehensive, starting with the product design which should use recyclable materials of low environmental impact and low energy consumption in production facilities, and continuing in the dealerships providing service where the energy supply should come from suppliers producing a high percentage of renewable energy, the buildings should be low energy constructions and, finally, cars should be recycled. Here the example of an IT company interviewed in the benchmark phase should be followed. The aspect of ecological impact should be a decisive criterion for all suppliers producing parts or supplying services.

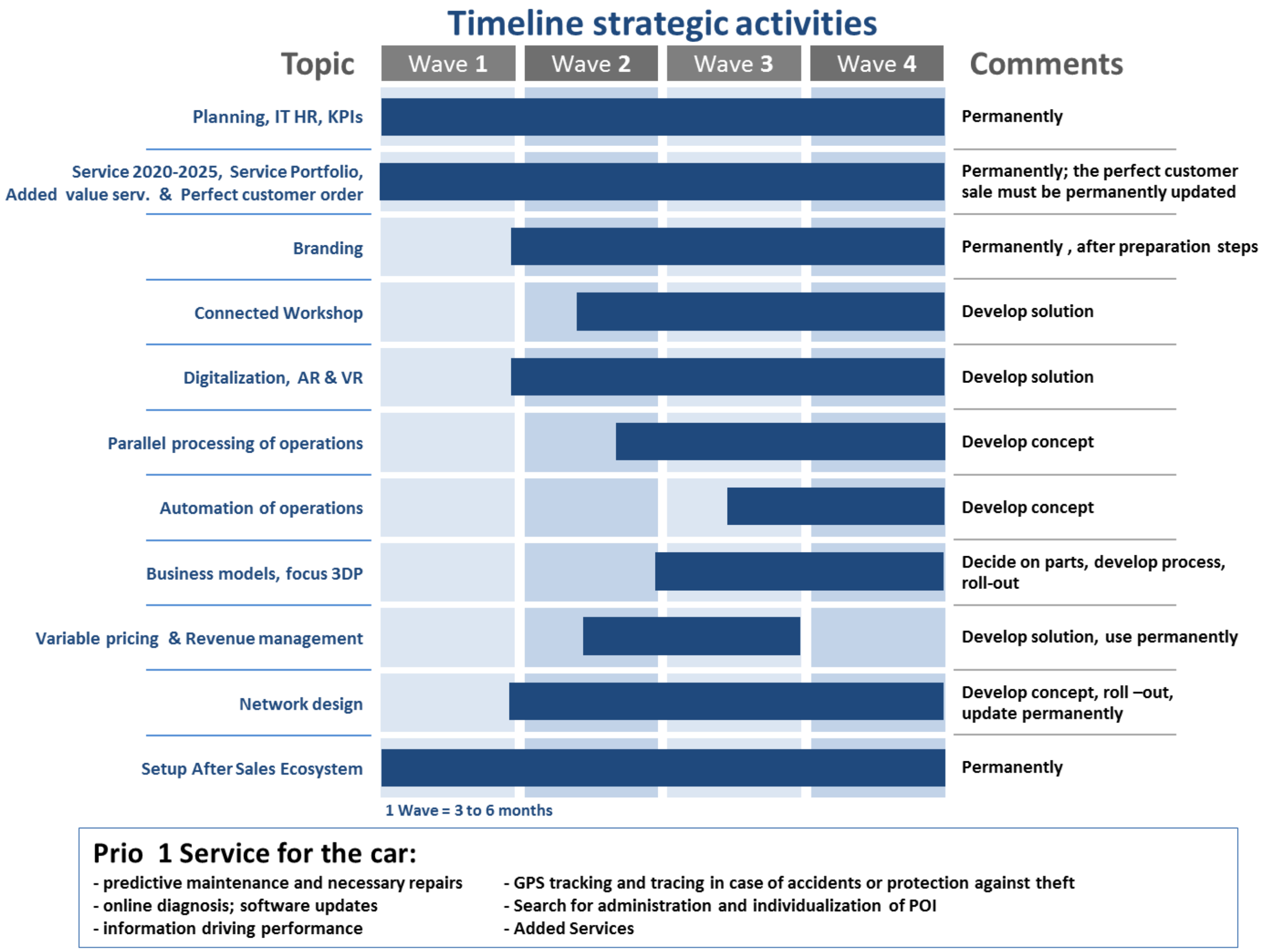


Figure 50: Timeline strategic activities

A major improvement would be the introduction of 3DP in the After Sales business. This concept was described in detail in Section 8.3.

The list with strategic activities, timeline and responsibilities are provided in Table 34:

Table 34: Responsibilities strategic activities

Topic	Group / OEM	Wholesale	Retail
Planning, IT HR, KPIs	Concept & Roll out	Adaptation & Implementation	Implementation
Service 2020-2025, Service Portfolio, Added value services & Perfect customer order	Concept & Roll out	Adaptation & Implementation	Implementation
Branding	Concept	Implementation	Implementation
Connected Workshop	Concept & Roll out	Implementation	Implementation
Digitalization, AR & VR	Concept & Roll out	Adaptation & Implementation	Adaptation & Implementation
Parallel processing of operations	Concept & Roll out	Implementation	Implementation
Automation of operations	Concept & Roll out	Implementation	Implementation
Business models, focus 3DP	Concept	Implementation	Implementation
Variable pricing & Revenue management	Concept & Roll out	Implementation	Implementation
Network design	Concept	Implementation	Implementation
Setup After Sales Ecosystem	Concept	Implementation	Implementation

In Table 34 the most common method in which responsibilities for strategic activities are divided is visualized. The wholesale and retail activities besides adaptation, network steering in the case of wholesale, and implementation are not limited to these tasks. Initiatives that are complementary to the activities initiated by the OEM and have sound results are highly recommended to all retail and wholesale partners in the network. As the dissertation concentrates on the German market, a comparison between several markets is beyond the scope of this thesis and we will address only a few major points to be taken into consideration. As the headquarters of Volkswagen are in Germany, a technologically well developed country, innovations relating to the automobile were made by the OEM based on German data and subsequently transferred (rolled-out) internationally. Local adaptations to the export markets were necessary; the goal was and is to reach a certain standard worldwide so that a Volkswagen customer receives the same service level internationally. The roll-out to other developed countries was less challenging than to developing countries. These days, thanks to digitization, Volkswagen and other traditional automotive manufacturers are experiencing disruption to their business models. Markets such as the USA have advanced IT knowledge, being leaders in this domain, and attention grabbing services are coming from digitization. In such cases the markets need freedom to develop their own local programs that enable them to cope with their competitors and fulfill customer expectations. Advanced markets in the Volkswagen organization are requested to share their knowledge with other markets and brands. The same procedure applies at the retail level too.

The proposed strategic activities can be structured in:

- A: with a general character that must be addressed at Group level, internationally

- B: at OEM level, international for more than one market but not with a general character
- C: at the wholesale level, such as national programs for all or varying retail categories; an adaption to other markets might be possible
- D: individual measures and activities at wholesale or retail level

Table 35 provides an overview of the proposed strategic activities and the stakeholders which can actively utilize the results.

Table 35: Overview strategic activities vs. stakeholders

Topic	Category of activity	Stakeholders
Planning, IT HR, KPIs	A	Top managers in the After Sales at Group, Brand, wholesale and retail level and management with direct responsibility for the listed topics
Service 2020-2025, Service Portfolio, Added **value services & Perfect customer order**	A, B,D	Top managers in the After Sales at Group, Brand, wholesale and retail level, retail managing directors, and managers responsible for development of programs at Group, Brand, wholesale and retail level
Branding	A	Top managers Sales & Marketing at Brand level, managing directors wholesale, marketing managers wholesale
Connected Workshop	A, B, D	Top managers in the After Sales at Group, Brand, wholesale and retail level and management with direct responsibility for network planning at wholesale level and workshop capacity planning at retail level
Digitalization, AR & VR	A, B	Top managers, CDO and IT responsible persons at Group and Brand level
Parallel processing of operations	A, B, D	Top managers in the After Sales at Group, Brand, wholesale and retail level, retail managing directors, managers responsible for operations at retail level, managers responsible for the development at Group or Brand level
Automation of operations	A, B, D	Top managers in the After Sales at Group, Brand, wholesale and retail level, retail managing directors, managers responsible for operations at retail level, managers responsible for the development at Group or Brand level
Business models, focus 3DP	A	Top managers in the After Sales at Group, Brand, wholesale and retail level and management with direct responsibility for the listed topics
Variable pricing & Revenue management	A	Top managers in the After Sales at Group, Brand, wholesale and retail level and management with direct responsibility for the listed topics
Network design	A	Top managers in the After Sales at Group, Brand, wholesale and retail level and management with direct responsibility for network planning at wholesale level
Setup After Sales Ecosystem	A, B, C	Depending on the topic, stakeholders are managers and specialists involved in activities with diverse companies that are part of the ecosystem of the respective business unit

In summary, we can say that connectivity, digitalization and the internet of things will bring major changes in processes, organization, culture and technology. In order to successfully cope with disruptive technologies flexibility, new structures, an environment of innovation, charismatic managers and staff who are prepared to take risks and responsibility are necessary. This environment is difficult to achieve in large and long established companies. Therefore the isolation of these competence centers and management as a startup is advisable. It is recommended that a lab, like a startup, be created for the testing of all new technologies and services in After Sales and logistics. OEMs need to decide what is better for their organization: not to invest in IT technologies such as mobility platforms related to services and payment, in applications linked to car connectivity or in data lakes and instead to pay on demand for these services; alternatively to invest in their own IT departments in order to build up this knowledge internally, or to acquire or merge with IT companies. A merger of "old economy" with High Tech has the potential to create future market leaders in the mobility business.

Rapid project development can be achieved by forming virtual teams in which the team members possess the special knowledge needed to solve a problem; teams that can hardly be formed physically. Further, by employing standard IT solutions developed by professional technology providers and fewer own developments, this will accelerate the IT automation, even if investments are necessary. Old fashioned and complex IT systems would be paralyzing for the transformation process.

8.4 Conclusion

The automotive industry will face an unprecedented transformation period in the coming years. Absolute customer orientation, correct and rapid responses to change under economically feasible conditions and consideration for the interests of staff will be of vital importance.

The OEM, wholesalers and retailers and the entire After Sales value chain must provide a consistent customer experience in order to stand out from the competition.

There is a fierce competition taking place. Highly innovative and financially strong technology providers want to enter the market. Google and Apple are the most prominent examples. Despite being asset light organizations they aim to become mobility providers. In electric cars the complexity of a vehicle is diminished and this provides an opportunity for new players to enter the market. Key OEM suppliers such as Bosch, Continental, ZF or Magna also possess the knowledge to produce cars and some might enter into cooperations with IT companies. Furthermore, DHL, a logistics provider, is building its own electric vehicles to deliver mail and packages.

Regarding product development, the product life cycle is continuously decreasing; the development time for new products is becoming more similar to the product development time in IT, which is another indicator for the merging of IT and machines. Another major point is the carbon footprint of a company. In the long term, the focus on a life-cycle analysis that considers the total impact of a product on our planet is necessary and products need to be developed accordingly.

With digitalization and the IoT we are experiencing another technology revolution. By means of the IoT objects can be integrated into a digital network. Objects have a unique identity, due to sensors and identification technology, and can be localized at any time. Digital product memories and objects with embedded systems communicate with their environment and are able to make decisions and deduce actions, and in this way the physical world is linked with the digital world. Cloud platform scalability allows for rapid roll-out and enhances a company's effectiveness. Successful control points are app stores and advertising platforms.

It is vital to build up the necessary ecosystems by relying on cooperation instead of keeping competitors at arm's length. We need to try to set up a win-win situation, instead of isolating ourselves from the competition, in order to rapidly adopt new technologies and gain knowledge in this field. Open platforms and alliances are recommended. Due to digitalization the marginal production costs and the distribution costs are zero. Managerial implications are: to develop communities and distributed business models and to be aware as digitalization enables disruptive business models across industries.

In order to run an ecosystem smoothly, compatibility and lifecycle management for all hardware, software, interfaces and company culture must be implemented. The value proposition of the ecosystem must be clear regarding the problem to be solved or the product to be developed.

The IoT creates the opportunity to set up new businesses, but a data governance model must also be set-up. A strong data security model is necessary. Data privacy and protection is a key issue. The customer needs transparency regarding the data shared with a dealer and the OEM. Therefore data must be stored in secure data centers, which are more secure than the local servers at dealerships or even wholesalers.

With big data, joint high-dimensional analysis and new parameter relationships are identified. Non-linear relationships and subtle influences are also revealed. Finally, more robust results sets are achieved by analyzing big data.

As established automotive companies and new players hope to increase business volume with innovative business, high M & A activity in the field of connected cars is observed. For example, Audi, BMW and Daimler have bought the Nokia map service and BMW has bought Car IT GmbH, to name just a few examples from the automotive industry sector. The list of cooperations is even longer.

Traditional automakers are held captive by massive capital investments in old technologies. Back in Silicon Valley, Apple, Google, Uber, Faraday and Tesla are planning a global offensive on autonomous and electric cars. These companies have the advantage of being asset light and having direct contact with customers, and some of them have considerable financial reserves. There is the danger that they will disrupt the existing industrial pillar, but a consistent development of knowledge – particularly in IT – and meeting of customer expectations can oppose this trend. Traditional OEMs do however have a good competitive position as they have gained a lot of knowledge of car development over the years.

In future, customers will be more diverse than today. In addition to the traditional customer segments, more and more will be constantly connected and will expect brands to work to accommodate them and to provide solutions. In any event, retailers, virtual stores and fast transaction processes will become increasingly common.

There is also a growing need for customer involvement in development, feedback and traceability of products and services which must be considered in upcoming corporate responsibility.

In the transition period of this technological transformation, many people may not cope with the new technology. This is where management needs to set up training programs and ensure communication so that people are not afraid they will lose their jobs.

Managers need to be visionary, quick and pragmatic. They need to manage the new technology, the processes, people and company culture. At the end of the day, in order to be economically successful the foremost goals to be addressed include: the continual increase of customer satisfaction, maximizing customer loyalty in all business segments, increasing business volume and market share and, in order to be able to invest in innovations and to hire good people, increasing profitability. Although some technology providers are challenging the traditional automotive business, many of those companies, except some larger players, have not yet proven that their business model is economically sustainable.

9. Evaluation

9.1 Research question

The purpose of this thesis was

- to do an in-depth analysis of four core processes in After Sales based on the Volkswagen brand in the German market,
- to present the insights and lessons learned from studying the After Sales service network of Volkswagen,
- to define a roadmap for further research and
- to discuss the needs of the sector.

Based on the analysis of four major processes in the After Sales business: repair process, warranty & goodwill, parts sales, and reverse service (or parts return process) the research questions are:

- What does the best practice dealer model look like?
- What are the main characteristics of a successful business?
- What can be learned from other industries: IT, logistics and aircraft service?
- What new technologies and practices can be used and adapted to the specific needs of service operations?
- What are the best KPIs to control the operations at different levels?
- What does the structure and design of an integrated multi-attribute set of measures at every level of the service supply chain look like?

The model created should also be applicable to other industries.

The outline of the thesis is illustrated in Figure 51.

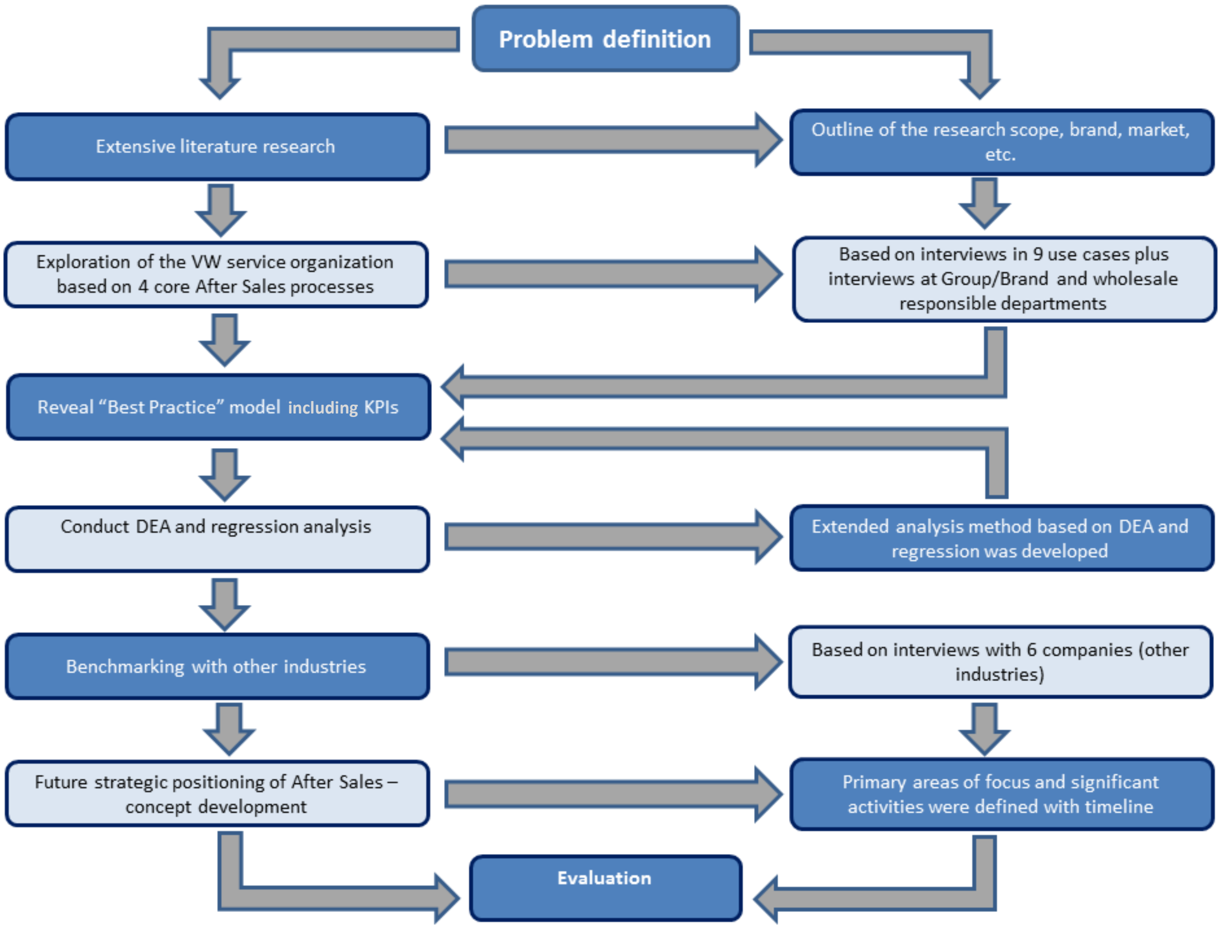


Figure 51: Thesis outline

9.2 Principal findings, summary

Before exploring in depth how a service organization, particularly Volkswagen, can organize its service operations in the supply chain to increase output, efficiency, customer loyalty, satisfaction and profitability the business environment and the trends were analyzed.

The primary topics addressed were: customer structure, profile and requirements, business network structure, product and workshop technology, human resources, IT systems, regulations and trade restrictions.

Results process analysis Volkswagen Organization
Repair process

- The chief steps of the repair process, depending on the exact situation, take between 28-42 min.; the total time on average being between 48 and 97 min. Good coordination between the steps, appointment making, appointment preparation and car reception, are crucial
- The technical support for retailers at the wholesale level is mainly online; the wholesaler has two hours to answer the questions
- The average time needed to answer a request (wholesale - retail) is 15 min plus the time until the request is opened. The average total time until an answer reaches the retailer is 56 min, requiring 3.8 dialogs between wholesale and retail technical support

- On analyzing the distribution of the technical requests per car-age since 2006 we can conclude that: until 2006 about 80% of technical requests came from segment I cars. In 2012 this quota dropped by 5% while at the same time the quota for cars aged 4-6 years increased to 18%

Warranty and goodwill

- The total handling time for warranty claims and parts at retailers depends on their complexity and takes between 15 min (in best cases) and up to 3 hours for cabs or police cars; the warranty process is partially automated
- The process could be simplified if there were a direct link between parts fitted in cars and warranty claims
- In 2012 80-90% of all claims submitted were processed automatically and 10-20% were checked manually by the wholesalers; the trend observed over a period of 8 years, 2004 to 2012, saw a drop in warranty cases from 80% to 50% while goodwill cases increased from 20% to 50%
- Due to the increased product quality, the number of problem cars decreased, but no clear focal points can be recognized which makes it difficult to allocate resources in order to solve the issues
- The total lead time from the retailer to the OEM is, in the best case, 8 days to receive payment, in the worst case it is 33.5 days in cases where the part must also be checked

Parts sales

- The lead time for parts sales when parts are available is, in the best case, 5 min and, in the worst case, 16 min for one part. This increases by 5 min when additional parts for service are ordered and by 30 min in cases of accident cars.
- The aim is for retailers to store parts with quick turnover with inventory coverage of 1.5 /1.7 months, and a standard stock coverage of 6 to 8 weeks is preferable
- Purchasing loyalty to the OEM is 96 % because ordering is easy and service is good
- The wholesale logistic regions have a goal of same day delivery. On average, the delivery rate is 99% in 24h; 97% from own warehouse storage and 2% from cross dock
- A wholesale region stores approx. 89,000 to 91,000 parts allowing a delivery rate of 97% in 24h which is economically more feasible than storing 350,000 parts to achieve a delivery rate of 99%-100%
- There are some differences between the regions. Firstly, the cross dock volume differs; secondly, the technology used, including IT Systems
- 90% of the revenue is realized from 10 to 12% (10,000) parts positions
- The average turnover is 3.5 – sufficient for 4 months. There are differing parts categories. Thousands of fast turnover parts are sold every day with a turnover of 9 -12 a year – coverage of 6 weeks. Slow turnover parts (1 a year – only a few sold a day) have a high delivery rate.
- Parts ordered remain in the inbound area buffer for 1-2 days in busy times; a continuous flow is not always realized, there are peaks and dips

- In Germany many processes are standardized and optimized, the same IT systems are used; there is transparency, the use of multi-way containers, good infrastructure and information flow and no repacking. Repacking accounts for 30% of capacity
- The logistics process in Germany has 4 levels: Group/OEM - OTLG - retail - customer
- The lead time is for volume orders: maximum six days (OEM - wholesale) plus two days (wholesale - retail), totaling eight days. Express orders: delivered from OEM via wholesale to retail within a maximum of 24 h
- The proportion of volume to express orders has changed over time at Group/OEM level from 80/30 to 50/50
- Using cross dock, parts can be delivered from inbound to outbound within 90 minutes. The cross dock process is not part of ordinary operations in the master depot in Kassel
- The cost level in Kassel is 37% because 50% are strategic stocks which amount to only 9.5% of revenue. If these stocks could be eliminated the ø turnover in Kassel would increase from 3.8 to 6 a year
- The claim rate in 2012 was 0.25%

Returns process

- The returns process with a maximum of 3.5% does not play a major role in the supply chain
- The part is sent back through the logistics channel and payment is made within 2-4 days, up to 12 days during vacations.

After this a key KPI Model with four dimensions, market, costs, processes and business, was developed. New KPIs were introduced as it became clear that the existing KPIs were not sufficient or not consistently applied in the entire value chain from retail to OEM or Group. Then the key **Level 1 and Level 2 After Sales KPIs** and their correlations were described. The measurability of the model is ensured by KPIs arranged on four levels. At the top are five aggregated KPIs: sales revenue across all businesses, customer satisfaction index, capacity, total costs incurred by the business and profitability measured by the overall profit margin. A detailed list of KPIs was also provided.

Based on the analysis of the traditional reporting one single ideal dealer could not be identified although Mid Dealer 3 shows the best performance in many criteria. As the analysis concentrates on After Sales we can note that four other companies also have good processes and KPIs, performing well in many criteria. These are: Mid Dealer 1, Small Dealers 1 and 2 and Large Dealer 3.

Another main finding was that good performers had the following relationships between: no. of car receptions (1) – no. of service advisors (1) – no. of work bays (3) – no. of throughputs (8). The location of the business did not play a major role; rather, management played an important role. It is also not surprising that businesses with well qualified people also had good performance and quality output.

There were no major financial differences in terms of revenue between large and mid-sized dealerships. Differences exist between small dealerships and the other two categories. The difference in the category small dealerships between the best and the worst is below 10%. Comparing the revenue per productive employee per month, with one exception, the differences between the analyzed businesses are up to 30%. This can be interpreted as an argument for using specialists; as bigger businesses that have specialized functions earn more revenue per productive employee than small businesses.

The revenue per FTE in After Sales is strongly influenced by the ratio between productive and unproductive employees and the total number of employees, since for small businesses it is more difficult to cover the infrastructure costs. Half of the retailers visited earn similar revenue per productive employee per month for service and parts. The remaining retailers have strengths in either service or parts businesses. There is a direct relationship between business volume and costs. The best performers are, on average, the mid-sized businesses. Large retailers have, on average, the highest costs. Significant differences in terms of costs, and also in the primary functions of service and parts, were identified between the small, mid-sized and large retailers.

Direct costs are higher in sales than in After Sales due to the acquisition prices for cars. In service the labor costs are the highest due to the higher number of employees as labor intensity in this business area is higher. Regarding labor costs there is a difference between the best performer and the large retailers of about 30% and the mid-sized dealers of 10% to 20%. A significant difference in labor costs of up to 60% is caused by the organization and ownership structure/situation.

Overall, the service business is more standardized with precise specifications, which means less variation in contrast to the parts business.

Flexibility is higher at the retail level and lower at the OEM level. The current organization allows a flexibility of 5% in terms of capacity at Group level. The most remarkable observation is that customers show more tolerance of small businesses while mid-sized and large dealerships are judged more critically.

The “Dealer Best Practice Model” was developed by defining KPIs that are the basic requisites for control and transparency.

The comparison at the wholesale level was also limited because some functions are centralized and differences arise mainly from the varying quality and knowledge of the employees performing the operations.

Improvement potential exists in the following areas:

- Improved ratio of value to non value steps
- Coordination in parts delivery from supplier to OEM and from OEM to wholesaler
- IT systems and administrative tasks
- Improved resources allocation to enable shorter reaction times to retail queries.

The DEA analysis confirmed the proposed KPI model. Data envelopment analysis, or DEA, was used for the estimation of productivity frontiers. As a non-parametric approach it makes no assumptions about the form of the productive operation or productivity function. DEA is a powerful benchmarking tool that helped evaluate the dealers, in terms of efficiency and productivity.

An analysis method was developed whereby DEAs were first conducted and then a regression was carried out, as the regression provides an indication as to which variables actually influence output and to what degree. Finally, a list of correlations between the KPIs mentioned above was provided.

By taking the most relevant DEAs and by listing the coefficient and the value of the t-test from the regression we established that significant correlations exist for the second model between CM3 and CSS satisfaction. It was also discovered that there is a significant correlation between CM3 overall, the number of service advisors, the number of technicians, FTE After Sales and hours sold. Although the analysis concentrates on After Sales, it is worth mentioning that in sales the highest correlation was identified between the sales performance in terms of cars sold and the sales staff. Therefore the next step in the research included the benchmark with other industries such as IT, logistics and aircraft service – industries where the digital transformation has so far been successful.

In the benchmark the aim was to achieve a profound understanding of the general business models of companies in industrial sectors complementary to the automotive industry, or in typical service businesses with an additional focus on After Sales. The businesses analyzed came from the following sectors: IT services and consulting, automated manufacturing and robots, aircraft maintenance and engineering, the high tech industry, freight transportation & warehousing and distribution & supply chain solutions.

Benchmark findings:

Success factors

- the product portfolio combined with investments in research and innovations. The products were mainly complex or integrated solutions, not easy to replicate consumer goods
- added value services and customized solutions
- investments in end-to-end solutions
- service quality, quick reaction times, reliability and trustworthiness
- other success factors were the ability to connect new technologies with the systems currently running today's enterprises, resulting in integrated solutions and a broad ecosystem of partners and alliances.

Top business drivers

- product or service portfolios, their quality, reliability, degree of individualization, and pricing
- performance and business efficiency

- strategic acquisitions in the high-margin segments and investments in new technologies and cooperations
- the ability to develop long-lasting relationships with customers.

In **chapter eight,** the future strategic positioning of After Sales, a comprehensive holistic strategic view that includes the short, middle, and long term activities necessary to achieve the vision and the measurable targets on the path to the final goal was developed. The reason for this is that the complete ecosystem, including mobility, users, and the workshop technician, is changing and existing business models will need to coexist with new models emerging in future.

In terms of HR, the managers and employees in the entire value chain have a direct and major impact on customer satisfaction and the economic success of a business.

The work principles in teams and business units, which function like a start up, differ and contradict the standard work principles contained in employee work contracts under the "old economy". A working environment full of creativity and energy does not conform to bureaucratic regulations and control. It needs trust and motivation and the acceptance of a different approach to solving tasks.

With 3DP production supply chains will change and in-sourcing and the re-allocation of internal resources will occur, but opportunities can also be exploited in sourcing. A proposal for a 3DP business case based on one example, the wheel carrier, was made.

Further:

- a proposal for a network planning calculation based on a big data approach was made
- a first proposal for the After Sales ecosystem partners from a strategic point of view was outlined and
- a list of examples from the benchmark companies was developed and prioritized.

One final remark in this subchapter relates to the way in which trends link to key success factors, strategic activities and KPIs. The answer is, in fact, rather simple. In most cases there is no one-to-one connection, and one trend rather leads and links to a few or many strategic activities that, when put into practice, require measureable KPIs. The primary links rounding off the dissertation can be identified as follows:

The customer

<u>Primary characteristics:</u> individualization, polarity of customers' behavior, declining loyalty towards brands and branded networks, increasing share of business customers.

The key success factors and strategic activities that answer to these trends include the product portfolio, the added services, customized solutions, investments in end-to-end solutions, product and service quality and performance including the ability to connect to new technologies. The KPIs that measure the results of the activities listed above include customer satisfaction surveys, capacity measures, several project implementation and process measures. Measurements of economic success, expressed by revenue and market share, are also applied.

Business network structure

Primary characteristics: consolidation of the distribution network, alternative distribution channels, stagnant revenues in mature markets, intense competition.

The key success factors and strategic activities that answer to these trends include network planning and design, digitalization, parallel processing of operations, automation of operations and business models.

The KPIs that measure the results of the activities listed above are capacity KPIs such as locations, work bays, HR, specific process KPIs and individual business models measurements.

Product and workshop technology

Primary characteristics: innovations, technical futures, costs of ownership, investments, operation efficiency, ecosystems.

The key success factors and strategic activities that answer to these trends include the product portfolio, customized solutions, investments in new technologies and innovations, the connected workshop, product and service quality, performance – including the ability to connect to new technologies, digitalization, parallel processing of operations and automation of operations.

The KPIs that measure the results of the activities listed above include customer and dealer satisfaction surveys, the implementation of several projects and process measures.

Human resources

Primary characteristics: qualification, fluctuation, personnel development schemes.

The key success factors and strategic activities that answer to these trends include human resources strategic activity planning, beginning with recruitment and continuing with qualifications, development schemes and salary policies.

The KPIs that measure the results of the activities listed above include the implementation of several projects, process measures, employee qualification and development monitoring and employee satisfaction surveys.

IT Systems and Internet

Primary characteristics: integrated, intuitive, convenient and easy to use IT systems, social networks, Big Data and business analytics.

The key success factors and strategic activities that answer to these trends include IT planning, qualified employees, connected workshops, digitalization, AR&VR, automation of operations and ecosystems.

The KPIs that measure the results of the activities listed above include the implementation of several projects and process measures.

Regulations and trade restrictions

Primary characteristics: competition restriction, emission laws, data protection.

The key success factors and strategic activities that answer to these trends include the service and product portfolio and network design.

The KPIs that measure the results of the activities listed above include the implementation of several projects and process measures.

Business models

Primary characteristics: ecosystems, new competitors such as the major technology companies, disruptive business models, investments.

The key success factors and strategic activities that answer to these trends include the service portfolio, added value services, co-operations and ecosystems, new business models such as that proposed for 3DP, branding, variable pricing and revenue management.

The KPIs that measure the results of the activities listed above include the implementation of several projects and process measures, measurements of economic success expressed by revenue and market share and revenue and profitability.

9.3 Conclusion

The current situation in the automotive business sector can be summarized in a few words: apart from legal regulations (BER, emission laws, etc.) the foremost challenges are new product technologies, diverse and changing customer expectations, and the difficulty finding good employees. These challenges require new ideas and innovation, especially in operations and organizations.

The number of dealerships visited is too small to claim statistical significance in quantifying the contact channels, but according to the questioned businesses, in today's world, 80% of customers contact the dealership by telephone, 15% come in personally and only 5% use the Internet. We can therefore conclude that the customers in the German market are conservative; new processes, such as the Internet, cannot be easily introduced.

Conclusion: Findings relating to process research at Volkswagen

- In order to provide perfect service to customers, besides providing individual treatment and many other supportive processes and operations, a retailer must carry out repairs quickly, in a professional manner and parts must be available
- Regarding the repair process there is an evolution in the lifetime technical support of a car
- Globalization is an added factor – many production locations export worldwide meaning problems are no longer market specific, they are global
- The complexity of the organization means that, in order to achieve results, other departments with no managerial authority and supervision are needed

- Better IT systems and evolution/analysis tools (data warehousing) provide a competitive advantage
- Warranty and goodwill have also undergone a transformation, being used as a strategic instrument to increase customer satisfaction and loyalty and ensure future business
- In parts sales, the repair process, parts availability and short delivery times are all major requirements

In order to provide any successful contribution customer data must be available in adequate quantity and quality. Data quality is crucial as many algorithms can provide a precise forecast if the data are correct and provided in sufficient quantity. Unfortunately, in an organization as large as Volkswagen, many functions are involved in data collection and reporting. One major reason for poor data quality is the correct understanding of which data should be collected. Furthermore, if some calculations have to be made mistakes can occur in the interpretation of the calculation formula. Another major factor is the difficulty for a multi-brand dealer in distinguishing the business achieved with one specific brand. Moreover, in instances of dealers with multiple locations which are not always distinguished as far as financial statements are concerned, accurate reporting for a single brand and location is almost impossible. In such instances the reporting specialists make estimations. A promising solution for a significant increase in data quality and quantity can be provided by automatic data registration. By introducing the Internet of Things wherever possible, the errors introduced into the process by the human factor can be diminished and a significant increase in data quantity and quality would be the result.

Another aspect related to data in general and customer data in particular is ownership. Because data is a strategic asset, major competition for sole access to the customer interface is currently ongoing. Due to changes in legal regulations and public awareness regarding the misuse of data, Volkswagen has introduced some initiatives to systematically analyze all categories of data with regard to ownership, value of content provided and conformity with new legal regulations. The meaningful usage of data correlated with the possibilities provided by an increase in IT can result in tremendous opportunities which can raise Volkswagen to the next level – from a product driven company to a mobility service provider and more.

We conclude that running a profitable After Sales operation nowadays is a challenging task. Faced with a number of external pressures, such as eroding profit margins, higher and changing customer expectations, rapidly changing technology and increasing competition, only automotive companies which follow best practices and have appropriate and effective KPIs to regulate and manage their business will achieve higher returns and customer satisfaction.

Contractual relationships are part of a successful business design. There are several contractual relationships in After Sales. The redesign of contractual relationships can reshape the service level support. Another challenge is the smooth transition from one mobility provider to the next. Here, cooperation is the key.

Despite advanced technologies the business model in the automotive business is still traditional. New business models need well-designed and integrated processes. Due to digitalization and the increasing share of electronics in cars it can be expected that the automotive business will reveal similar characteristics to the IT business. The ability to store and process huge amounts of data in a short time and the intelligent use of such data and resources will define the success or failure of a business.

One key success factor is the usage of the customer data; previous studies on customer mobility have revealed that human behavior is highly predictable based on the tracks left in digital spatial data.

It is crucial for every business to have direct access to the customer. Intermediaries, such as the platform providers, have the potential to disrupt today's existing business models, and pose a danger.

9.4 Discussion of the methods used

The research methodology relies on extensive external and internal research with a qualitative and quantitative approach. The findings in the first and second part are based on:

- Structured, in-depth interviews with 108 members of the network, ranging from the primary decision makers to specialists involved in the processes of the After Sales service network, and
- direct observation.

The objective of the interviews was to highlight the most important activities in the service delivery operations within the network.

In the next step, using numerical data, a Data Envelopment Analysis (DEA) was performed to determine the "efficient frontier" of service operations. A key advantage of DEA over other statistical approaches is that it more easily accommodates both multiple inputs and multiple outputs. Therefore, DEA is commonly used to evaluate the efficiency of a number of DMUs. It allows users to conduct optimization procedures and extended managerial analysis.

For the purpose of this thesis, due to capacity limitations, eight observations, eight DMUs were used.

The selection of the DMUs was an important step in non-parametric models. In order to obtain meaningful estimations, as many observations as possible should be included. The relative nature of a DEA makes it vulnerable to problems with the degrees of freedom. The number of degrees of freedom will increase with the number of DMUs in the sample, and will decrease with the number of input and output measurements. According to Golany and Roll (1989) the number of DMUs should be at least twice the number of inputs and outputs considered. Because of the low number of businesses analyzed in connection with the analytical requirements of the DEA, the number of input- and output-factors was limited in the first twenty-nine runs to 3 aspects each. Later on an additional seven runs with more than 3 input- or output criteria were conducted.

The input oriented model was used as it looks at the amount by which inputs can be proportionally reduced with fixed outputs. In this case the DEA determined how much input a DMU would need, if it is used efficiently, in order to achieve the same output level.

The analysis started with the general picture – in this case the main KPIs that describe the financial results of the DMUs analyzed, including all the primary functions of a retail business, and was then broken down to the After Sales function in general, following which a deeper analysis of the After Sales function was carried out.

The next step was to take a deeper look at Mid Dealer 3 and the other best performers in the respective categories and to describe the resources and performance of the best practice dealers. The list was completed with other meaningful KPIs and ratios in order to achieve a complete picture of an ideal retail business.

The final step in the analysis was a regression, although it must be pointed out that this procedure is subject to statistical limitations due to the low number of observations.

However, the results achieved still provide an indication as to which variables actually influence the output.

A DEA has a major advantage in that it points to real inefficiencies that are often substantial and generally not identifiable with other techniques.

Finally, we can conclude that the methodology employed provides valuable insights by first using the DEA to identify the efficient DMUs and, once the best case has been identified, applying regression provides an indication of the influence of significant inputs and their respective influence on output.

The benchmark research methodology was a combination of primary and secondary data, analyzed by following the adequate principles of qualitative research (Mayring, 2015). The first step involved extensive research of the literature resulting in the creation of a checklist containing all the important criteria or factors necessary for the success of a company.

The checklist was adapted after the interview with the first company and again later, due to the differences among the businesses analyzed.

The literature research is regarded as secondary data, while the interviews with the managers of the different benchmark partners delivered the insights and concrete answers to the questions defined and documented in the specific checklists used.

The purpose of this thesis, to carry out an in-depth analysis of the core processes in After Sales, to present the insights and lessons learned from studying other industries, to define a roadmap for further research and to discuss the needs of the sector, has been fulfilled.

The research methods used, including extensive literature research, structured interviews, direct observations based on checklists in an analysis of the German market, Data Envelopment Analysis (DEA) to determine the “efficient frontier” of service operations, supplemented by a regression analysis to indicate the influence of significant inputs and their respective influence on output, were appropriate to the aims and ideas formulated in the thesis.

The resulting best practice model, KPI steering model, success factors and roadmap can be easily generalized and adapted to the needs of other industries.

9.5 Recommendation

The first major task in retail is to correctly identify the needs, spoken and unspoken, of the customer, and to keep him mobile the retailer must deliver good performance not only by repairing the car in a short period of time but also by managing the customer's expectations. Here, customer service is essential. The service offered must be customer centric and personalized with the aim being to maximize the retention of customers. The goal is to offer end-to-end solutions and to manage customer mobility needs by managing trust and complexity throughout the entire customer life-cycle.

As products, processes and services become more digitalized the transition and coexistence between the digital and real worlds has to be optimal. The merger of real and digital worlds means OEMs and the retail business will have to review their processes, the time-to-market of their products and their business models. Processes must be accelerated as more and more products from the consumer electronics industry need to be connected to cars or integrated in workshop processes. Digitalization and the IoT also require the transformation into a product company with advanced IT capabilities.

Apart from establishing digital capabilities, improving internal processes and enabling the efficient planning of processes, two key elements are differentiation and agility. Finally, all these various initiatives must be coordinated, integrated and orchestrated.

In addition to the methodology developed above, namely using DEA and regression to identify the effective dealers and the variables that influence output, the development of a balance score card would meaningfully complement the analysis methods. The balance score card helps understand the financial consequences of decisions taken and the drivers of long-time financial success. The advantage is that it complements existing financial KPIs with KPIs that describe drivers of future performance, ideally derived from the vision and strategy of a company.

In terms of sustainability, a deeper analysis and preparation of a business case for implementing 3DP technology in After Sales should be undertaken.

Collaboration in the value chain and outside the industry, a so called ecosystem, is vital.

On the retail level collaboration between dealers in order to share capacity, inventories, specialists, print shops would be desirable. Outside the industry a broad ecosystem of partners and strategic alliances ought to be set up based on the topics addressed.

Education and training must also be reconsidered. Instead of absolute truths, more relativity ought to be integrated into the training concepts. A culture of continuous learning will enhance the innovative capacity and flexibility of the company, as only top companies are able to reinvent themselves when it becomes necessary.

OEMs have to find new sources from which to generate revenue and profit along the value chain. Additional and different points of contact with customers will develop and OEMs need to try out different possibilities and to find, or permanently establish, their position in the mobility and service environment.

Appendices

Appendix 1 – Interview Checklist

Interview Checklist

General Information about the business:

1. Company/department size
2. Organization structure (ask for copy)
3. Services provided (sales new cars, used cars, service, body, paint, parts, NORA, financing replacement cars, leasing, renting, etc, other customer oriented service)
   The management of supplementary services - Do you know what customers want, at what cost to provide - which to offer as a standard, which as an option, - how to price them?
4. Number of shifts / day
5. Production facilities and warehouses must be listed
6. The storage method (cross dock, warehouses,..) is important
7. Inventory (value, inventory turns)
8. Inventory data: raw materials / genuine parts, work-in-progress (no. of cars in the workshop and parts orders), finished goods, amount of productive time, no. of working days/week, frequency of the productive cycle/how often a part/repair is made (EPE every part every day)
9. What new technologies (web services, wireless applications, advanced software applications, RFID)
10. Which are the key steps that create value?
11. Which steps are wastes? (Examples of non-value actions: wait times, walk times, rework, and unused information)
12. How is the order flow? Is order flow erratic?
    - size and frequency of shipment
13. What is the quality level (number of repeat repairs)? Is quality erratic (variable, unreliable, irregular)?
14. How long does a customer wait for an appointment? Are deliveries erratic?
15. How can value be advanced for the end-customer?
16. List the total steps, total time, the value creating steps (I asked myself if a customer would pay for it or he would be less satisfied without it), the value creating time
17. Who decides what at which step (things such as decision points, feedback loops, review events)
18. What are the costs of these steps?
19. Which services are procured and managed centrally, and which not?
20. What is the constraint of the company (bottleneck)?
21. Which items in which department require less time than others, how much time is spent on coordination (if not coordinated this results in high inventory levels for fast items and missing orders for slow items)
22. What are (estimate) the negative effects of some decisions (specify decisions) on lost sales, excess inventory, wasted costs, long delivery lead times, unreliable due-date performance, time wasted in heated quarrels between departments

Transport links:

23. The shipping method: plane, truck, train, boat
24. No. of regular shipping /day
25. No. of costly expedited shipments in the past year
26. The distance in km, m
27. The shipping batch size

Appendix 1 – Interview Checklist (Cont.1)

Position	Question
General Manager	**1 to 5, 7, 9, 17 to 20 , 22, 30, 31**
Service Manager	**10, 11, 12, 13, 14, 15, 17, 18, 20, 21, 22, 29, 30, 31**
Parts Manager	**6, 8, 10, 11, 12, 13, 14, 15, 17, 18, 20, 21, 22, 23 to 28, 29, 30, 31**

Appendix 2 – Retail – Repair process

Confidential material that

cannot be disclosed

Appendix 2 – Retail – Repair process (Cont.1)

Confidential material that

cannot be disclosed

Appendix 2 – Retail – Repair process (Cont.2)

Confidential material that cannot be disclosed

Appendix 2 – Retail – Repair process (Cont.3)

Confidential material that cannot be disclosed

Appendix 2 – Retail – Repair process (Cont.4)

Confidential material that

cannot be disclosed

Appendix 3 – Wholesale/Technical Product Support

Confidential material that

cannot be disclosed

Appendix 4 – OEM – Repair process

Confidential material that

cannot be disclosed

Appendix 4 – OEM – Repair process (Cont.1)

Confidential material that

cannot be disclosed

Appendix 5 – Warranty process

Confidential material that

cannot be disclosed

Appendix 5 – Warranty process (Cont.1)

Confidential material that

cannot be disclosed

Appendix 5 – Warranty process (Cont.2)

Confidential material that

cannot be disclosed

Appendix 5 – Warranty process (Cont. 3)

Confidential material that cannot be disclosed

Appendix 5 – Warranty process (Cont.4)

Confidential material that cannot be disclosed

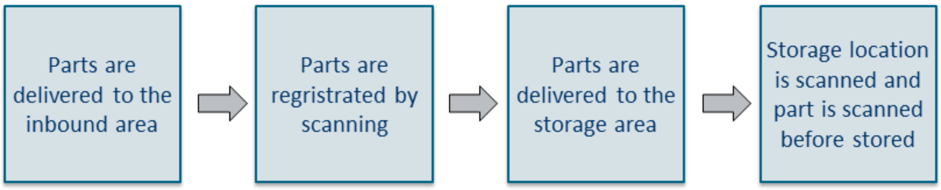
Appendix 6 – Warranty & Goodwill process (Wholesale)

Confidential material that

cannot be disclosed

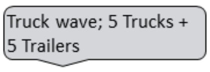
Appendix 7 – Logistics Wholesale

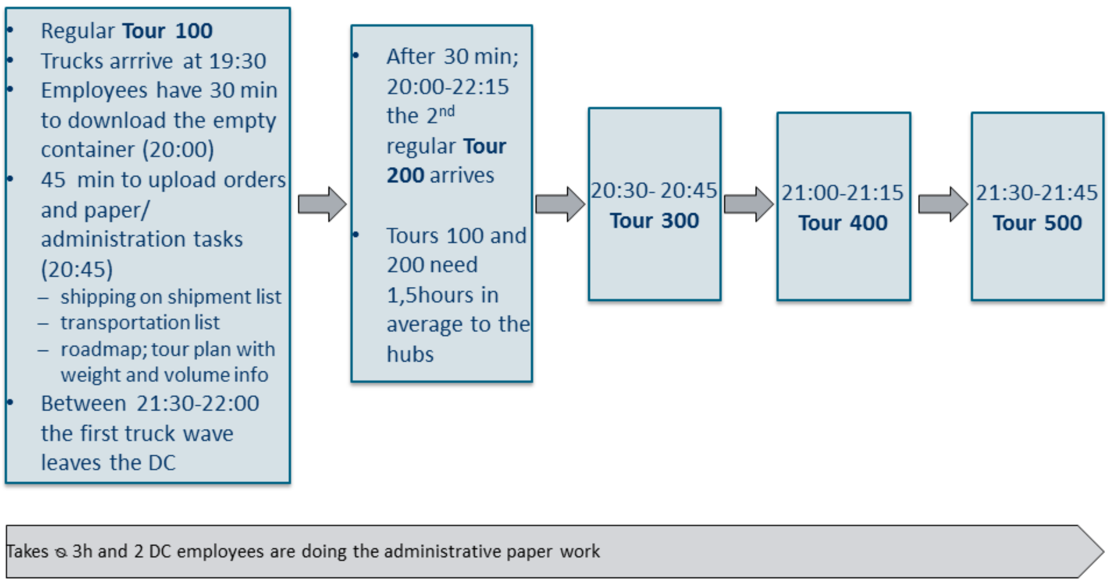
OTLG Inbound activities



- Car down volume Distribution Center 1 (DC) is higher than in other DCs; about 2.000-2.300 parts/ day. 8,5% because of the short distance to master depot in Kassel
- When ordered from MD, the part arrives in the DC 1 in max. 4 hours
- Average output DC 1 27.000 positions/ day (max. 30.000 positions/ day)
- Parts are stored in the Car Down area a few hours
  DC 1 has 5 hubs: Kassel, Herfurt, Soest, Mühlhausen and Hildesheim

Shipping Area flow





Appendix 7 – Logistics Wholesale (Cont.1)

Logistics OTLG ⟺ Car Down Process / Cross Dock Operations
⟹ the whole process runs in the outbound area

Part delivered to OTLG (master depot Kassel) ⟹ Part is registrated by scanning ⟹ Since customer is already fixed in the IT System no inbound ticket is neccessary. Customer ticket is instead printed and attached to the order ⟹

When car down is used the part is in average of 90 min in the outbound area

⟹ Part delivered to outbound area

- **The Car Down process closes the gap between „First Pick“ and Target Service Degree**
- **<u>Outbound area</u>:**
  the ordners are consolidated in the outbound area according to tour groups based on customer groups
  to hub ⟹ then to customers
  or direct to customers

Logistics OTLG Process: Warranty Parts

Main activity is the part registration for that the parts are checked, also the producer identification code

Part is scanned

⟹ Stored for 30 days then scrapped
IT System Getas gives the information what container has to be scraapped
Send to one of the Q-Department or analysis centers in Europe

⟹ The most time-consuming activity is when a stored part is requested during the 30 days as all parts in the containers have to be checked until the right part is found;
There are up to 300 parts in one container

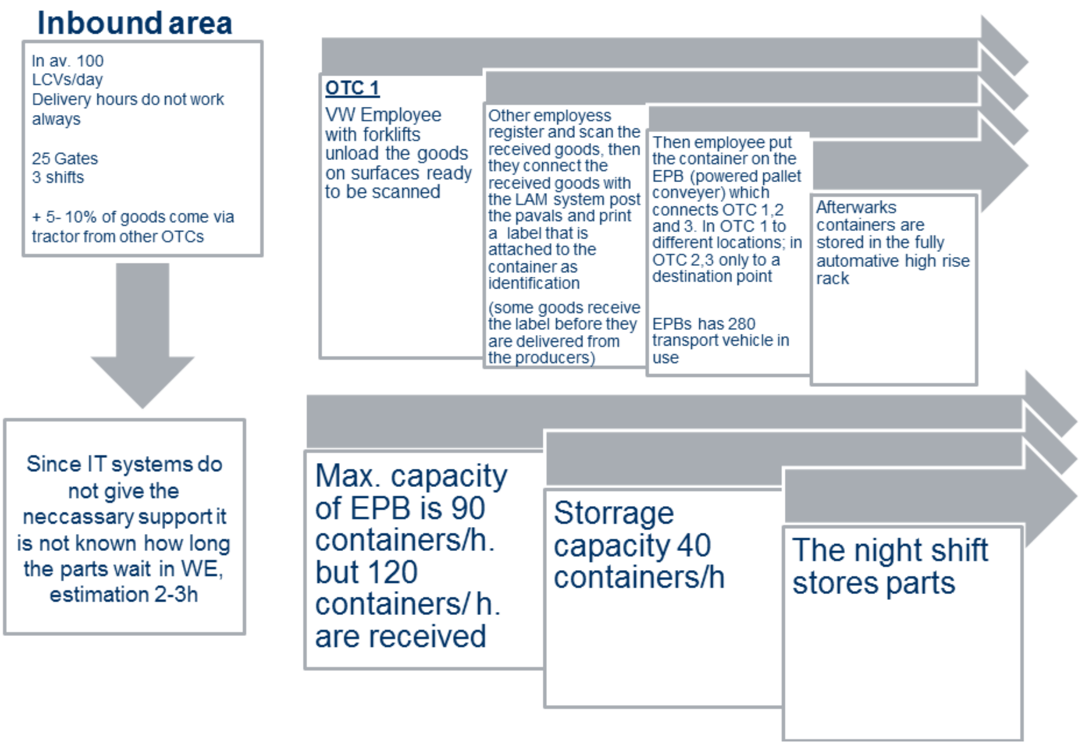
- **Parts from different dealers are stored in one box**
- **Employees work in 1 shift, 40h/week, in average they register 150-170 parts/ employee/ day 10-20 container; max 1,300-1,400 parts**
- **Warranty parts are registrated daily; sometimes up to 2-3 days; max. deliveries/peaks before and after holidays**

It is not known what part is coming until the part is registered at wholesale

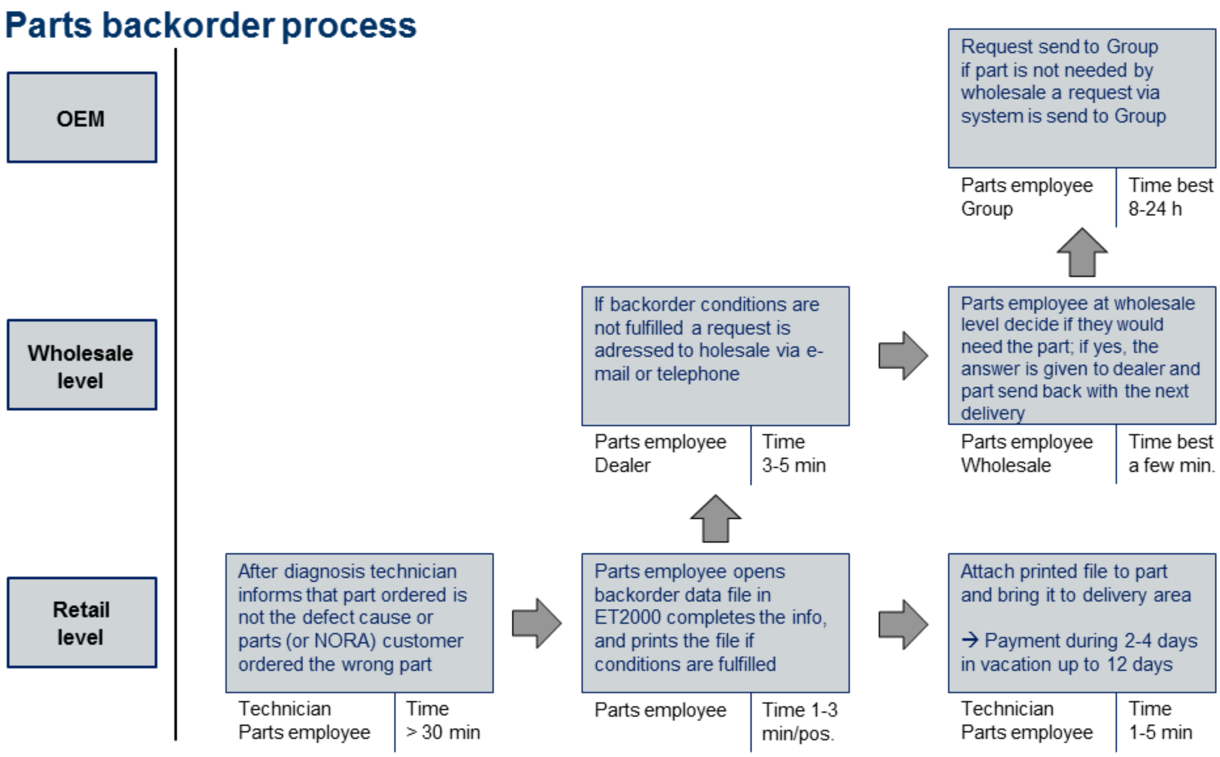
Appendix 8 – Logistics Group

OTC 1

→ 100 LCVs daily unloaded with fork lifts (1 LCV in 20-25 minutes) Goods from • Suppliers • Packaging suppliers • Other OTCs → In inbound OTC 1 no railway receiving area	**Inbound** 1.500 container daily on EBP (bigger parts) Standardized container (blue) owned by VW Area Inbound in OTC 1 is 8.500 m² and in totally 16.390 m²	Inbound small parts also automated. 500 KLT container are registered/shift 3,000-5,000 pallets/day 60% of KLTs stored in OTC 1 →palets go via conveyer system transport to the location where they are stored than →per lift to high-bay storage (Hochregal) • Per shift > 1000 KLT container „dekommissioniert“ de-consigned sale	The packaging supplier will register the goods packed in SAP → then the supplier of goods is paid → Packed parts delivered to OTCs with cargo lift → Infos on cargo lift: part nr, total nr of parts, Q-check (2%)	**Outbound** → Robot cell in OTC1 das consignment sale (picking) for heavy parts (works 24h) • Some parts have to be picked manually by employees too depending on the number ordered



Appendix 9 – Parts backorder process



Appendix 10 – Input Data

	Hours sold	Nr. of Through-puts	FTE After Sales	FTE Rest	New Car Sales
Large Dealer 1	37138.00	13698.00	47.30	52.70	2487.00
Large Dealer 2	18224.00	8826.00	41.10	40.90	3001.00
Large Dealer 3	31407.00	5932.00	33.00	22.00	651.00
Mid Dealer 1	28062.00	5856.00	36.10	61.90	515.00
Mid Dealer 2	18340.00	8621.00	41.70	23.30	257.00
Mid Dealer 3	22508.00	5157.00	41.00	28.00	2706.00
Small Dealer 1	11311.00	4473.00	12.00	9.00	1.00
Small Dealer 2	6760.00	3245.00	8.00	12.00	139.00

	Used Car Sales	Nr. of Workbays	Productive FTE	Hourly Rate (achieved)	Nr. of Direct Reception Workbays
Large Dealer 1	1142.00	27	24.1	91	2
Large Dealer 2	1131.00	13	28.9	88	4
Large Dealer 3	867.00	15	17.1	70	2
Mid Dealer 1	634.00	20	23.2	84	1
Mid Dealer 2	164.00	18	14.3	83	4
Mid Dealer 3	3481.00	8	28.00	29	2
Small Dealer 1	1.00	6	7.2	80	2
Small Dealer 2	213.00	4	4.5	66	1

	CM3	CM3 After Sales	CM 3 Rest	CM3 Service	CM3 Parts
Large Dealer 1	1818214	1696568.35	121645.60	1263563.09	433005.26
Large Dealer 2	2810511.1	1673784.67	1136726.40	1262691.96	411092.71
Large Dealer 3	1361631	1316093.82	45537.17	612827.99	703265.83
Mid Dealer 1	1432024.4	1286114.68	145909.69	799616.48	486498.20
Mid Dealer 2	450383.22	399152.09	51231.13	124138.00	275014.09
Mid Dealer 3	2814954	1522571.00	1292383.00	928405.00	594166.00
Small Dealer 1	14895.64	41555.93	26660.29	22657.02	18898.91
Small Dealer 2	398603.92	280211.90	118392.02	174755.64	105456.26

Appendix 10 – Input Data (Cont.1)

	Revenue After Sales	Revenue	Revenue Rest	Revenue Service	Revenue Parts
Large Dealer 1	8714004.37	28213511.07	19499506.70	4199748.21	4514256.16
Large Dealer 2	6533089.50	65576832.09	59043742.59	3777185.53	2755903.97
Large Dealer 3	6031843.15	30228091.51	24196248.36	2146475.05	3885368.10
Mid Dealer 1	6232199.39	23902949.66	17670750.27	2335593.06	3896606.33
Mid Dealer 2	2122895.68	5277528.68	3154633.00	700984.95	1421910.73
Mid Dealer 3	3951280.00	28414649	24463369.00	1597466.00	2353814.00
Small Dealer 1	173128.53	204837.86	31709.33	89295.14	83833.39
Small Dealer 2	1076420.39	6466802.99	5390382.60	481172.63	595247.76

	CSS Overall Satisfaction	CSS Loyality	New Car Sales	Used Car Sales	Direct Costss
Large Dealer 1	8.50	10.80	2487.00	1142.00	970538.5
Large Dealer 2	6.80	9.10	3001.00	1131.00	2354691.9
Large Dealer 3	8.10	10.00	651.00	867.00	887435.91
Mid Dealer 1	8.10	10.60	515.00	634.00	341783.62
Mid Dealer 2	8.90	10.50	257.00	164.00	60600.39
Mid Dealer 3	8.10	11.20	2706.00	3481.00	591077
Small Dealer 1	9.30	11.00	1.00	1.00	37.82
Small Dealer 2	9.00	11.20	139.00	213.00	98778.82

	Labour Costss	Direct Operating Costs	Direct Costs Service	Labour Costs Service	Direct Operating Costs Service
Large Dealer 1	4469082.99	942142.13	131025.01	2122547.88	177550.06
Large Dealer 2	3070606.18	858524.82	113245.84	1381633.31	352036.88
Large Dealer 3	2429799.84	786893.95	65605.17	1168784.04	150186.85
Mid Dealer 1	2634308.88	350471.03	0.00	1070821.01	118056.69
Mid Dealer 2	875008.25	187807.21	1843.73	271211.89	56243.20
Mid Dealer 3	2630294	1046070	690.00	810700.00	52114.00
Small Dealer 1	81298.93	7745.86	0.00	51043.01	2838.11
Small Dealer 2	556496.78	140210.37	2293.72	211288.14	54043.90

Appendix 10 - Input Data (Cont.2)

	FTE Overall	No. of Service Advisors	No. of Techni-cians	Number of Test Devices
Large Dealer 1	100	6,3	22	9
Large Dealer 2	82	7,8	15	6
Large Dealer 3	55	5	7	6
Mid Dealer 1	98	5,1	20	5
Mid Dealer 2	65	4,7	11	9
Mid Dealer 3	69	8	22	8
Small Dealer 1	21	3	4	3
Small Dealer 2	20	2	3	2

	Labour Costs Parts	Direct Operat-ing Costs Parts	Direct Costs Parts
Large Dealer 1	897616.69	100464.57	0.00
Large Dealer 2	644590.48	56919.65	15483.88
Large Dealer 3	456399.26	41576.05	17581.38
Mid Dealer 1	515184.15	26400.56	0.00
Mid Dealer 2	160961.65	20183.49	0.00
Mid Dealer 3	262373.00	13418.00	5031.00
Small Dealer 1	6863.36	627.22	0.00
Small Dealer 2	70813.54	18700.04	49.35

Appendix 11 – DEA Trial 1.1

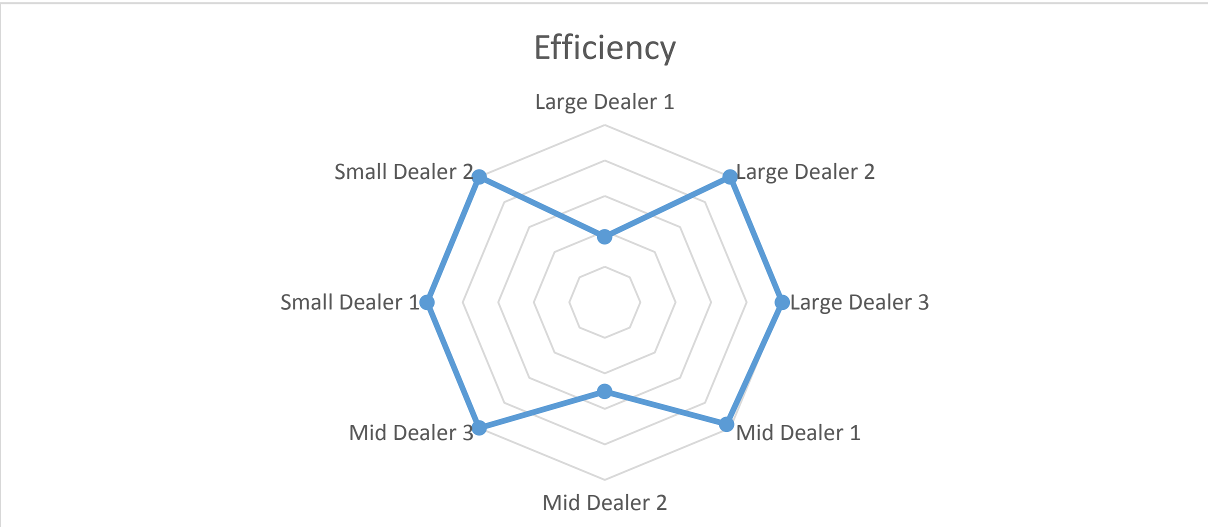
Inputs	Outputs
FTE Sales & Other Businesses	CM 3 Sales & Other Businesses
New Car Sales	Revenue Sales & Other Businesses
Used Car Sales	

Because of the rule of thumb the maximum number of input and output criteria was maximum three for each category, therefore many trials were done by using different combinations of KPIs. In the first trial as an input were introduced the human resources in Sales and Other Businesses as an key resource, also the performance of the staff expressed by the new and used car sold and as output financial results like revenue and profit expressed via the contribution margin three (CM 3).

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	0.37014	0.280	Large Dealer 2	0.121	Large Dealer 3
2	Large Dealer 2	1.00000	1.000	Large Dealer 2		
3	Large Dealer 3	1.00000	1.000	Large Dealer 3		
4	Mid Dealer 1	0.97123	0.017	Large Dealer 2	0.682	Large Dealer 3
5	Mid Dealer 2	0.50172	0.031	Large Dealer 2	0.053	Large Dealer 3
6	Mid Dealer 3	1.00000	1.000	Mid Dealer 3		
7	Small Dealer 1	1.00000	1.000	Small Dealer 1		
8	Small Dealer 2	1.00000	1.000	Small Dealer 2		

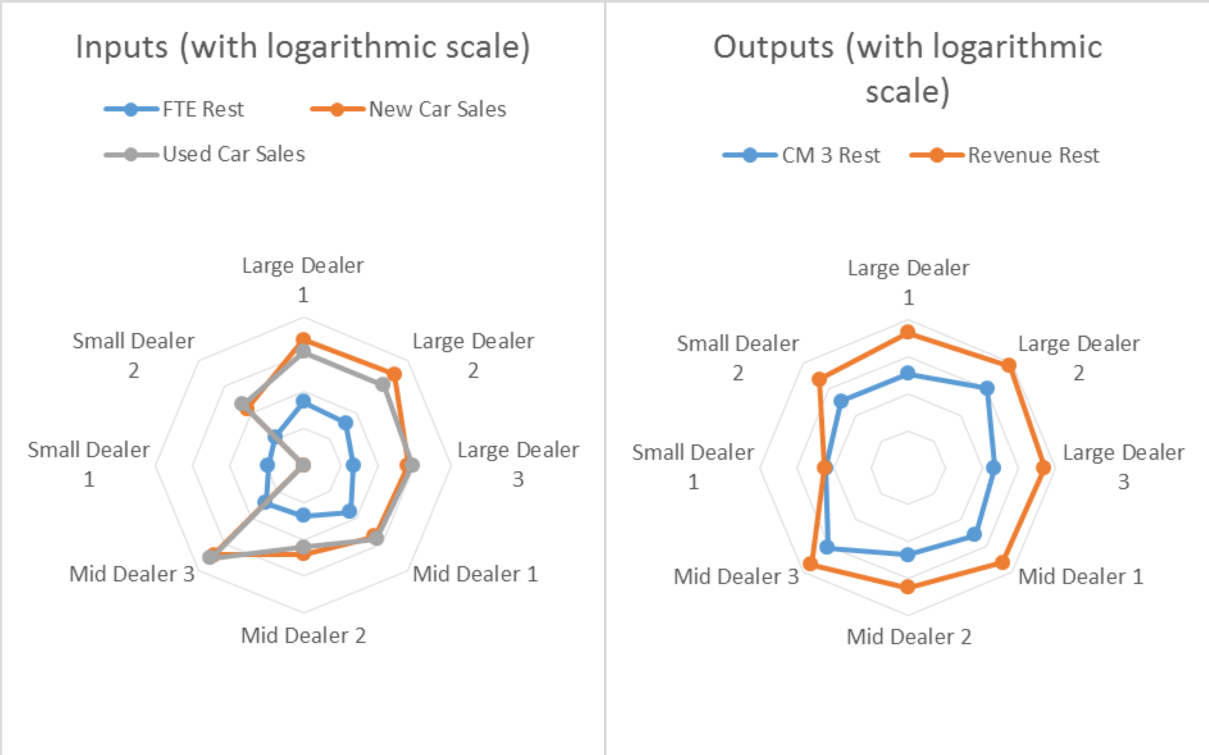
The efficient dealers for the FTE Sales & Other Businesses, New Car Sales, Used Car Sales inputs and CM 3 Sales & Other Businesses, Sales & Other Businesses Revenue outputs are Larger Dealer 2, Large Dealer 3, Mid Dealer 3, Small Dealer 1 and Small Dealer 2.

Radar Chart with overall efficiencies:



From the radar chart we see that even though Mid Dealer 1 is not as efficient its efficiency rate is still close to 1. On the other hand, we can also see that the Mid Dealer 2 and Large Dealer 1 have the lowest efficiency rates in Sales & Other Businesses.

Radar Chart with inputs vs. outputs:



On the radar charts below we see what are the inputs and outputs for every dealer. Because of very different scales, the logarithmic scale was used for a better comparison between them.

We see that for the efficient dealers, it is always the case that their inputs are among the smallest and the outputs among the highest. The one that stands out the most is the Small Dealer 1, whose inputs are the lowest while its outputs are still relatively high. This is why Small Dealer 1 is a dominant dealer. The dealer does not have a sales contract for VW; he makes money with agent fees and used car sales.

About the inefficient dealers, if we take a look at the Large Dealer 1, we can see that its inputs are always among the highest, while the outputs are not. In the input chart, we see that the FTE Rest, the New Car Sales and the Used Car Sales for Large Dealer 1 are among the highest ones. The opposite can be seen in the output chart, as the CM 3 Rest is very low compared to the others because of high costs, especially labor costs and low sales margins. This is why Large Dealer 1 is not efficient. We can conduct similar conclusions for the Mid Dealer 2, as it always produces the lowest outputs with high inputs, the financial performance is suboptimal.

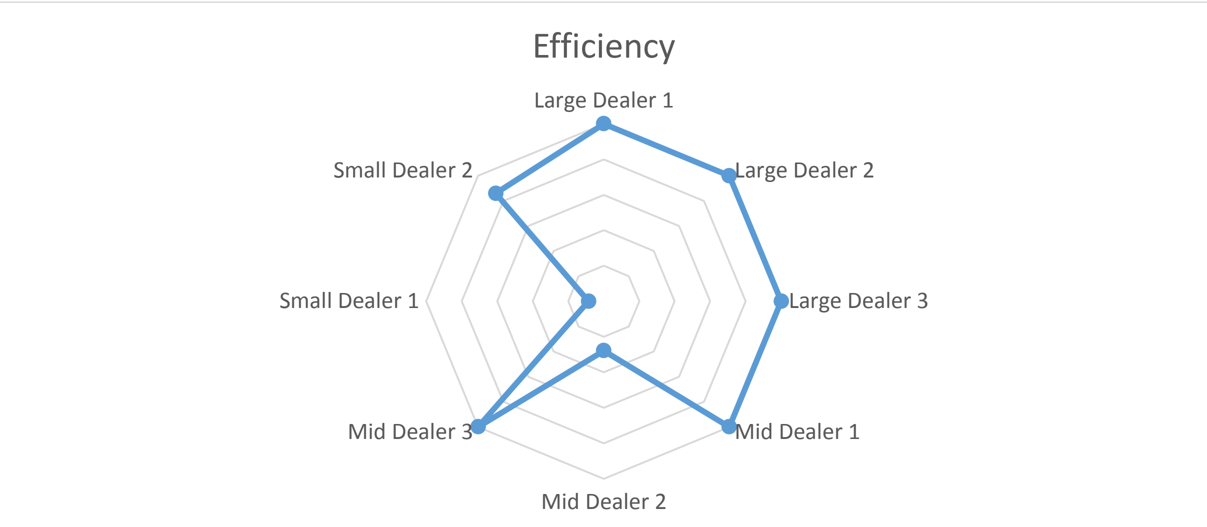
By comparing the number of staff members and the labor costs for Large Dealer 1 and Large Dealer 2, we conclude that Large Dealer 2 has more staff but the labor costs are lower and the revenue is higher.

Appendix 11 – DEA Trial 1.2

Inputs	Outputs
Nr. of Throughputs	CM3 After Sales
FTE After Sales	Revenue After Sales

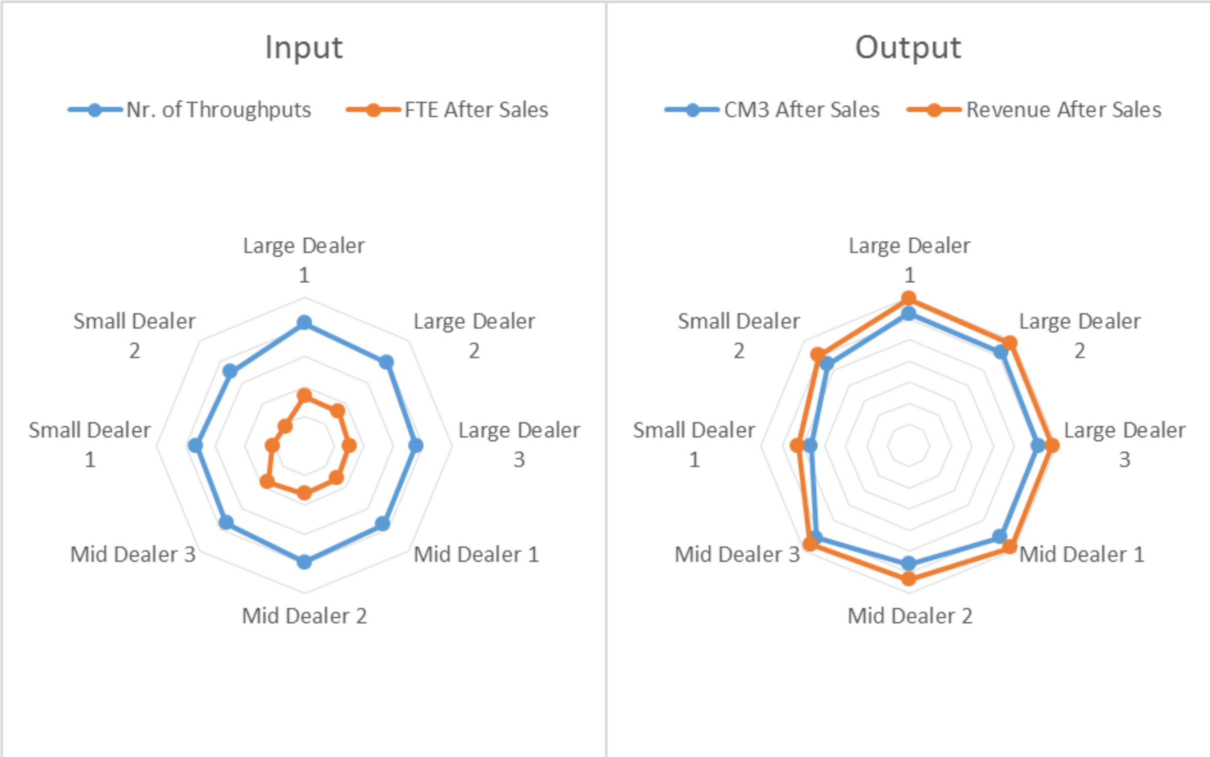
DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	1,00000	1,000	Large Dealer 1		
2	Large Dealer 2	1,00000	1,000	Large Dealer 2		
3	Large Dealer 3	1,00000	1,000	Large Dealer 3		
4	Mid Dealer 1	1,00000	1,000	Mid Dealer 1		
5	Mid Dealer 2	0,27798	0,060	Large Dealer 1	0,265	Large Dealer 3
6	Mid Dealer 3	1,00000	1,000	Mid Dealer 3		
7	Small Dealer 1	0,08573	0,015	Large Dealer 2	0,012	Large Dealer 3
8	Small Dealer 2	0,86008	0,167	Large Dealer 2		

The efficient dealers for the inputs listed above: Nr. Of Throughputs, FTE After Sales and outputs: CM 3 After Sales, Revenue After Sales are Large Dealer 1, Large Dealer 2, Large Dealer 3, Mid Dealer 1 and Mid Dealer 3.



From the radar chart we can see that even though Small Dealer 2 is not as efficient its efficiency rate is still close to 1. On the other hand, we can also see that the Mid Dealer 2 and Small Dealer 1 have low efficiency rate, with efficiency rate of Small Dealer one being the lowest.

In this case, all efficient dealers are dominant dealers. With similar amounts of inputs, they produce similar amounts of outputs.



We see on the output chart that all the dealers produce similar amount of outputs. The only one that we see a difference in is Small Dealer 1. Small Dealer 1 has the lowest amount of outputs, but its inputs are relatively high. The only one with smaller inputs is Small Dealer 2, but because its outputs are among the highest ones, it is more efficient than Small Dealer 1. That is why Small Dealer 1 is the least effective one.

Small Dealer 1 and 2 are small family firms, but have a different number of technicians. Because of this, Small Dealer 1 has less productive FTE which has major influence on revenue and CM3.

Mid dealer 2 also has quite low efficiency rate. Its inputs are relatively high compared to other dealers but its outputs are relatively low.

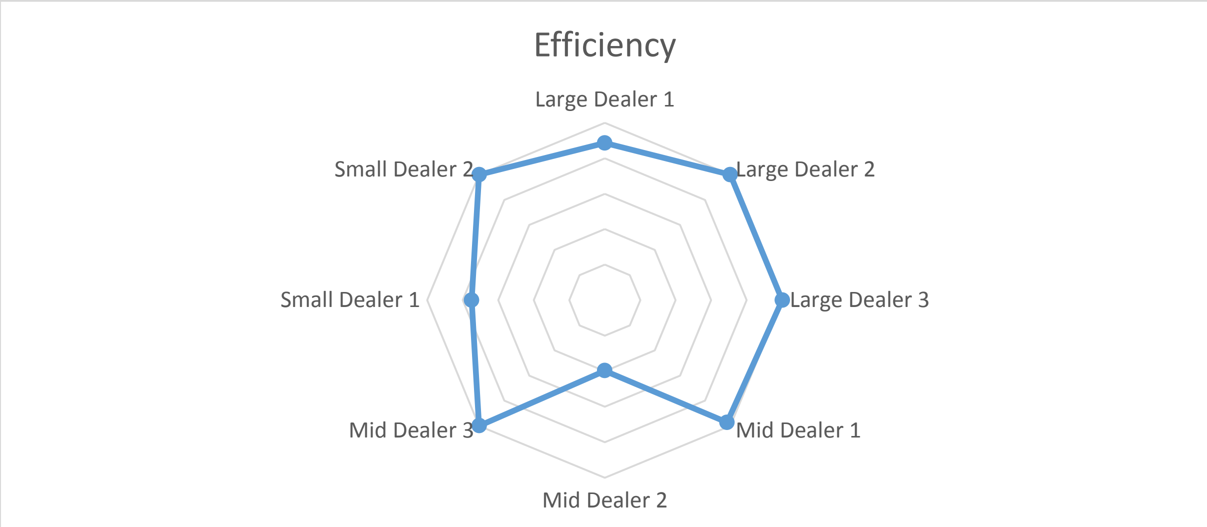
Appendix 11 – DEA Trial 1.3

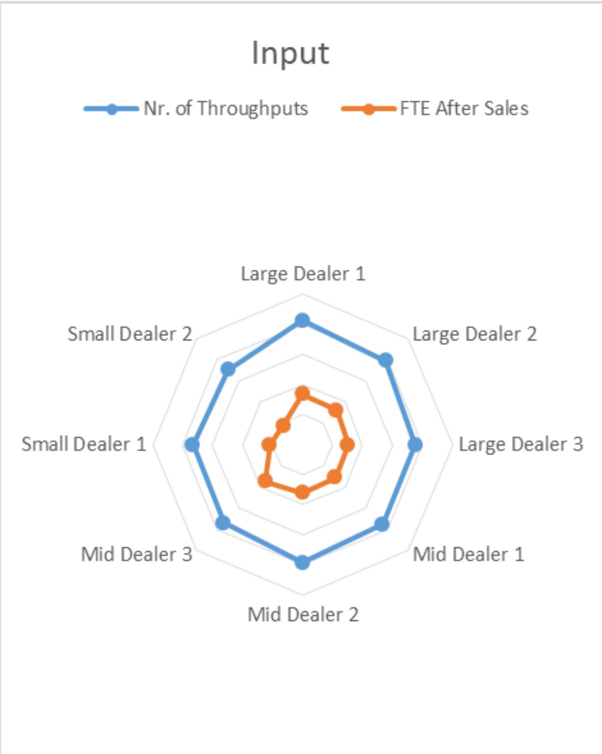
Inputs	Outputs
Nr. of Throughputs	CM3 After Sales
FTE After Sales	CSS Overall Satisfaction
	CSS Loyalty

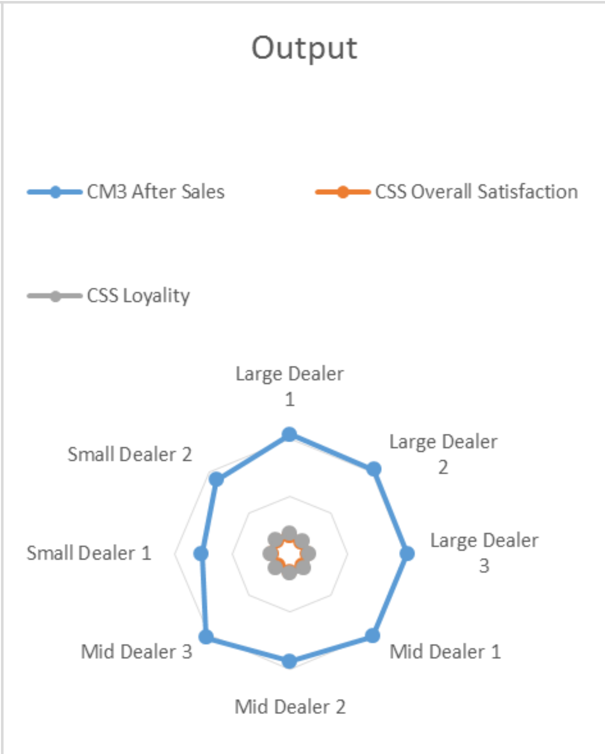
DMU No.	DMU Name	Efficien-cy	Optimal Lambdas with Benchmarks					
1	Large Dealer 1	0,88559	0,979	Large Dealer 2	0,204	Small Dealer 2		
2	Large Dealer 2	1,00000	1,000	Large Dealer 2				
3	Large Dealer 3	1,00000	1,000	Large Dealer 3				
4	Mid Dealer 1	0,92355	0,762	Large Dealer 3	0,168	Mid Dealer 3	0,098	Small Dealer 2
5	Mid Dealer 2	0,39715	0,096	Mid Dealer 3	0,902	Small Dealer 2		
6	Mid Dealer 3	1,00000	1,000	Mid Dealer 3				
7	Small Dealer 1	0,74965	1,033	Small Dealer 2				
8	Small Dealer 2	1,00000	1,000	Small Dealer 2				

The efficient dealers for the Nr. Of Throughputs, FTE After Sales inputs and CM 3 After Sales, CSS Overall Satisfaction and CSS Loyalty outputs are Large Dealer 2, Large Dealer 3, Mid Dealer 3 and Small Dealer 2.

From the radar chart we can see that even though Large Dealer 1 is not as efficient, its efficiency rate is still close to 1 and that the Mid Dealer 2 is the least efficient dealer.







We see from the radar chart above, that all the dealers have very similar amount of CSS Overall Satisfaction and CSS Loyalty. This is because they are measured differently from other outputs and they have very small scale differences compared to other outputs. From the pictures above it is hard to distinguish who has better or lower index.

Dominant dealer is Mid Dealer 3. Their output is high and it is achieved with smaller amounts of inputs. On the output side, it is comparable to Large Dealer 2 and Large Dealer 3, but its inputs are lower.

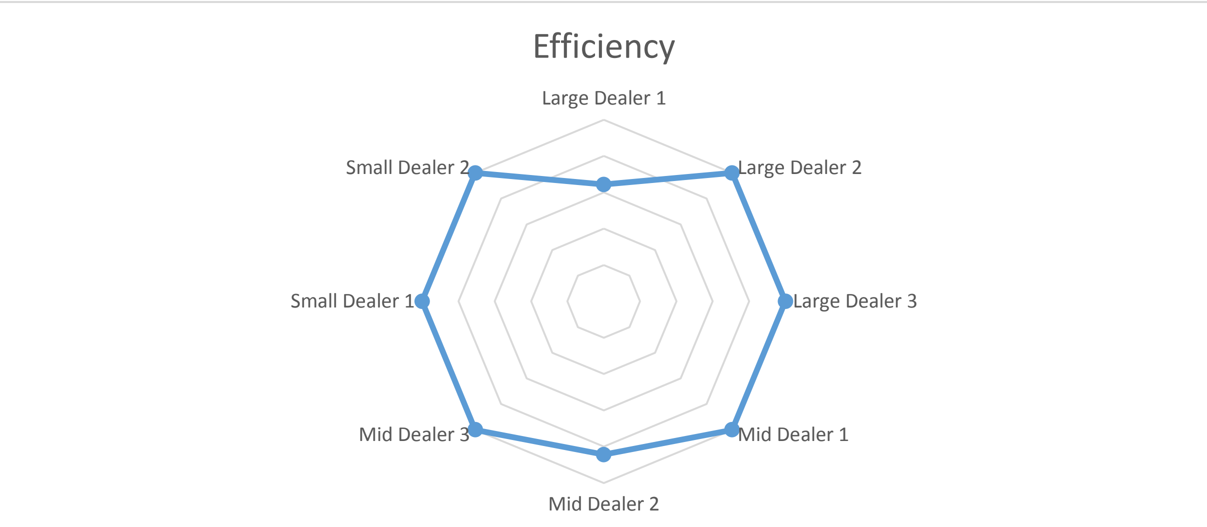
We see that only dealers with smaller CM3 after sales are Mid Dealer 2, Small Dealer 1 and Small Dealer 2. If we look then on the inputs chart, we see that both Mid Dealer 2 and Small Dealer 1 have high inputs but Small Dealer 2 has not. This is why the first two are not efficient and Small Dealer 2 is. The conclusion from this analysis is that small dealers have smaller inputs but the same outputs as all others in terms of CSS Overall Satisfaction and CSS Loyalty, which are independent of size and business volume. Traditionally, small dealer build stronger relationships with their customers because they are aware of the fact that it is more expensive to acquire new customers instead to retain the old ones and the service is not that anonymous as in large dealerships.

The difference between the CSS Satisfaction and Loyalty values is so small that even with the help of the illustration on a logarithmic scale the significance is not given.

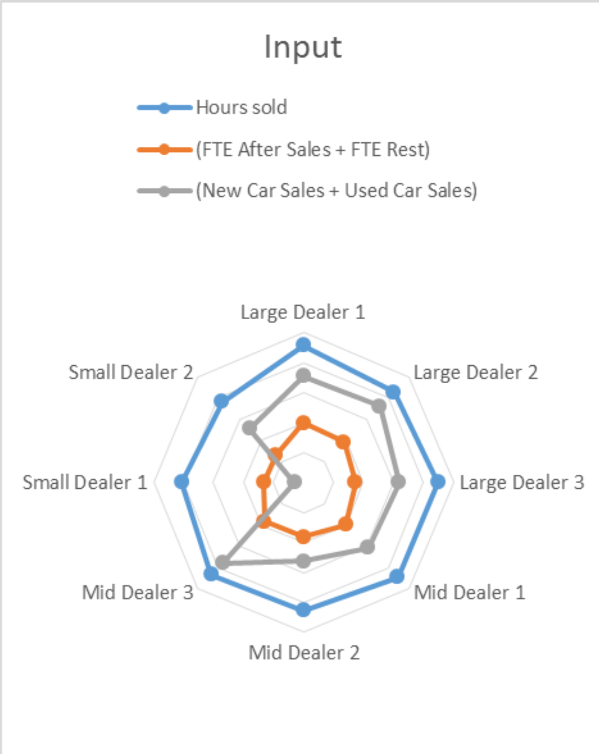
Appendix 11 – DEA Trial 1.4

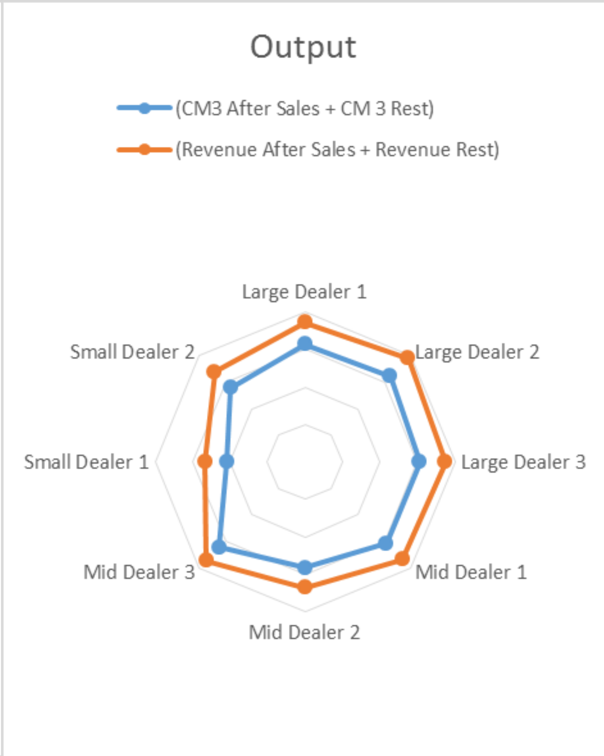
Inputs	Outputs
Hours sold	CM3 overall
FTE overall	Revenue overall
(New Car Sales + Used Car Sales)	

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks					
1	Large Dealer 1	0,64308	0,358	Large Dealer 2	0,433	Large Dealer 3	0,555	Small Dealer 2
2	Large Dealer 2	1,00000	1,000	Large Dealer 2				
3	Large Dealer 3	1,00000	1,000	Large Dealer 3				
4	Mid Dealer 1	1,00000	1,000	Mid Dealer 1				
5	Mid Dealer 2	0,84408	0,308	Mid Dealer 1	0,604	Small Dealer 1		
6	Mid Dealer 3	1,00000	1,000	Mid Dealer 3				
7	Small Dealer 1	1,00000	1,000	Small Dealer 1				
8	Small Dealer 2	1,00000	1,000	Small Dealer 2				



The efficient dealers for the Hours Sold, FTE After Sales + FTE Sales & Other Businesses, New Car Sales + Used Car inputs and CM3 After Sales + CM 3 Sales & Other Businesses, Revenue After Sales + Revenue Sales & Other Businesses outputs are Large Dealer 2, Large Dealer 3, Mid Dealer 1, Mid Dealer 3, Small Dealer 1 and Small Dealer 2.





The only dealers which are not efficient are Large Dealer 1 and Mid Dealer 2.

Dominant dealer is Small Dealer 2. Its output is high and it is achieved with relatively small amounts of inputs.

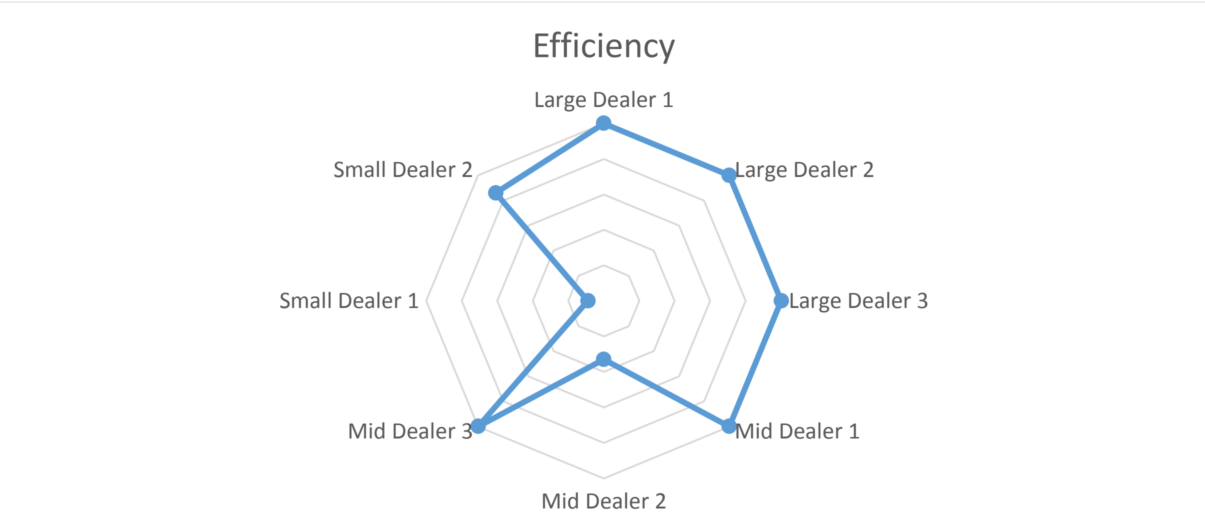
Even though Large Dealer 1 produces similar outputs to others, its inputs are too high for it to be efficient. In comparison to Large Dealer 1, Mid Dealer 2 is faced with the opposite problem; its outputs are too low to be efficient. The only dealer with lower outputs is Small Dealer 1, but he stands out also with the inputs due to the fact that the business does not have a sales contract being only agent in car sales transactions. Compared to others, Small dealer 1 needs very low inputs to produce the amount of outputs. On the other hand Mid Dealer 1 needs a similar amount of inputs that all other dealers, but produces lower outputs.

Appendix 11 – DEA Trial 1.5

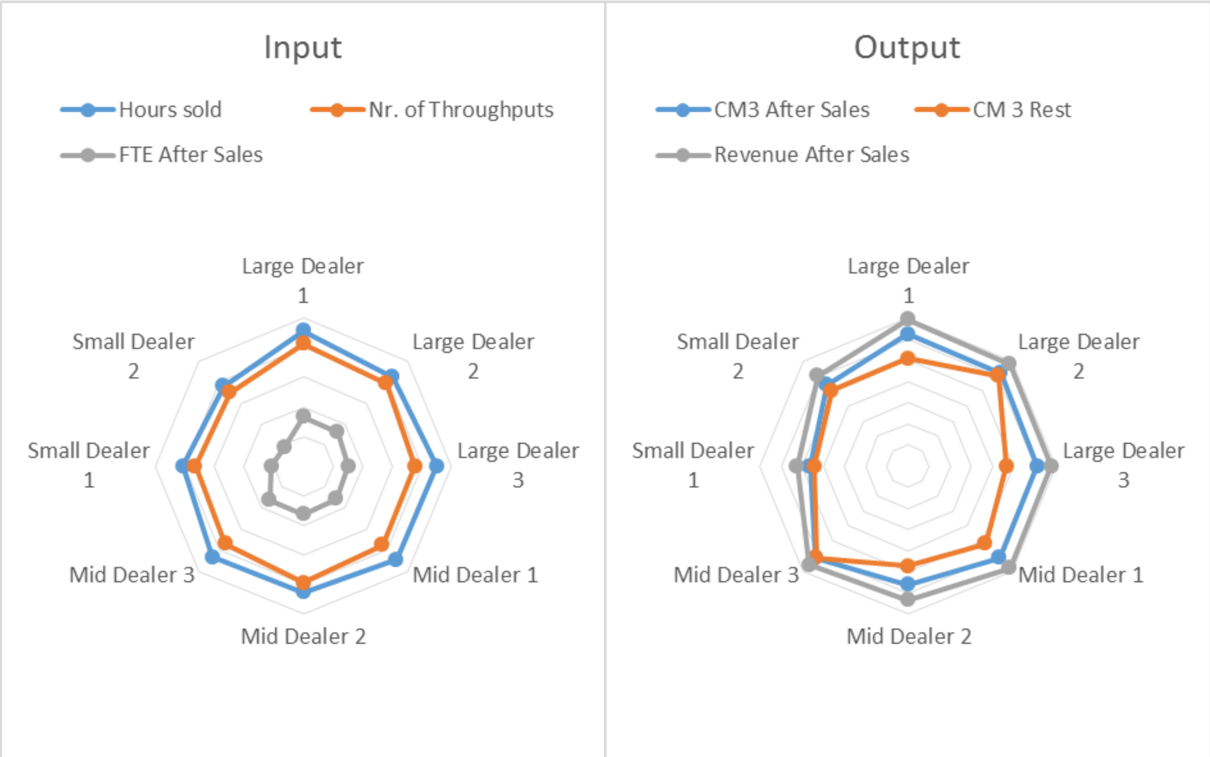
Inputs	Outputs
Hours sold	CM3 After Sales
Nr. of Throughputs	CM 3 Sales & Other Businesses
FTE After Sales	Revenue After Sales

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	1,00000	1,000	Large Dealer 1		
2	Large Dealer 2	1,00000	1,000	Large Dealer 2		
3	Large Dealer 3	1,00000	1,000	Large Dealer 3		
4	Mid Dealer 1	1,00000	1,000	Mid Dealer 1		
5	Mid Dealer 2	0,32936	0,314	Large Dealer 2	0,011	Mid Dealer 1
6	Mid Dealer 3	1,00000	1,000	Mid Dealer 3		
7	Small Dealer 1	0,08921	0,002	Large Dealer 1	0,023	Large Dealer 2
8	Small Dealer 2	0,86008	0,167	Large Dealer 2		

The efficient dealers for the Hours Sold, Nr. of Throughputs, FTE After Sales inputs and CM3 After Sales, CM 3 Sales & Other Businesses, Revenue After Sales outputs are Large Dealer 1, Large Dealer 2, Large Dealer 3, Mid Dealer 1 and Mid Dealer 3.



From the radar chart we see that the Mid Dealer 2 and Small Dealer 1 have low efficiency rates, with Small Dealer 1 having the lowest efficiency rate.



Dominant dealer is Large Dealer 1. Its outputs are always the highest ones, which are achieved by using average amounts of inputs.

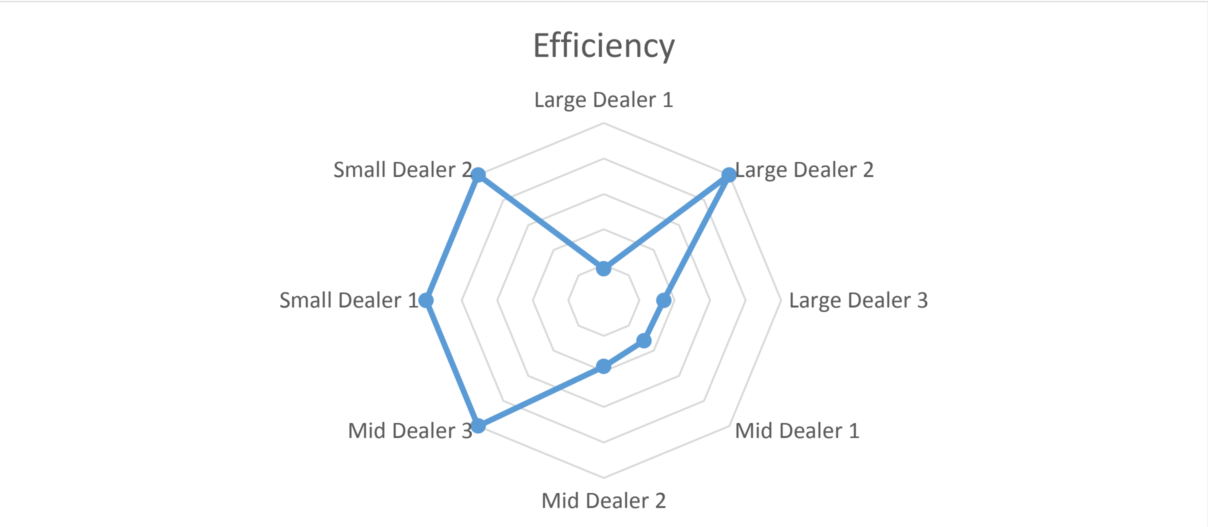
Small Dealer 1 has a very low efficiency rate. This is because their outputs are low and also achieved by using similar amount of inputs as for example Small Dealer 2, whose output is higher.

Appendix 11 – DEA Trial 1.6

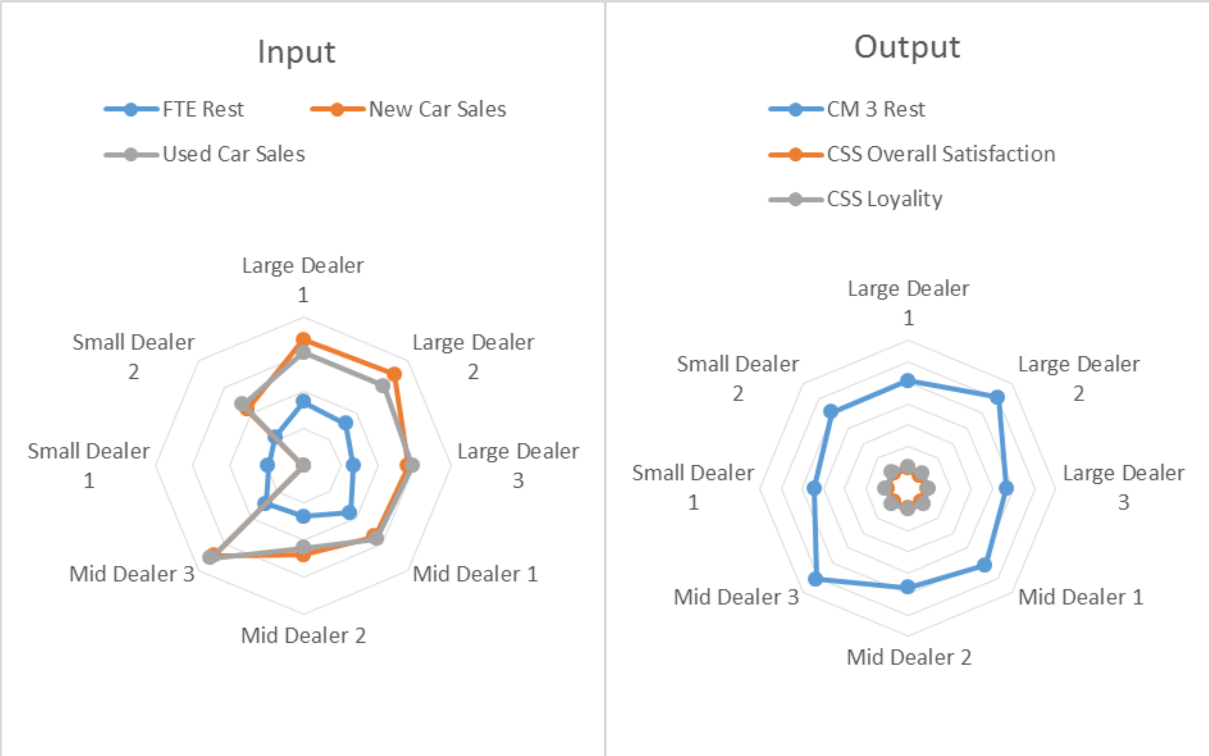
Inputs	Outputs
FTE Sales & Other Businesses	CM 3 Sales & Other Businesses
New Car Sales	CSS Overall Satisfaction
Used Car Sales	CSS Loyalty

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks					
1	Large Dealer 1	0,20038	0,031	Large Dealer 2	0,048	Mid Dealer 3	0,907	Small Dealer 1
2	Large Dealer 2	1,00000	1,000	Large Dealer 2				
3	Large Dealer 3	0,38632	0,081	Mid Dealer 3	0,827	Small Dealer 1		
4	Mid Dealer 1	0,32120	0,014	Large Dealer 2	0,977	Small Dealer 1	0,876	Small Dealer 2
5	Mid Dealer 2	0,38995	0,005	Large Dealer 2	0,016	Mid Dealer 3	0,940	Small Dealer 1
6	Mid Dealer 3	1,00000	1,000	Mid Dealer 3				
7	Small Dealer 1	1,00000	1,000	Small Dealer 1				
8	Small Dealer 2	1,00000	1,000	Small Dealer 2				

The efficient dealers for the FTE Sales & Other Businesses, New Car Sales, Used Car Sales inputs and CM 3 Sales & Other Businesses, CSS Overall Satisfaction, CSS Loyalty outputs are Large Dealer 2, Mid Dealer 3, Small Dealer 1 and Small Dealer 2.



From the radar chart we can see that the Larger Dealer 1 is the least effective dealer. We can also see that the Larger Dealer 3, Mid Dealer 1 and Mid Dealer 2 all have low efficiency rates.



Dominant dealer is Small Dealer 1. With low inputs, they produce relatively high outputs. As mentioned in the previous trials this business does not have sales contracts and in accordance the costs for sales standards does not exist.

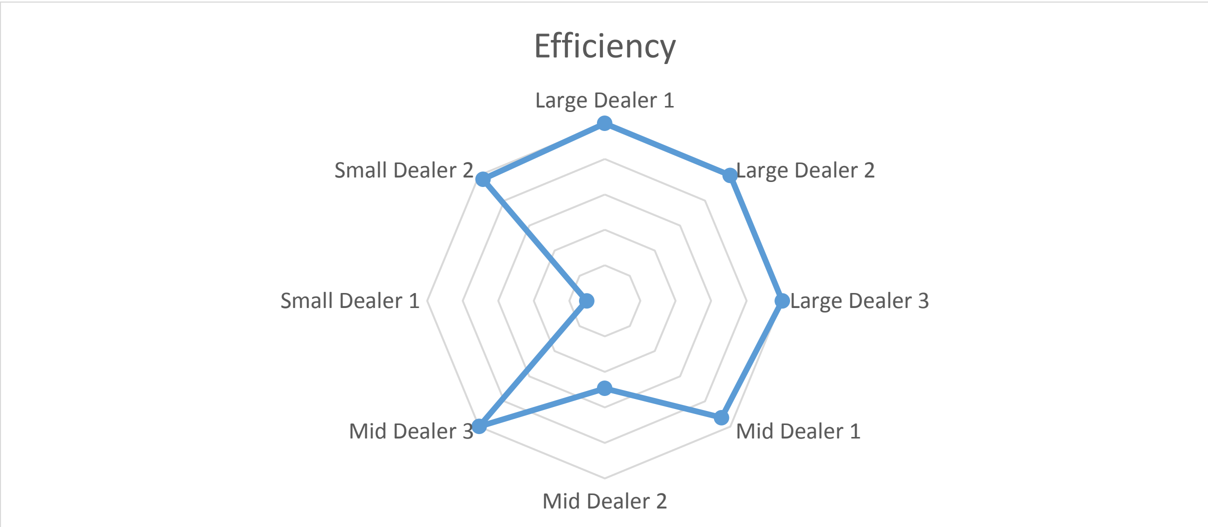
Among the inefficient dealers, Large Dealer 1 is the least efficient. They use on average the most inputs but they produce similar outputs as others.

Appendix 11 – DEA Trial 1.7

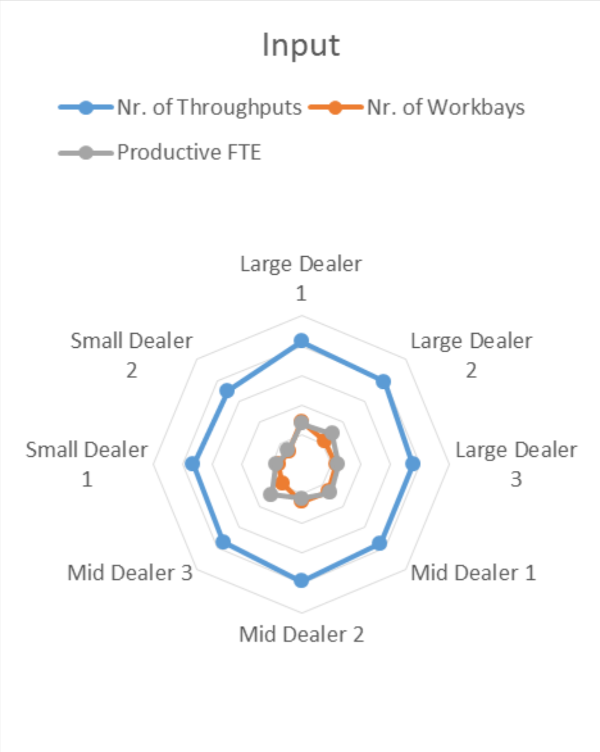
Inputs	Outputs
Nr. of Throughputs	CM Sales & Other Businesses
Nr. of Work bays	CM3 Service
Productive FTE	CM3 Parts

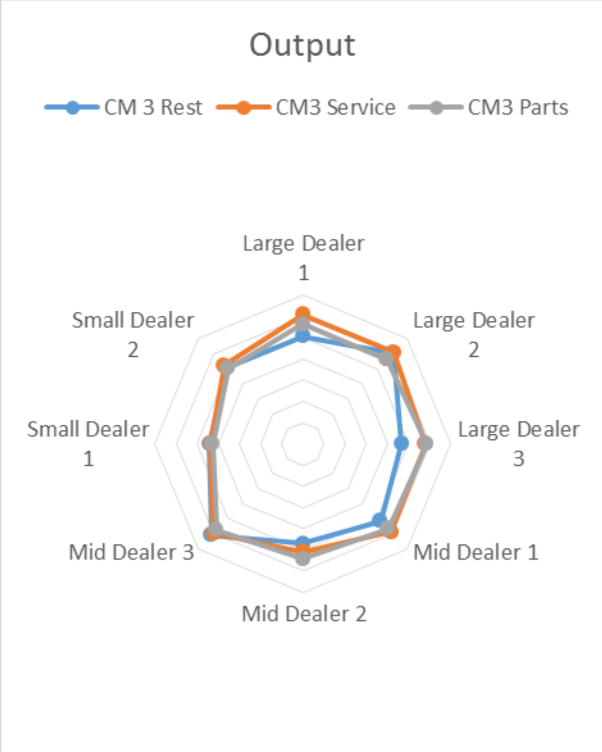
DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks				
1	Large Dealer 1	1.00000	Large Dealer 1				
2	Large Dealer 2	1.00000	Large Dealer 2				
3	Large Dealer 3	1.00000	Large Dealer 3				
4	Mid Dealer 1	0.93067	Large Dealer 2	0.226	Large Dealer 3	0.384	Mid Dealer 3
5	Mid Dealer 2	0.49289	Large Dealer 3	0.027	Mid Dealer 3		
6	Mid Dealer 3	1.00000	Mid Dealer 3				
7	Small Dealer 1	0.10201	Large Dealer 3	0.020	Mid Dealer 3		
8	Small Dealer 2	0.96921	Large Dealer 2	0.089	Large Dealer 3	0.013	Mid Dealer 3

The efficient dealers for the Nr. of Throughputs, Nr. of Workbays, Productive FTE inputs and CM Sales & Other Businesses, CM3 Service, CM3 Parts outputs are Large Dealer 1, Large Dealer 2, Large Dealer 3 and Mid Dealer 3.



We see on the chart above that dealers with low efficiency rate are Mid Dealer 2 and Small Dealer 1. Although Mid Dealer 1 and Small Dealer 2 are not efficient, their efficiency rate is close to 1.





The dominant dealer is Large Dealer 2. Its output level is the highest one for all the outputs and its input level is similar to the others. For example, its input is smaller than the input of Large Dealer 1 but its output is higher. The number of productive FTEs in comparison to the total number of FTEs at Large Dealer 2 is higher than at Large Dealer 1. This confirms the general rule that the higher the number of productive FTEs in a business the higher the efficiency rate.

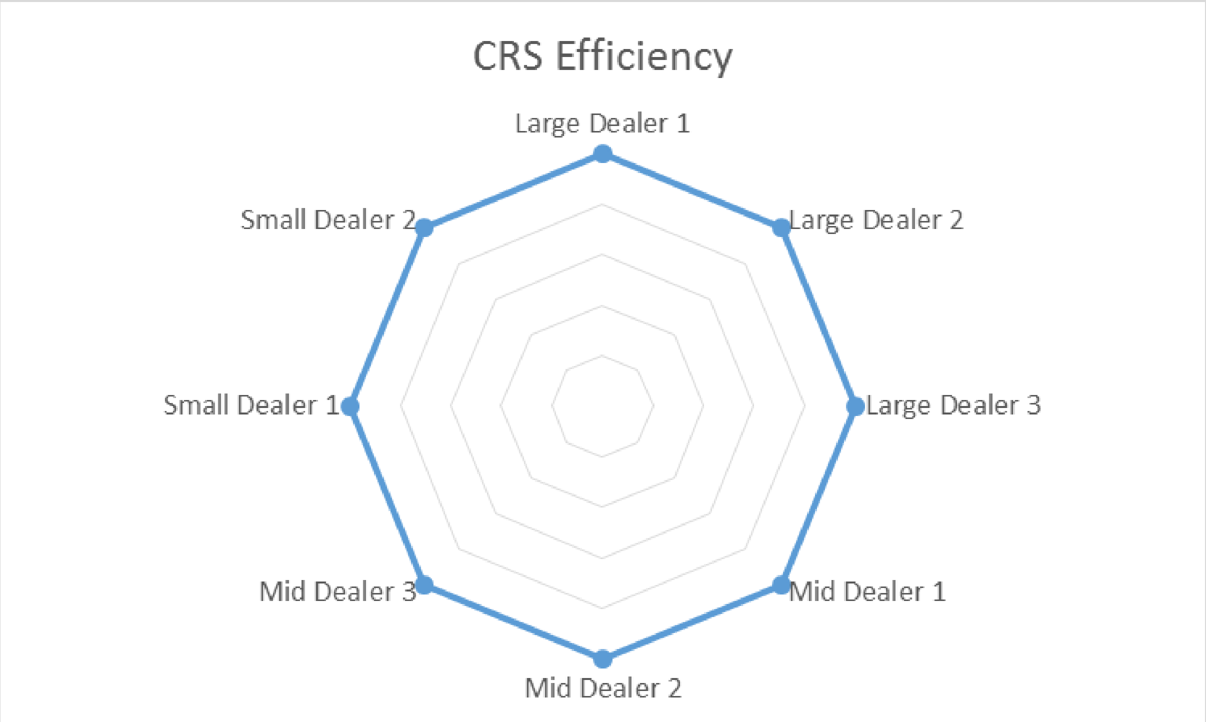
Small Dealer 1 is the least efficient dealer. It uses similar input level as other dealers, but it produces less than others. For example, Small Dealer 2 uses less input than Small Dealer 1, but its output performance is better than the performance of Small Dealer 1.

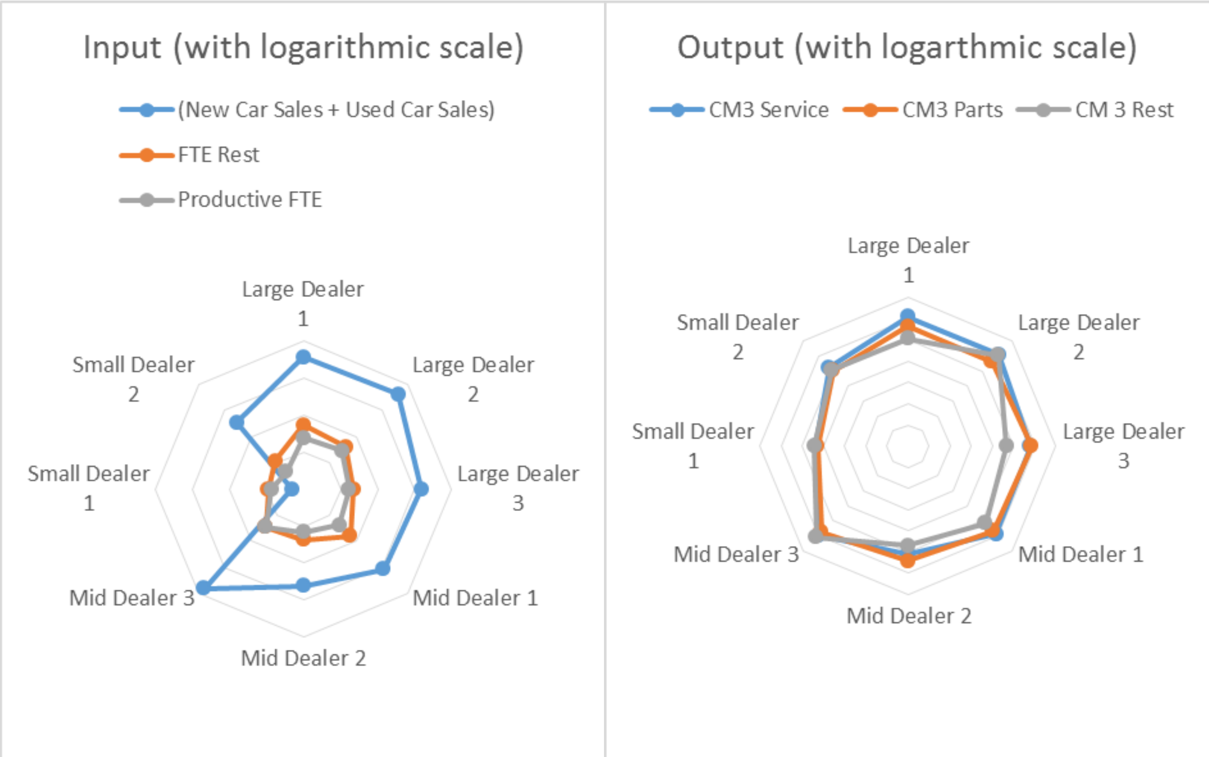
Appendix 11 – DEA Trial 1.8

Inputs	Outputs
(New Car Sales + Used Car Sales)	CM3 Service
FTE Sales & Other Businesses	CM3 Parts
Productive FTE	CM 3 Sales & Other Businesses

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks	
1	Large Dealer 1	1,00000	1,000	Large Dealer 1
2	Large Dealer 2	1,00000	1,000	Large Dealer 2
3	Large Dealer 3	1,00000	1,000	Large Dealer 3
4	Mid Dealer 1	1,00000	1,000	Mid Dealer 1
5	Mid Dealer 2	1,00000	1,000	Mid Dealer 2
6	Mid Dealer 3	1,00000	1,000	Mid Dealer 3
7	Small Dealer 1	1,00000	1,000	Small Dealer 1
8	Small Dealer 2	1,00000	1,000	Small Dealer 2

For the New Car Sales plus Used Car Sales, FTE Sales & Other Businesses, Productive FTE inputs and profitability KPIs expressed by CM 3 Service, CM 3 Parts and CM 3 Sales & Other Businesses outputs all dealers are efficient.





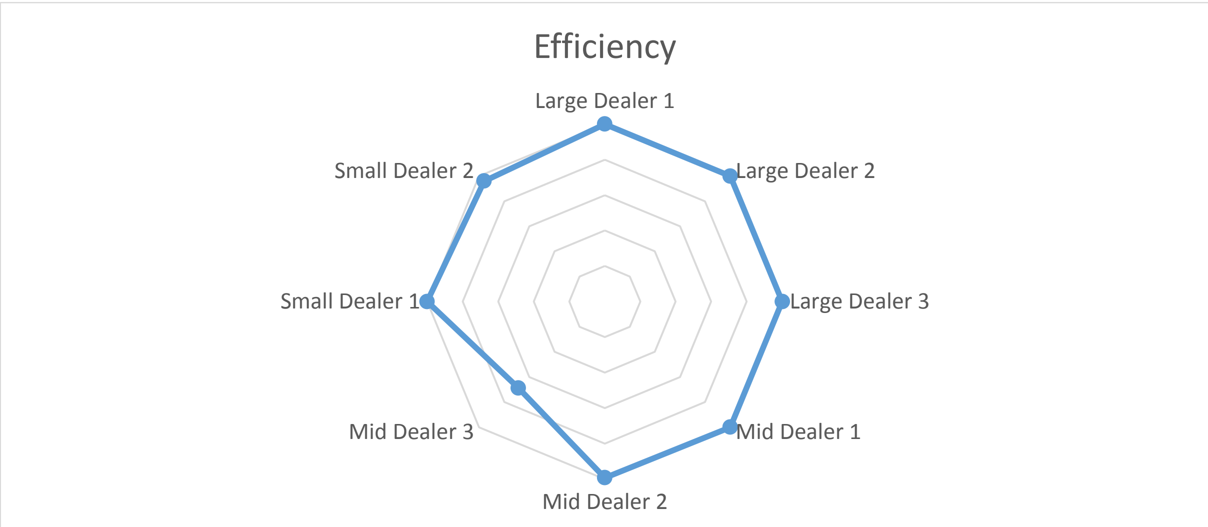
Dominant dealer is Small Dealer 1. They use less input than others but their output level is relatively high. As mentioned before the business does not have a sales contract so the efficiency is provided by the After Sales function.

Appendix 11 – DEA Trial 1.9

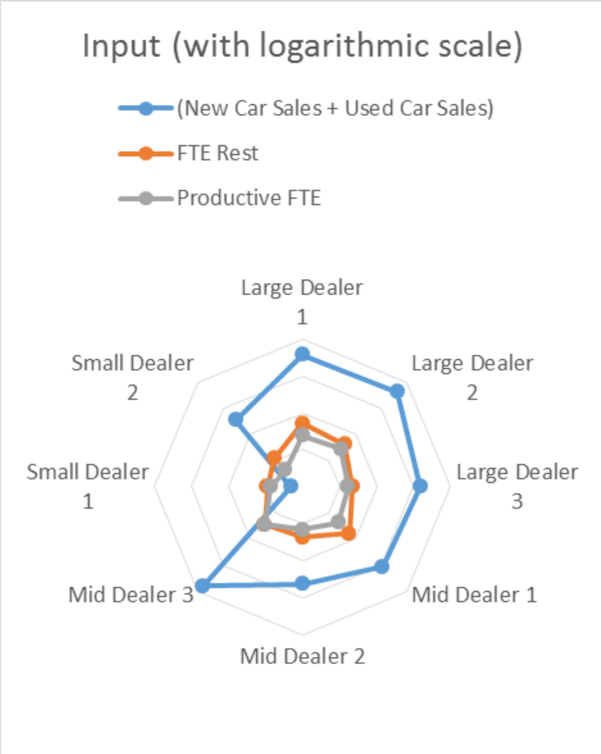
Inputs	Outputs
(New Car Sales + Used Car Sales)	Revenue Service
FTE Sales & Other Businesses	Revenue Parts
Productive FTE	Revenue Sales & Other Businesses

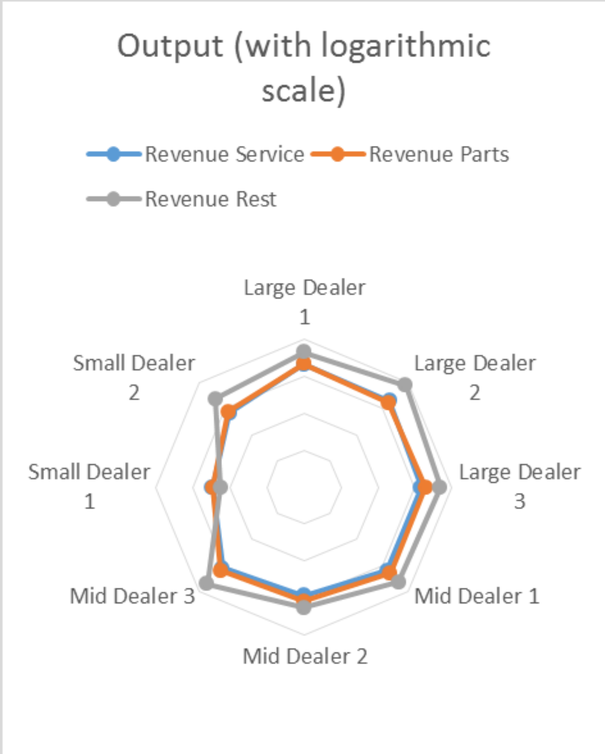
DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	1,00000	1,000	Large Dealer 1		
2	Large Dealer 2	1,00000	1,000	Large Dealer 2		
3	Large Dealer 3	1,00000	1,000	Large Dealer 3		
4	Mid Dealer 1	1,00000	1,000	Mid Dealer 1		
5	Mid Dealer 2	0,99219	0,363	Mid Dealer 1	0,069	Small Dealer 1
6	Mid Dealer 3	0,68750	1,000	Mid Dealer 3		
7	Small Dealer 1	1,00000	1,000	Small Dealer 1		
8	Small Dealer 2	0,96073	0,223	Large Dealer 3	0,035	Small Dealer 1

The efficient dealers for the New Car Sales + Used Car Sales, FTE Sales and Other Businesses, Productive FTE inputs and Revenue Service, Revenue Parts and Revenue Sales & Other Businesses outputs are Large Dealer 1, Large Dealer 2, Large Dealer 3, Mid Dealer 1 and Small Dealer 1.



We see that even though Mid Dealer 2 and Small Dealer 2 are not efficient, their efficiency rates are close to 1.





Dominant dealer is Small Dealer 1. Even though they use very little input from the new car sales and used car sales. Their output performance is still very good.

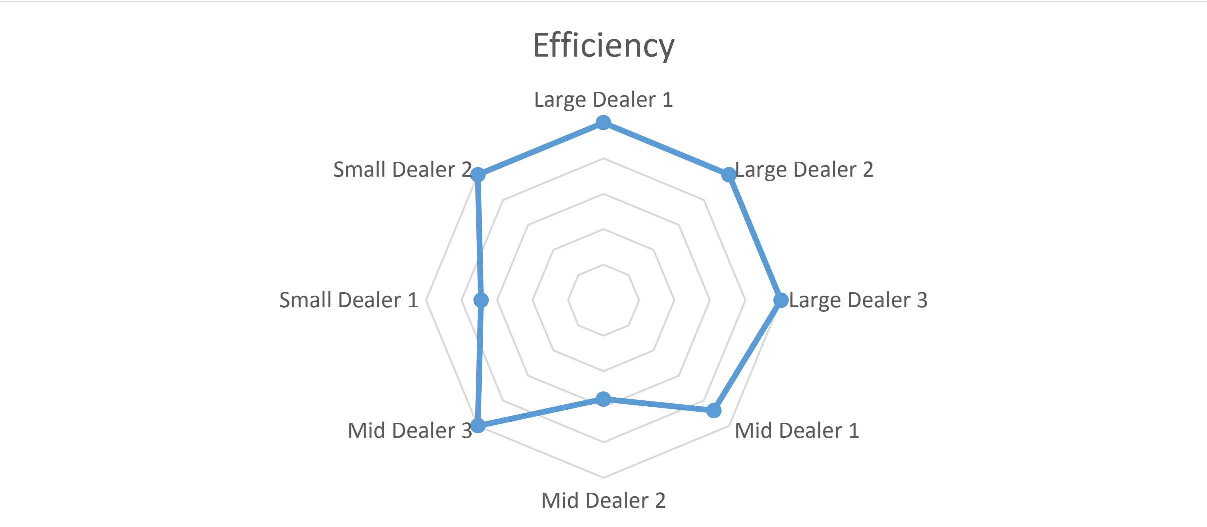
Although Mid Dealer 3 is predominant in many comparisons in this case by taking this combination of inputs and outputs he is surprisingly the worst performer. Their input level of New Car Sales plus Used Car Sales is the highest one comparable to LD3 who spends significantly less input. On the other hand their output level is comparable to other dealers, for example Mid Dealer 1 has similar output performance level, but they use significantly less New Car Sales plus Used Car Sales.

Appendix 11 – DEA Trial 1.10

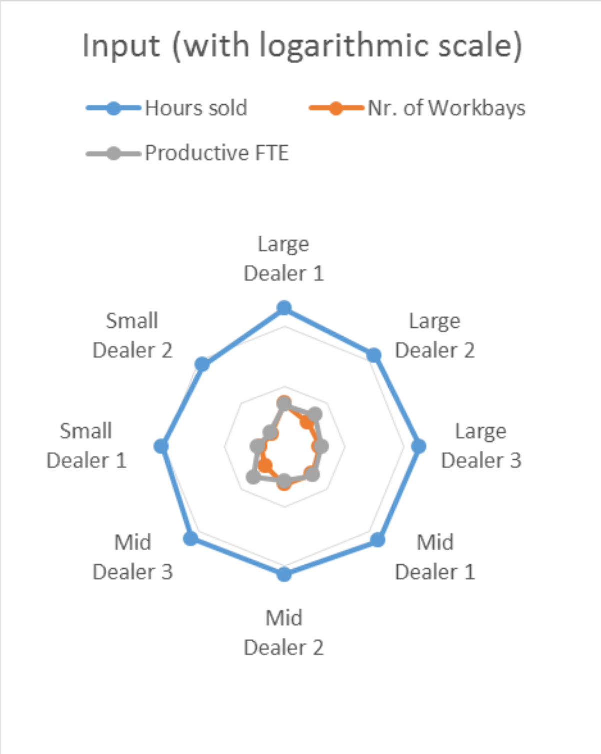
Inputs	Outputs
Hours sold	(CM3 Service + CM3 Parts)
Nr. of Work bays	(Revenue Service + Revenue Parts)
Productive FTE	CSS Overall Satisfaction

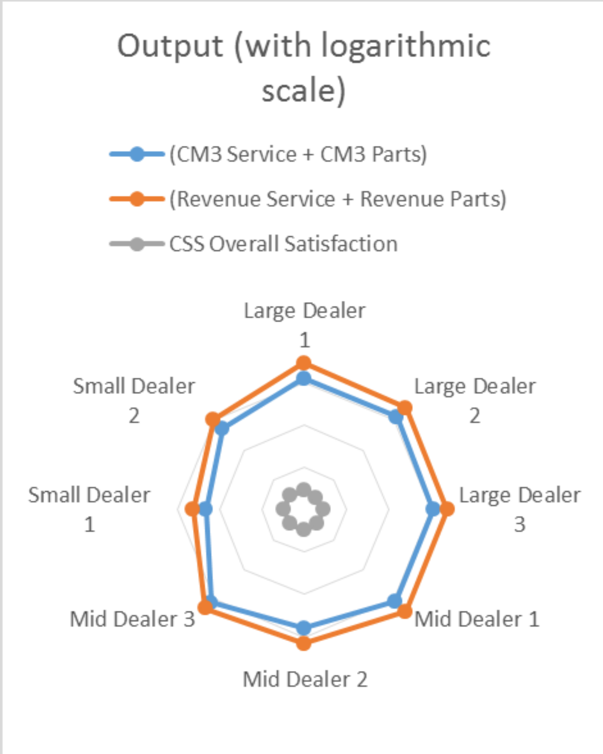
DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks		
1	Large Dealer 1	1.00000	Large Dealer 1		
2	Large Dealer 2	1.00000	Large Dealer 2		
3	Large Dealer 3	1.00000	Large Dealer 3		
4	Mid Dealer 1	0.87869	Large Dealer 1	0.257	Large Dealer 2
5	Mid Dealer 2	0.55658	Large Dealer 1	0.073	Large Dealer 2
6	Mid Dealer 3	1.00000	Mid Dealer 3		
7	Small Dealer 1	0.68889	Small Dealer 2		
8	Small Dealer 2	1.00000	Small Dealer 2		

The efficient dealers for the Hours sold, Nr. of Work bays, Productive FTE inputs and CM3 Service + CM3 Parts, Revenue Service + Revenue Parts and CSS Overall Satisfaction outputs are Large Dealer 1, Large Dealer 2, Large Dealer 3, Mid Dealer 3 and Small Dealer 2.



The least efficient dealer is Mid Dealer 2. Mid Dealer 1 is not efficient but their efficiency rate is quite high.





Dominant dealers are Large Dealer 2 and Mid Dealer 3. Large Dealer 2 uses less input than Large Dealer 1 and Large Dealer 3 to achieve similar output level as them. Same is true for Mid Dealer 3, although they use little more input than LD2 they also produce higher level of output CM3 Service + CM3 Parts. Mid Dealer 3 is efficient although his hourly rates are the lowest compared to all other dealerships.

The least efficient dealer is Mid Dealer 2. They use similar input level as Large Dealer 2, but their output CM3 Service + CM3 Parts is smaller.

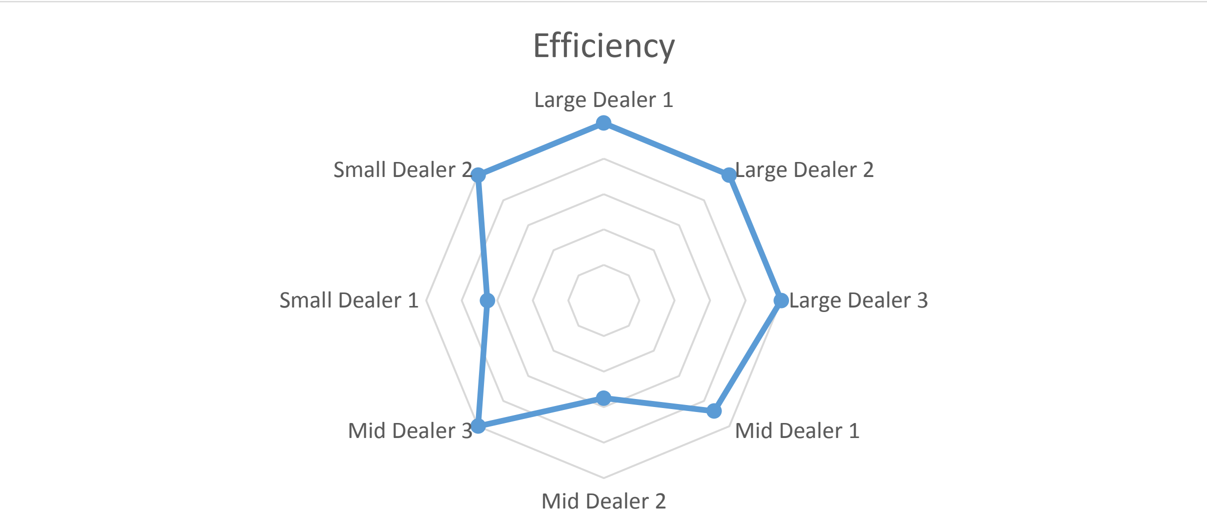
Appendix 11 – DEA Trial 1.11

Inputs	Outputs
Hours sold	(CM3 Service + CM3 Parts)
Nr. of Workbays	(Revenue Service + Revenue Parts)
Productive FTE	CSS Loyality

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks		
1	Large Dealer 1	1.00000	Large Dealer 1		
2	Large Dealer 2	1.00000	Large Dealer 2		
3	Large Dealer 3	1.00000	Large Dealer 3		
4	Mid Dealer 1	0.88020	Large Dealer 1	0.257	Large Dealer 2
5	Mid Dealer 2	0.54921	Large Dealer 1	0.072	Large Dealer 2
6	Mid Dealer 3	1.00000	Mid Dealer 3		
7	Small Dealer 1	0.65476	Small Dealer 2		
8	Small Dealer 2	1.00000	Small Dealer 2		

The KPI combination used as input vs. output is very similar to trial 10 except the fact that CSS Overall satisfaction KPI was replaced with the loyalty KPI. The results are also similar to the DEA done in trial ten.

The efficient dealers for the Hours sold, Nr. of Work bays, Productive FTE inputs and CM3 Service + CM3 Parts, Revenue Service + Revenue Parts and CSS Loyalty outputs are Large Dealer 1, Large Dealer 2, Large Dealer 3, Mid Dealer 3 and Small Dealer 2.

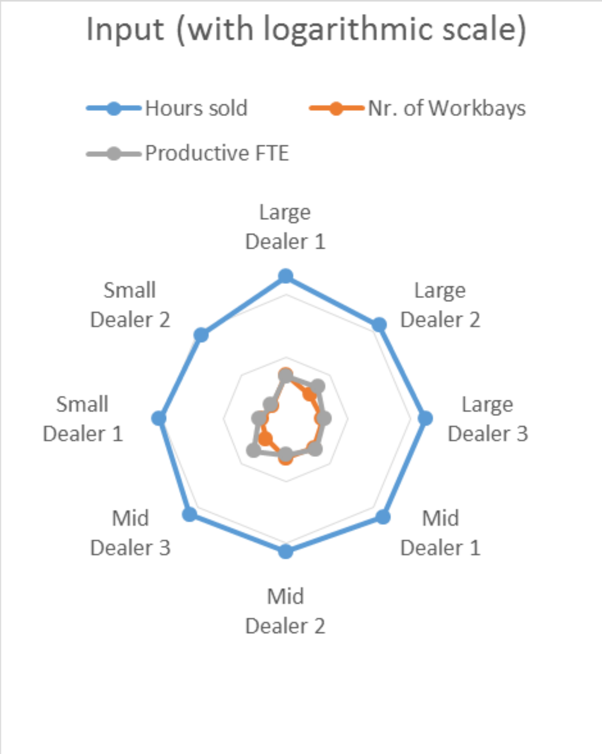


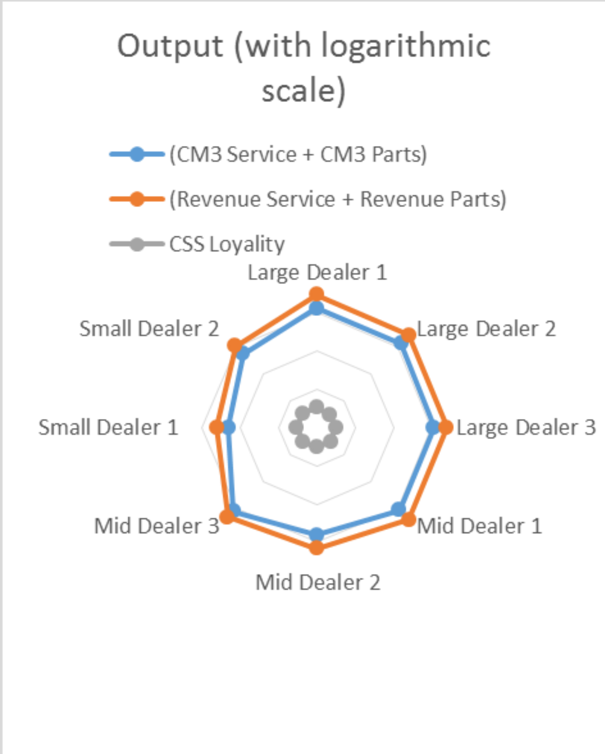
Although Mid Dealer 1 is not efficient, its efficiency rate is quite high. The least efficient dealer is Mid Dealer 2.

Dominant dealer is Small Dealer 2. Among all efficient dealers, we see that their output level is similar. But Small Dealer 2 is the one who uses the least amount of input to achieve it.

Their input level is similar to the input level of Small Dealer 1, who is not efficient, but their output level is as high as others efficient dealers.

Mid Dealer 2 is the least efficient dealer, since they use similar input as Large Dealer 2 but its output CM3 Service + CM3 Parts is low.



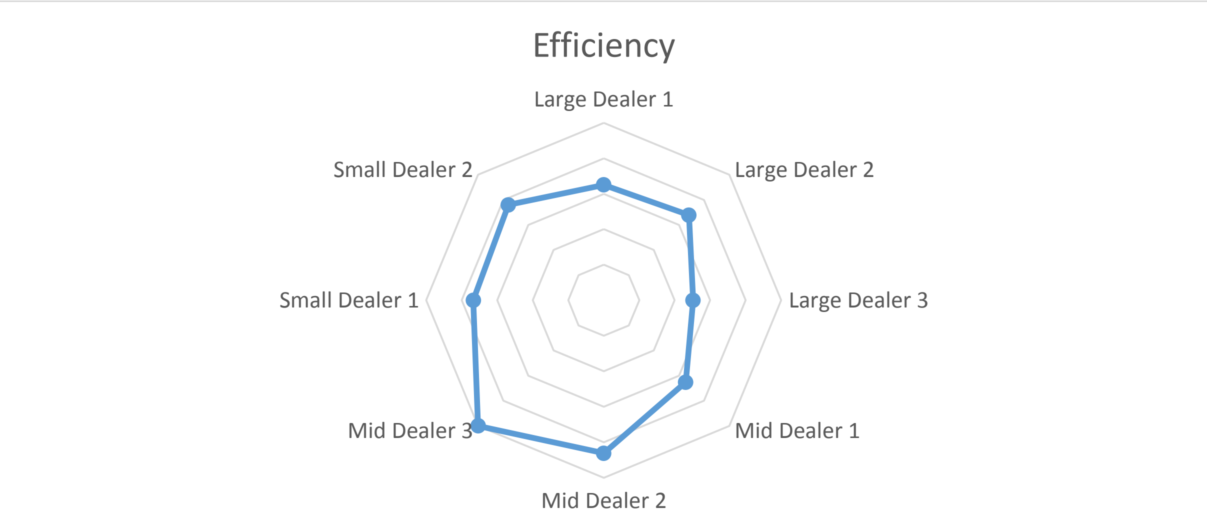


Appendix 11 – DEA Trial 1.12

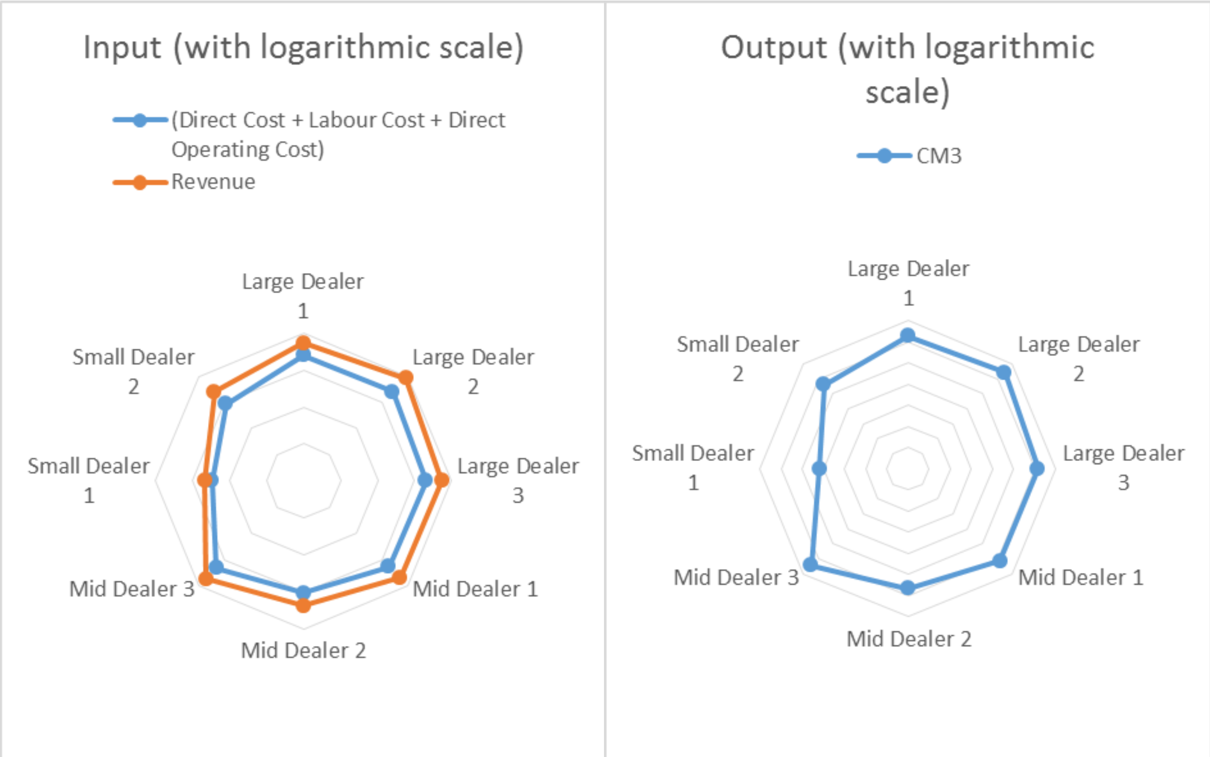
Inputs	Outputs
Revenue	CM3
(Direct Costs + Labor Costs + Direct Operating Costs)	

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks	
1	Large Dealer 1	0.65052	0.646	Mid Dealer 3
2	Large Dealer 2	0.67804	0.998	Mid Dealer 3
3	Large Dealer 3	0.50296	0.484	Mid Dealer 3
4	Mid Dealer 1	0.65261	0.509	Mid Dealer 3
5	Mid Dealer 2	0.86144	0.160	Mid Dealer 3
6	Mid Dealer 3	1.00000	1.000	Mid Dealer 3
7	Small Dealer 1	0.73404	0.005	Mid Dealer 3
8	Small Dealer 2	0.75964	0.142	Mid Dealer 3

The efficient dealer for the Revenue, Direct Costs + Labor Costs + Direct Operating Costs, inputs and CM3 outputs is Mid Dealer 3.



In the chart above, we can see that efficiency rates for most of the dealers are similar. The only one who standout is Mid Dealer 3, which is the only one efficient. Also, Mid Dealer 2 has higher efficiency rate than other inefficient dealers and Large Dealer 3, whose efficiency rate is low.



Mid Dealer 3 is the only efficient dealer. This is why it is also a dominant dealer. Its output level is similar to the output level of Large Dealer 2, but they use less input to achieve it. Mid Dealer 3 has good cost management and the advantage that in that region the staff salary is attractive for entrepreneurs.

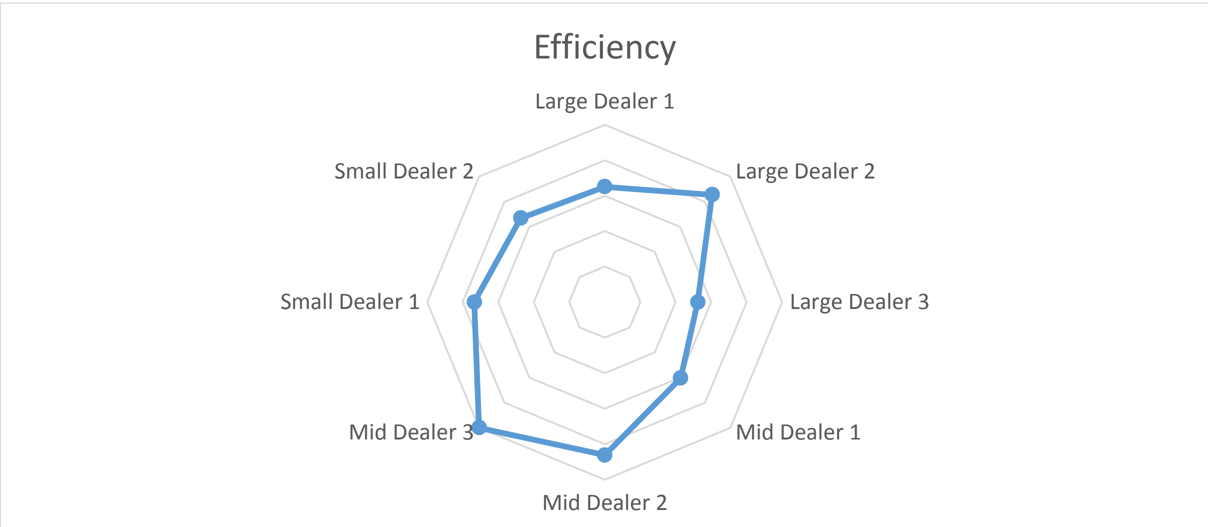
On the other hand, Large Dealer 3 has the worst efficient rate. They use too many input to achieve their output level. If we compare it to Mid Dealer 3, we see that Mid Dealer 3 uses similar inputs but have better output.

Appendix 11 – DEA Trial 1.13

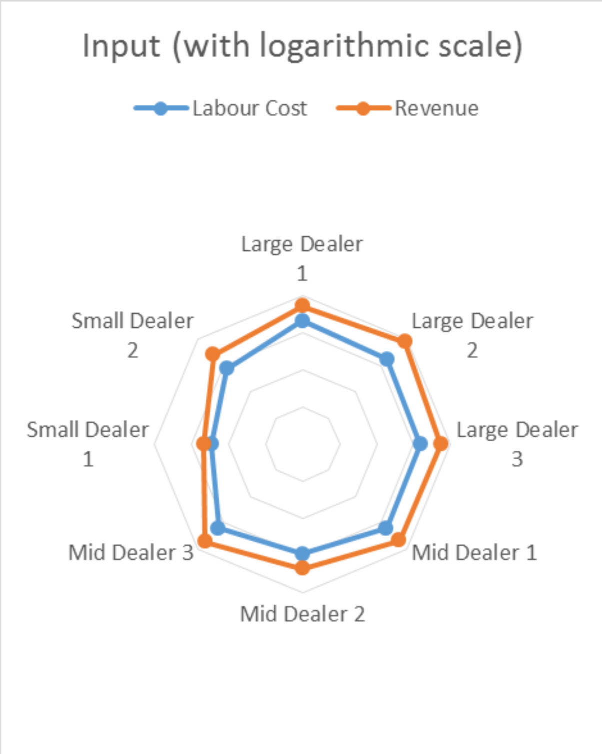
Inputs	Outputs
Revenue	CM3
Labor Costs	

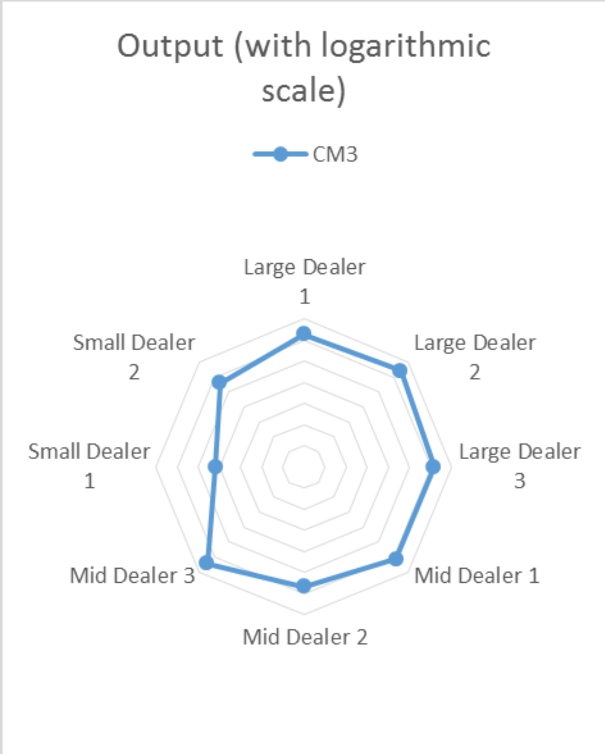
DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks	
1	Large Dealer 1	0.65052	0.646	Mid Dealer 3
2	Large Dealer 2	0.85525	0.998	Mid Dealer 3
3	Large Dealer 3	0.52363	0.484	Mid Dealer 3
4	Mid Dealer 1	0.60474	0.509	Mid Dealer 3
5	Mid Dealer 2	0.86144	0.160	Mid Dealer 3
6	Mid Dealer 3	1.00000	1.000	Mid Dealer 3
7	Small Dealer 1	0.73404	0.005	Mid Dealer 3
8	Small Dealer 2	0.66929	0.142	Mid Dealer 3

The efficient dealer for the Revenue, Labor Costs inputs and CM3 outputs is Mid Dealer 3. This was expected because labor costs is the highest value in terms of costs in a developed country as Germany. Since Mid Dealer 3 was the most efficient in terms of total costs, he also the most efficient in terms of labor costs all other input vs. output KPI remaining unchanged as in the trial number twelve.



Large Dealer 2 and Mid Dealer 2 are not efficient but their efficiency rate is relatively high.





Mid Dealer 3 is the only efficient dealer, which makes it also a dominant dealer. Its output level is the highest, while their input is similar to the output level of Large Dealer 1, Large Dealer 2, Large Dealer 3, and Mid Dealer 1.

Large Dealer 3 has the worst performance. It uses similar amounts of input as Mid Dealer 3, but it produces less output.

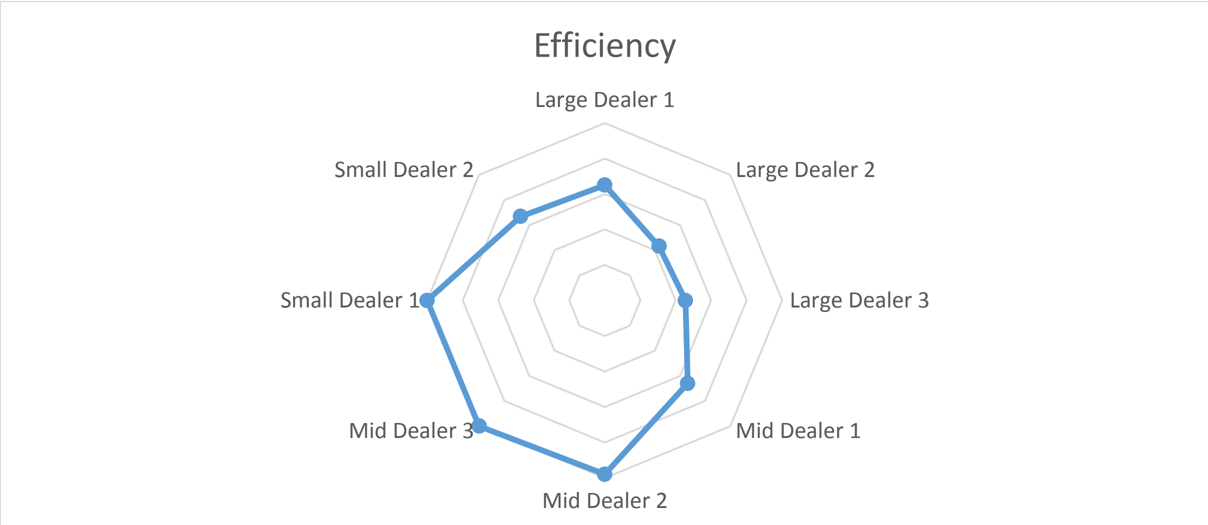
Same applies for Large Dealer 1 and Large Dealer 2, but they still produce more output than Large Dealer 3. Therefore they also have higher efficiency rates than Large Dealer 3.

Appendix 11 – DEA Trial 1.14

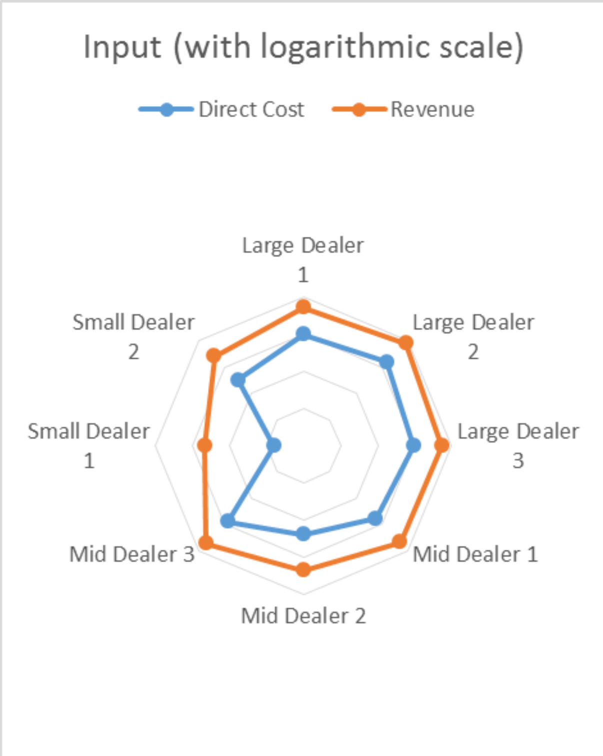
Inputs	Outputs
Revenue	CM3
Direct Costs	

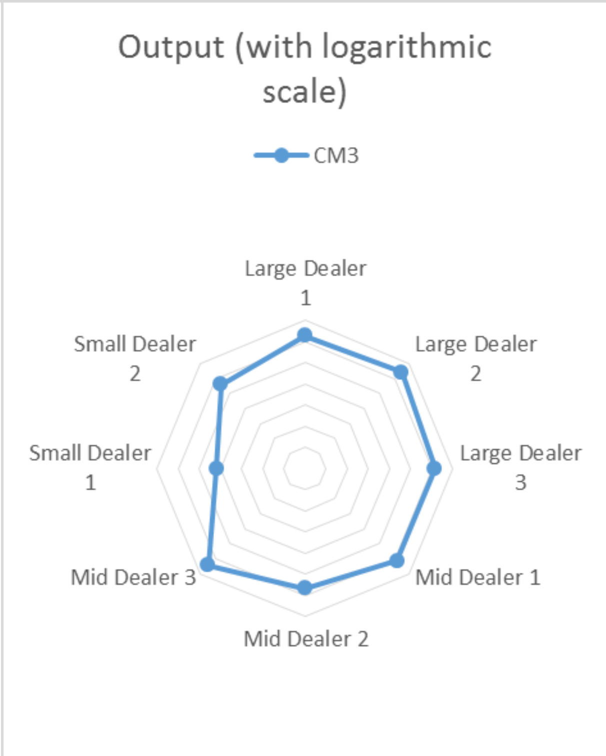
DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	0.65052	0.646	Mid Dealer 3		
2	Large Dealer 2	0.43262	0.998	Mid Dealer 3		
3	Large Dealer 3	0.45469	0.484	Mid Dealer 3		
4	Mid Dealer 1	0.66012	0.380	Mid Dealer 3	24.297	Small Dealer 1
5	Mid Dealer 2	0.97914	0.100	Mid Dealer 3	11.403	Small Dealer 1
6	Mid Dealer 3	1.00000	1.000	Mid Dealer 3		
7	Small Dealer 1	1.00000	1.000	Small Dealer 1		
8	Small Dealer 2	0.66996	0.112	Mid Dealer 3	5.670	Small Dealer 1

The efficient dealers for the Revenue, Direct Costs inputs and CM3 outputs are Mid Dealer 3 and Small Dealer 1.



In the chart above we see that Mid Dealer 2 efficiency rate close to 1, even though it is not efficient. All others have lower efficiency rates, especially Large Dealer 2 and Large Dealer 3.





Dominant dealer is Small Dealer 1. They use small amount of inputs to achieve relatively high level of output.

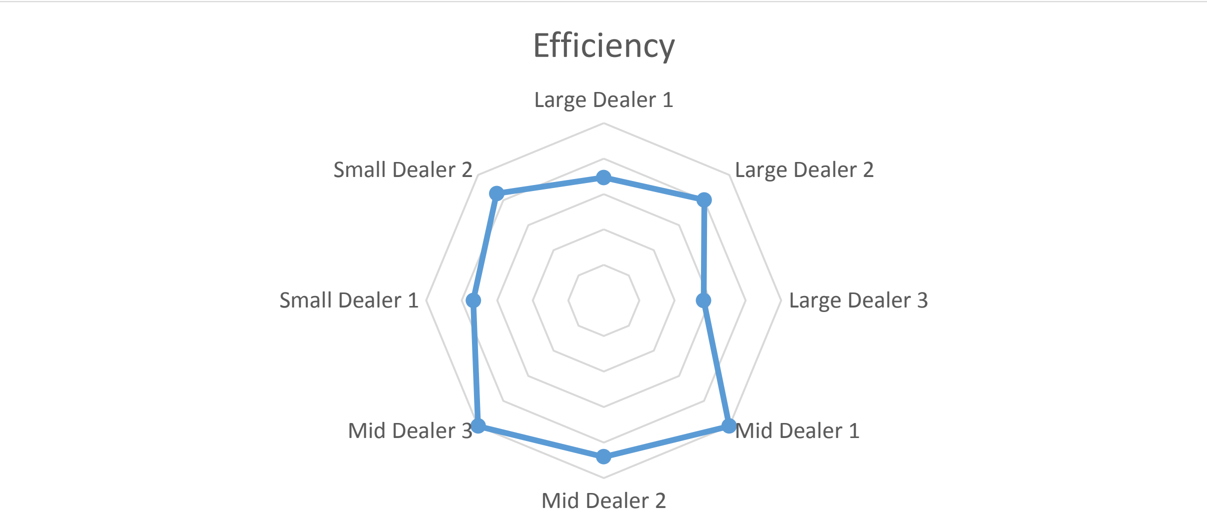
We also see why Large Dealer 2 and Large Dealer 3 have the lowest efficiency rates. Their inputs are higher than other while their outputs are similar to others. This result is consistent due to the fact that large dealers in general have the highest investments and as a consequence also the higher direct costs.

Appendix 11 – DEA Trial 1.15

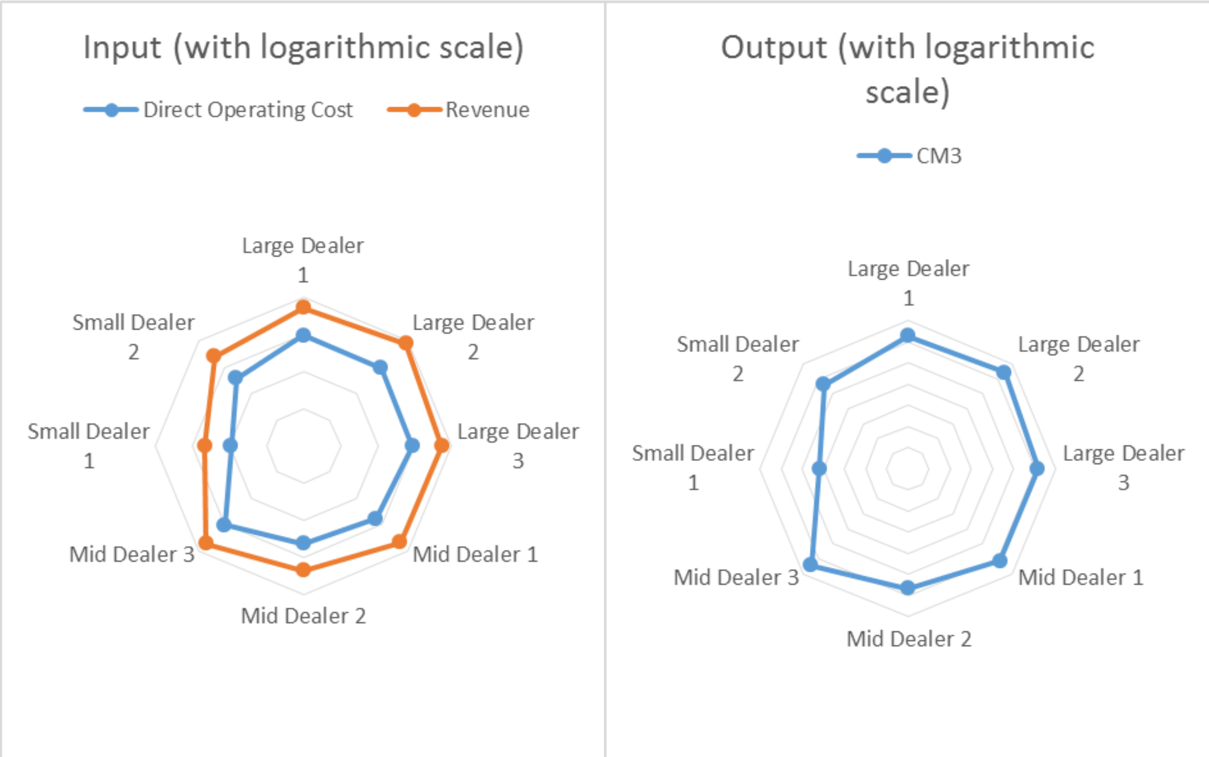
Inputs	Outputs
Revenue	CM3
Direct Operating Costs	

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	0.69281	0.126	Mid Dealer 1	0.582	Mid Dealer 3
2	Large Dealer 2	0.80119	1.963	Mid Dealer 1		
3	Large Dealer 3	0.56301	0.347	Mid Dealer 1	0.307	Mid Dealer 3
4	Mid Dealer 1	1.00000	1.000	Mid Dealer 1		
5	Mid Dealer 2	0.88074	0.011	Mid Dealer 1	0.155	Mid Dealer 3
6	Mid Dealer 3	1.00000	1.000	Mid Dealer 3		
7	Small Dealer 1	0.73404	0.005	Mid Dealer 3		
8	Small Dealer 2	0.85233	0.158	Mid Dealer 1	0.061	Mid Dealer 3

The efficient dealers for the Revenue, Direct Operating Costs inputs and CM3 outputs are Mid Dealer 1 and Mid Dealer 3.



We see that in this case all the dealers have quite efficiency rates between 0.7 and 0.9 rounded numbers. The lowest efficiency rate has Large Dealer 3.



In this case, Mid Dealer 1 and Mid Dealer 3 are both dominant dealers. Mid Dealer 3 uses more input than Mid Dealer 1, but also has higher output level.

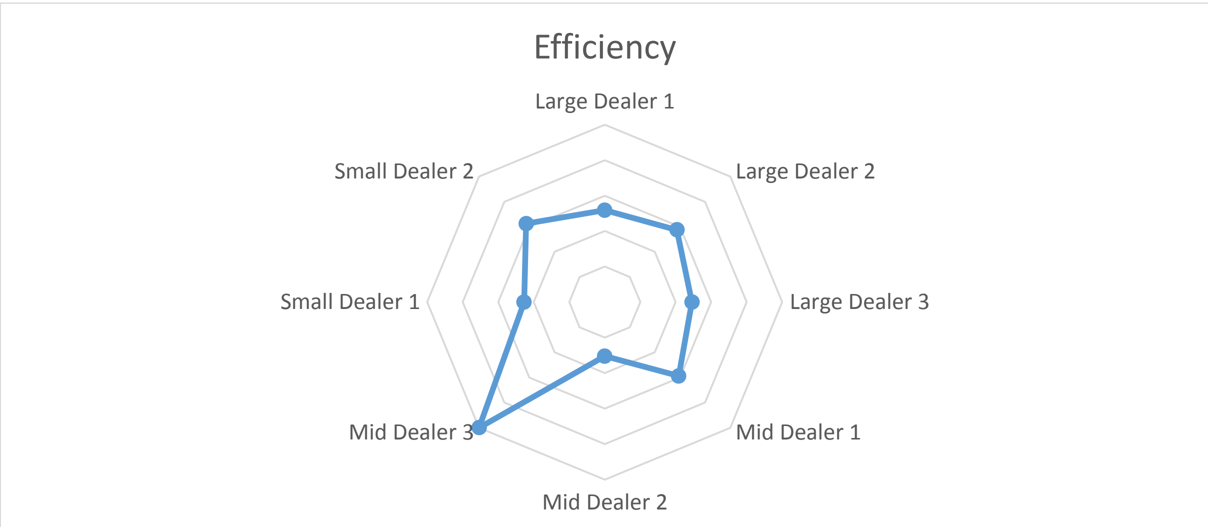
Large Dealer 3 uses similar inputs as Mid Dealer 3, but their output level is lower. This is why it is not efficient. We can observe similar for others. Mid Dealer 2 uses less input than Mid Dealer 1, but their output is also lower. Similar conclusions can be made for Small Dealer 1 and Small Dealer 2.

Appendix 11 – DEA Trial 1.16

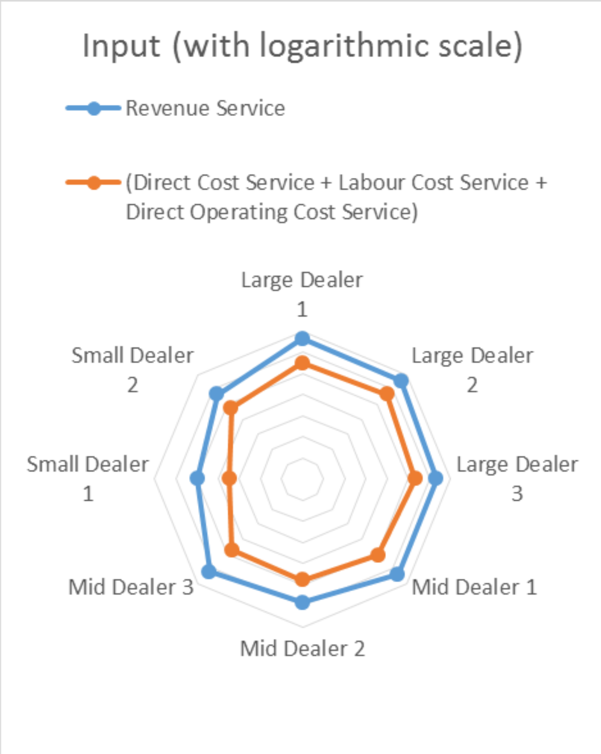
Inputs	Outputs
Revenue Service	CM3 Service
(Direct Costs Service + Labour Costs Service + Direct Operating Costs Service)	

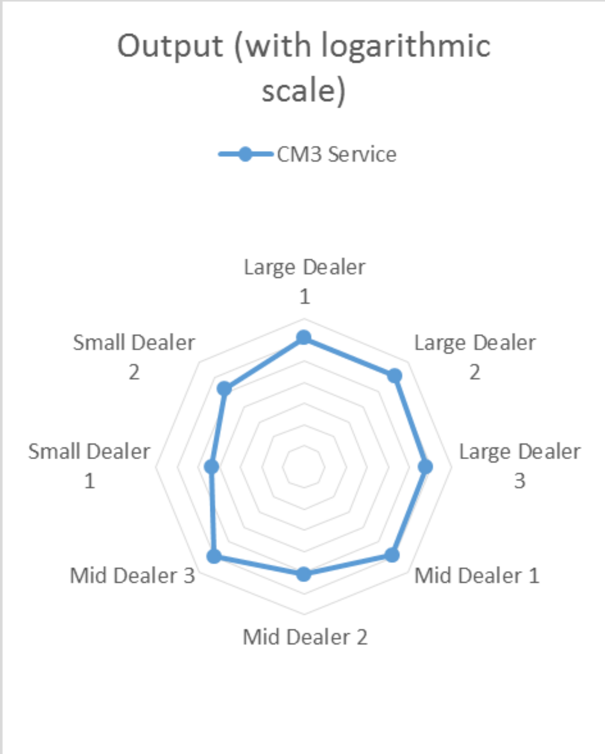
DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks	
1	Large Dealer 1	0.51769	1.361	Mid Dealer 3
2	Large Dealer 2	0.57521	1.360	Mid Dealer 3
3	Large Dealer 3	0.49125	0.660	Mid Dealer 3
4	Mid Dealer 1	0.58909	0.861	Mid Dealer 3
5	Mid Dealer 2	0.30471	0.134	Mid Dealer 3
6	Mid Dealer 3	1.00000	1.000	Mid Dealer 3
7	Small Dealer 1	0.45405	0.024	Mid Dealer 3
8	Small Dealer 2	0.62492	0.188	Mid Dealer 3

The efficient dealer for the Revenue Service, Direct Costs Service + Labor Costs Service + Direct Operating Costs Service inputs and CM3 Service outputs is Mid Dealer 3.



Dealer with the lowest efficiency rate is Mid Dealer 2.





Mid Dealer 3 is the only efficient dealer. Therefore, it is also a dominant dealer. To achieve the output level, which is similar to output level of Large Dealer 1, Large Dealer 2 and Mid Dealer 1, they use less inputs as them.

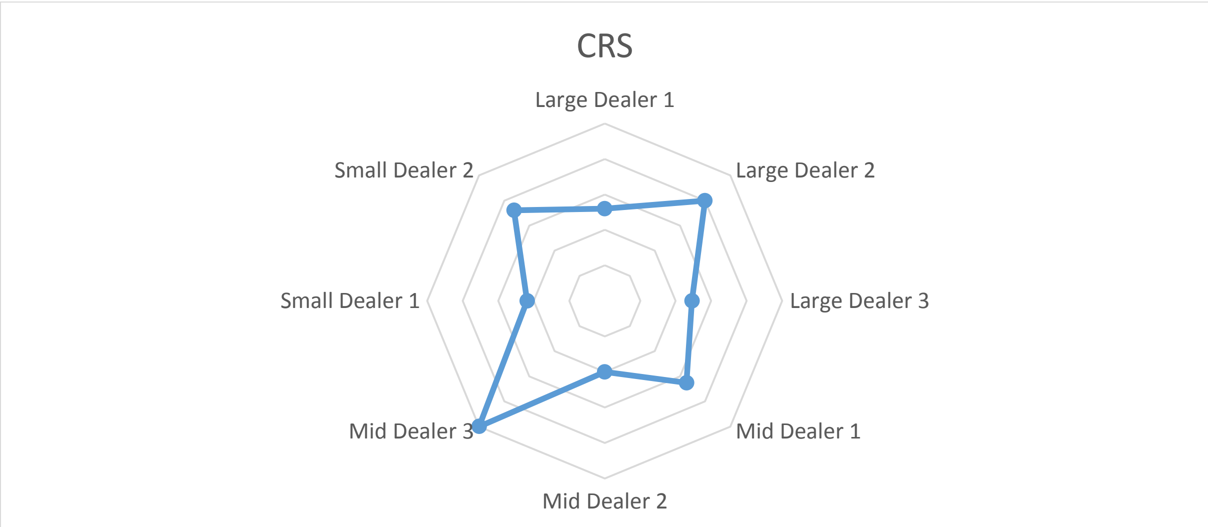
Mid Dealer 2 is performing the worst. They use similar inputs as Mid Dealer 3, but their output is among the lowest.

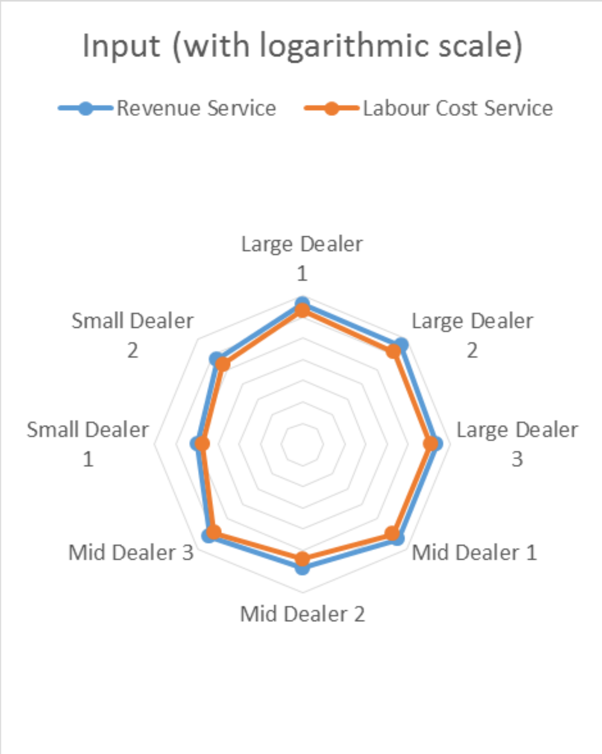
Appendix 11 – DEA Trial 1.17

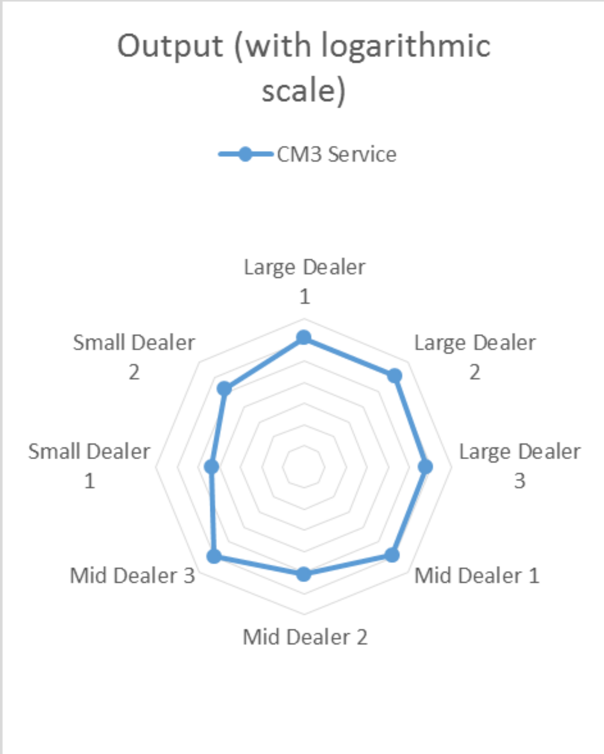
Inputs	Outputs
Revenue Service	CM3 Service
Labor Costs Service	

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks	
1	Large Dealer 1	0,51983	1,361	Mid Dealer 3
2	Large Dealer 2	0,79804	1,360	Mid Dealer 3
3	Large Dealer 3	0,49125	0,660	Mid Dealer 3
4	Mid Dealer 1	0,65206	0,861	Mid Dealer 3
5	Mid Dealer 2	0,39969	0,134	Mid Dealer 3
6	Mid Dealer 3	1,00000	1,000	Mid Dealer 3
7	Small Dealer 1	0,43659	0,024	Mid Dealer 3
8	Small Dealer 2	0,72224	0,188	Mid Dealer 3

The efficient dealer for the Revenue Service, Labor Costs Service inputs and CM3 Service outputs is Mid Dealer 3. Mid Dealer 2 has the lowest efficiency rate. This is consistent with the results from trial 16 due to the fact that in Germany, a developed country, labor costs is the highest cost position.







Since Mid Dealer 3 is the only efficient dealer it is also a dominant one. From the charts above it is hard to see why since their output and input levels are similar so Large Dealer 1, Large Dealer 2, Large Dealer 3 and Mid Dealer 1. But if we look at the original data, which is not in logarithmic scale, we see that they indeed use less input than Large Dealer 1 and Large Dealer 2 and similar input as Large Dealer 3 and Mid Dealer 1 but they have higher outputs than Large Dealer 3 and Mid Dealer 1.

Mid Dealer 2 has the lowest efficiency rate because their output level is too low. They use similar input as Mid Dealer 3 but have much less output as Mid Dealer 3.

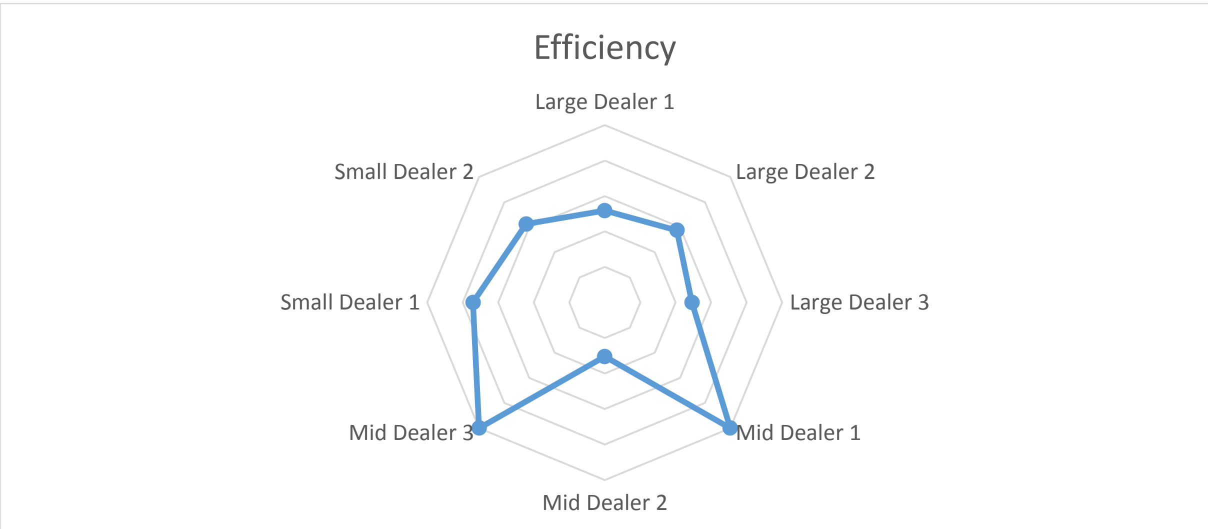
Consistency between input and output levels can be observed at Small Dealer 1.

Appendix 11 – DEA Trial 1.18

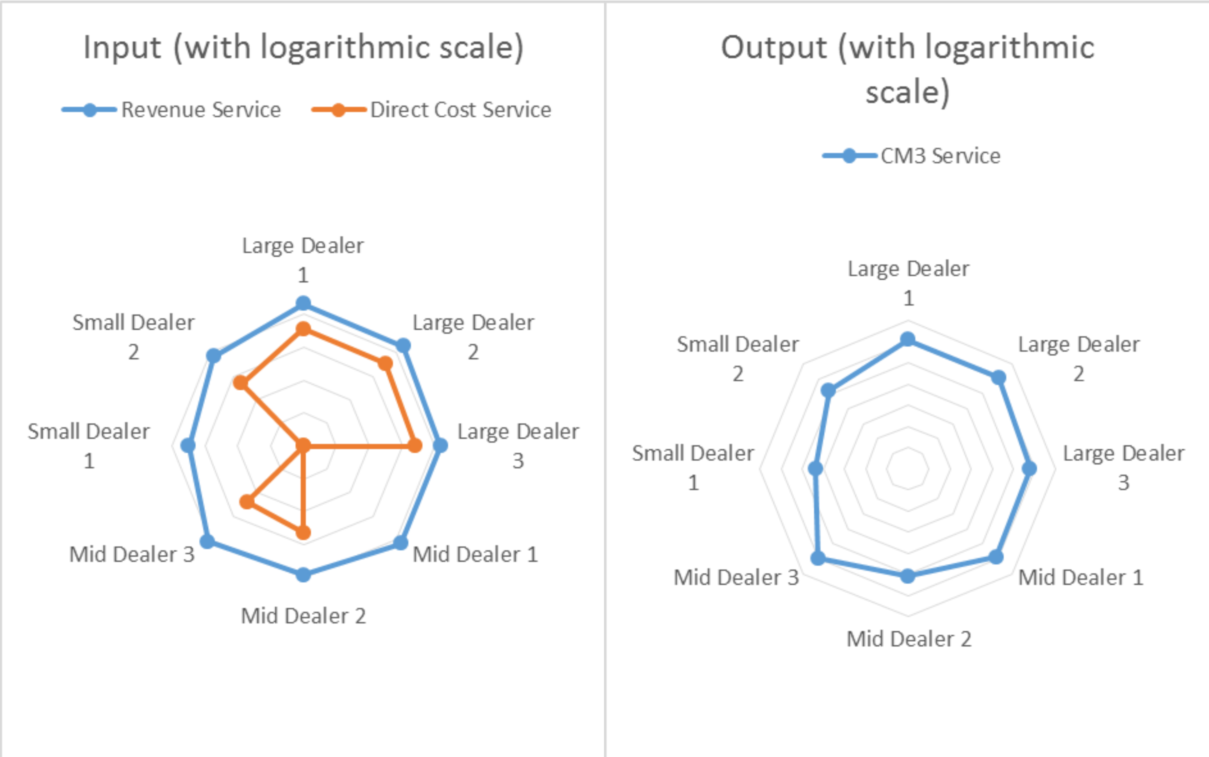
Inputs	Outputs
Revenue Service	CM3 Service
Direct Costs Service	

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks	
1	Large Dealer 1	0,51769	1,361	Mid Dealer 3
2	Large Dealer 2	0,57521	1,360	Mid Dealer 3
3	Large Dealer 3	0,49125	0,660	Mid Dealer 3
4	Mid Dealer 1	1,00000	1,000	Mid Dealer 1
5	Mid Dealer 2	0,30471	0,134	Mid Dealer 3
6	Mid Dealer 3	1,00000	1,000	Mid Dealer 3
7	Small Dealer 1	0,74112	0,028	Mid Dealer 1
8	Small Dealer 2	0,62492	0,188	Mid Dealer 3

The efficient dealers for the Revenue Service, Direct Costs Service inputs and CM3 Service outputs are Mid Dealer 1 and Mid Dealer 3.



We see that Mid Dealer 2 has the lowest efficiency rate.



By solely analyzing the radar chart one can conclude that Mid Dealer 1 is a dominant dealer. The explanation is that the dealer does not have any direct costs service and still produce similar output as Mid Dealer 3 but, it might also be an accounting mistake at Mid Dealer 1 where cost positions are not correctly posted. Therefore, a more correct conclusion is that also Mid Dealer 3 is again a dominant dealer.

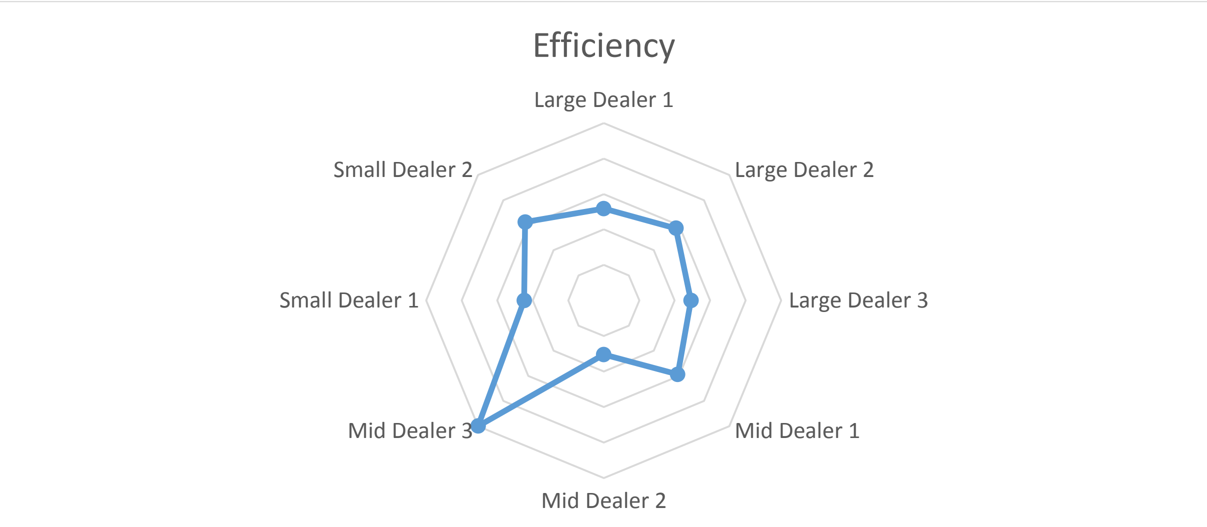
Mid Dealer 2 is performing the worst since they use high levels of inputs to produce low level of output. The overhead at Mid Dealer 2 is higher than at similar other businesses. They use similar amount of inputs as Mid Dealer 3 but their output is lower. Similar we see also for Small Dealer 2. Large Dealer 1 and Large Dealer 2 use too much input to be efficient. Their output is similar to Mid Dealer 1 and Mid Dealer 3 but their inputs are higher. Small Dealer 1 has output which is too low to be efficient.

Appendix 11 – DEA Trial 1.19

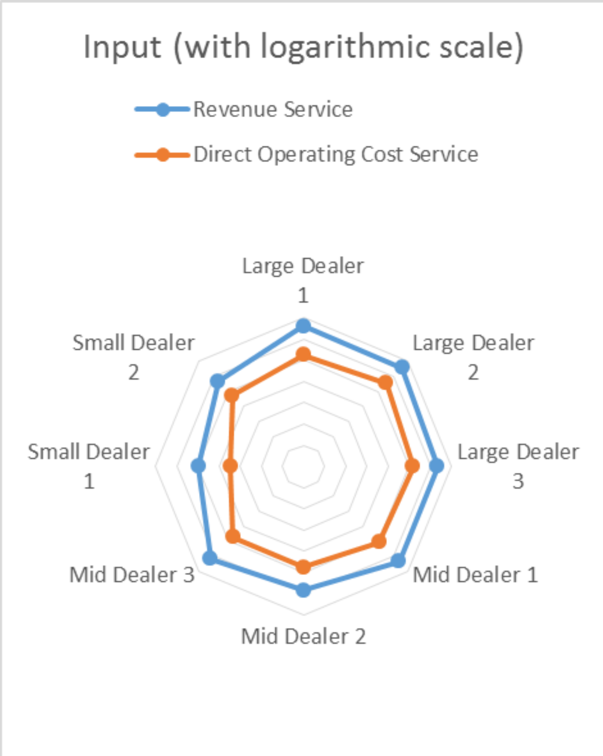
Inputs	Outputs
Revenue Service	CM3 Service
Direct Operating Costs Service	

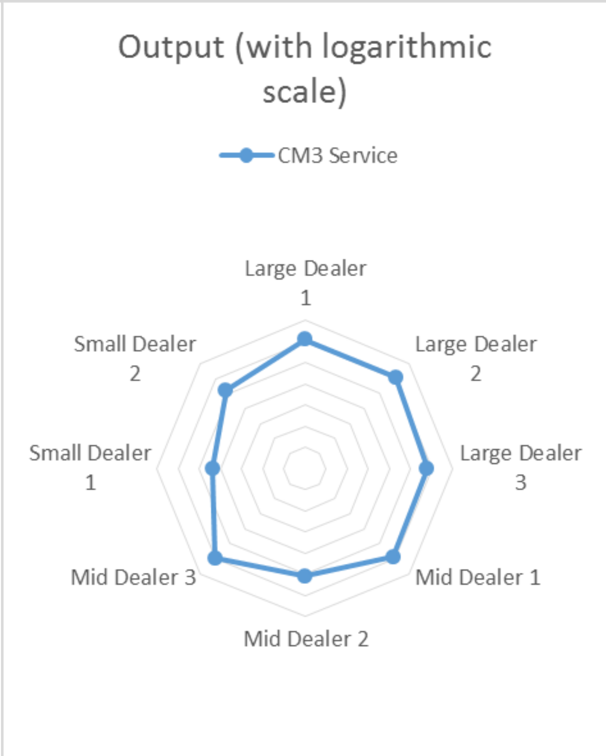
DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks	
1	Large Dealer 1	0,51769	1,361	Mid Dealer 3
2	Large Dealer 2	0,57521	1,360	Mid Dealer 3
3	Large Dealer 3	0,49125	0,660	Mid Dealer 3
4	Mid Dealer 1	0,58909	0,861	Mid Dealer 3
5	Mid Dealer 2	0,30471	0,134	Mid Dealer 3
6	Mid Dealer 3	1,00000	1,000	Mid Dealer 3
7	Small Dealer 1	0,44812	0,024	Mid Dealer 3
8	Small Dealer 2	0,62492	0,188	Mid Dealer 3

The efficient dealer for the Revenue Service, Direct Operating Costs Service inputs and CM3 Service outputs is Mid Dealer 3.



We see that Mid Dealer 2 has the lowest efficiency rate.





On the charts above we see why Mid Dealer 3 is the efficient dealer when compared to other dealers. They produce the highest amount of the output by using less input than other dealers who produce the same amount output. Also Mid Dealer 2, Small Dealer 1 and Small Dealer 2, who produce less output, have very high levels of inputs. This is why Mid Dealer 3 is the efficient dealer and also a dominant dealer.

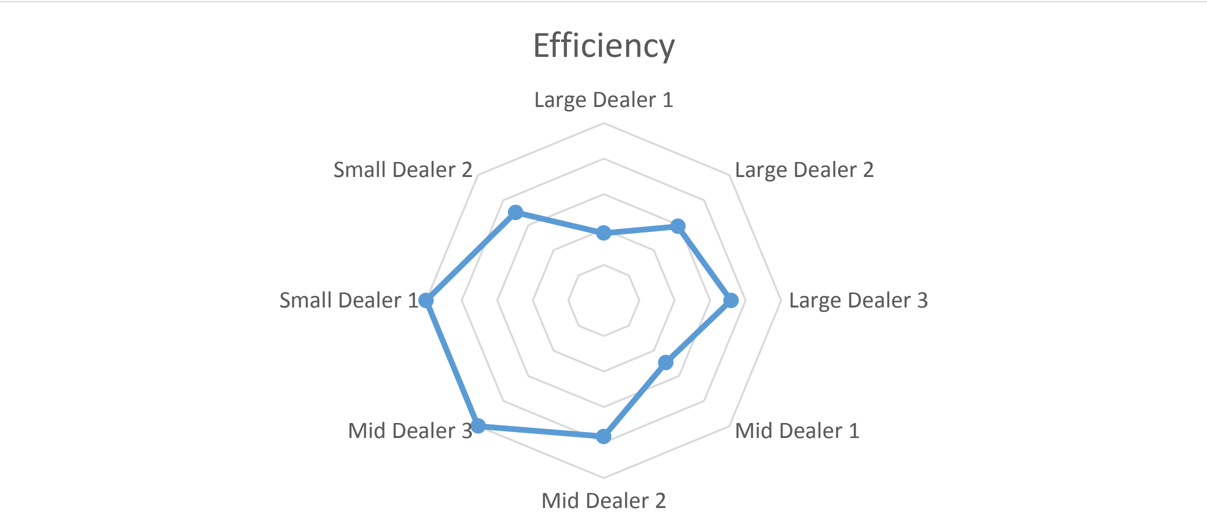
Mid Dealer 2 has the worst efficiency rate because it is the only dealer who uses inputs on the highest level to produce low output.

Appendix 11 – DEA Trial 1.20

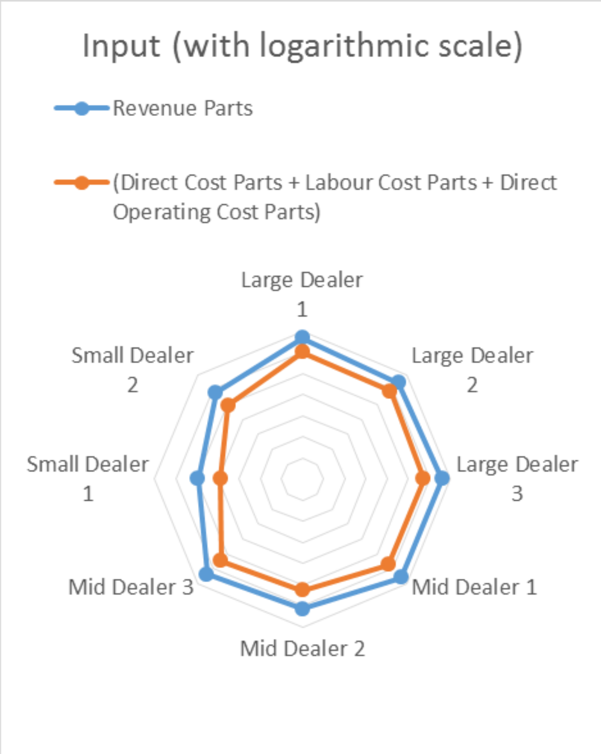
Inputs	Outputs
Revenue Parts	CM3 Parts
(Direct Costs Parts + Labor Costs Parts + Direct Operating Costs Parts)	

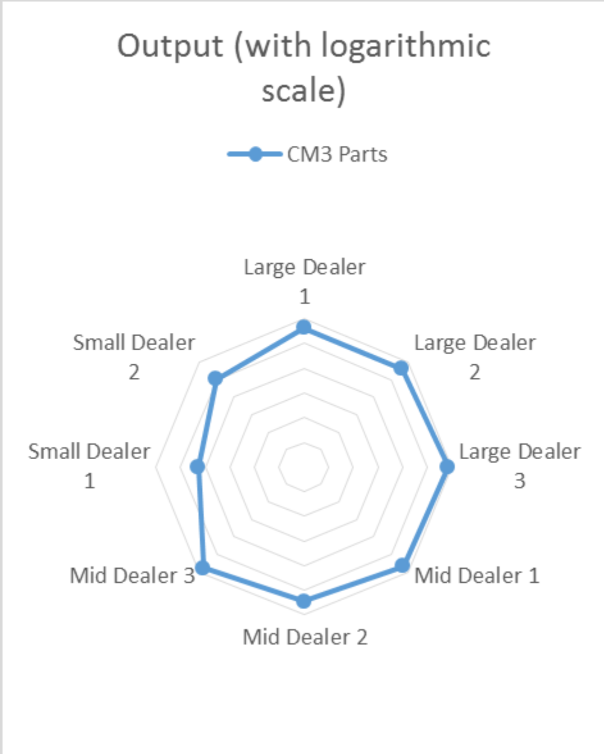
DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks	
1	Large Dealer 1	0,37999	0,729	Mid Dealer 3
2	Large Dealer 2	0,59094	0,692	Mid Dealer 3
3	Large Dealer 3	0,71705	1,184	Mid Dealer 3
4	Mid Dealer 1	0,49461	0,819	Mid Dealer 3
5	Mid Dealer 2	0,76621	0,463	Mid Dealer 3
6	Mid Dealer 3	1,00000	1,000	Mid Dealer 3
7	Small Dealer 1	1,00000	1,000	Small Dealer 1
8	Small Dealer 2	0,70184	0,177	Mid Dealer 3

The efficient dealers for the Revenue Parts, Direct Costs Parts + Labor Costs Parts + Direct Operating Costs Parts inputs and CM3 Parts outputs are Mid Dealer 3 and Small Dealer 1.



The worst efficiency rate has Large Dealer 1. As a consequence of the modest financial performance the parts function was consolidated in another businesses that belongs to the same owner.





Dominant dealer is Mid Dealer 3. When compared to Small Dealer 1, they use more inputs but their output level is much higher than the output of Small Dealer 1.

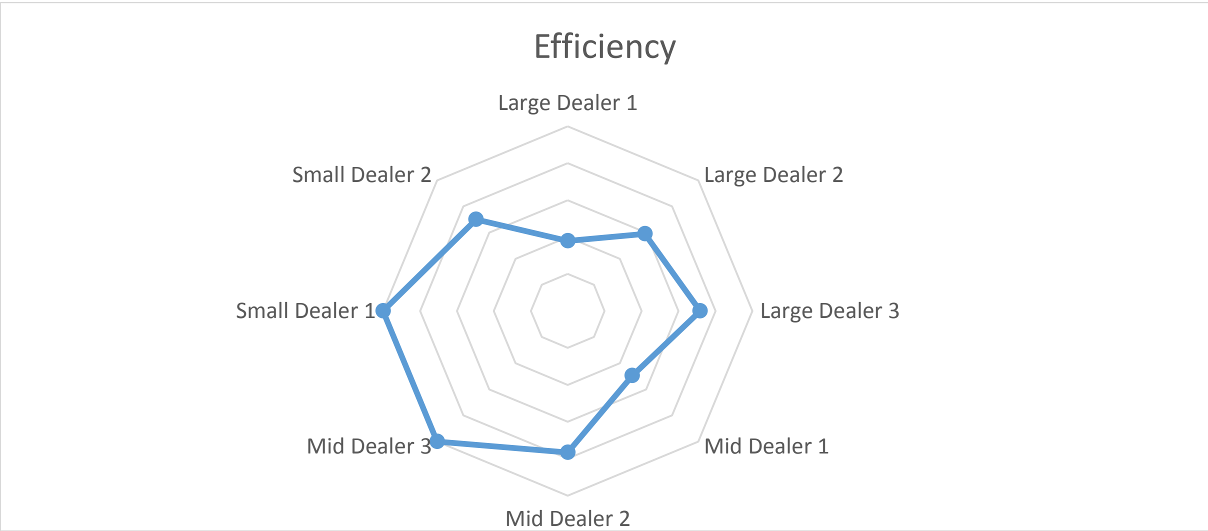
The worst performer is Large Dealer 1. They use the highest amount of inputs but their output level is worse than output of Mid Dealer 3, who uses less inputs to produce more output. Similarly is also true for others, we see for example that Mid Dealer 1 uses similar amounts of input as Mid Dealer 3 but their output is smaller. Mid Dealer 3 is more efficient than Mid Dealer 2 in the parts function even though Mid Dealer 2 has some big business customers that order parts at them. This is consistent with the fact that the most profitable business is with parts sold through repairs in the own workshop.

Appendix 11 – DEA Trial 1.21

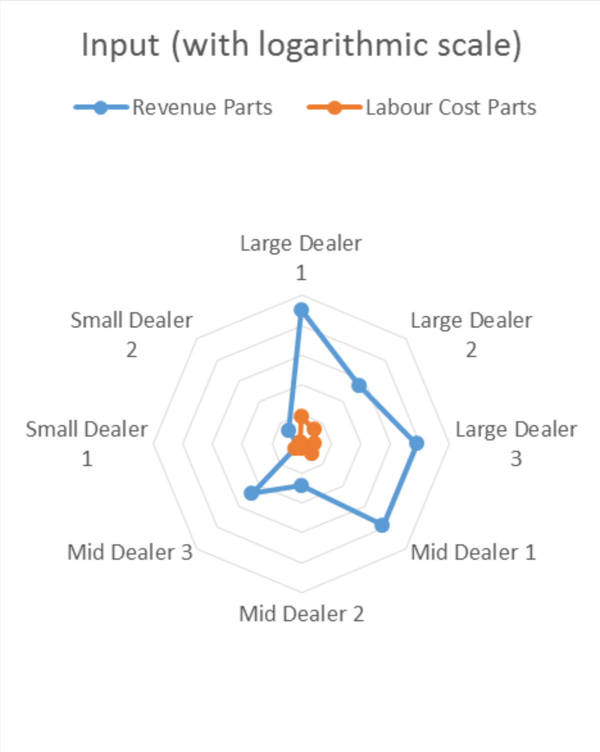
Inputs	Outputs
Revenue Parts	CM3 Parts
Labor Costs Parts	

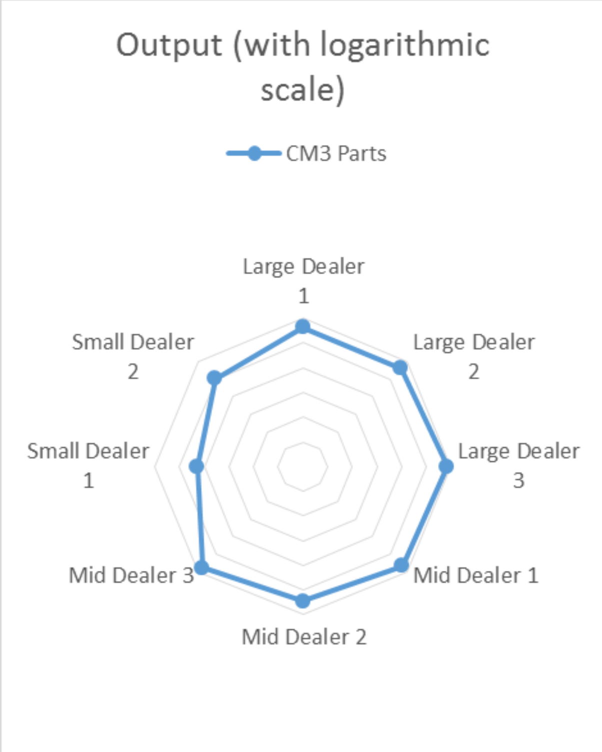
DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks	
1	Large Dealer 1	0,37999	0,729	Mid Dealer 3
2	Large Dealer 2	0,59094	0,692	Mid Dealer 3
3	Large Dealer 3	0,71705	1,184	Mid Dealer 3
4	Mid Dealer 1	0,49461	0,819	Mid Dealer 3
5	Mid Dealer 2	0,76621	0,463	Mid Dealer 3
6	Mid Dealer 3	1,00000	1,000	Mid Dealer 3
7	Small Dealer 1	1,00000	1,000	Small Dealer 1
8	Small Dealer 2	0,70184	0,177	Mid Dealer 3

The efficient dealers for the Revenue Parts, Labor Costs Parts inputs and CM3 Parts outputs are Mid Dealer 3 and Small Dealer 1.



The dealer with the lowest efficiency rate is Large Dealer 1. The performance of all other dealers compared to the performance of Mid Dealer 3 and Small Dealer 1 is lower.





In this case it is hard to determine which dealer is the dominant one. Even though Small Dealer 1 has a lower output level than Mid Dealer 3, it is achieved by using less input also due to the business volume, it is also an efficient business. This is why we can conclude that both Small Dealer 1 and Mid Dealer 3 are dominant dealers.

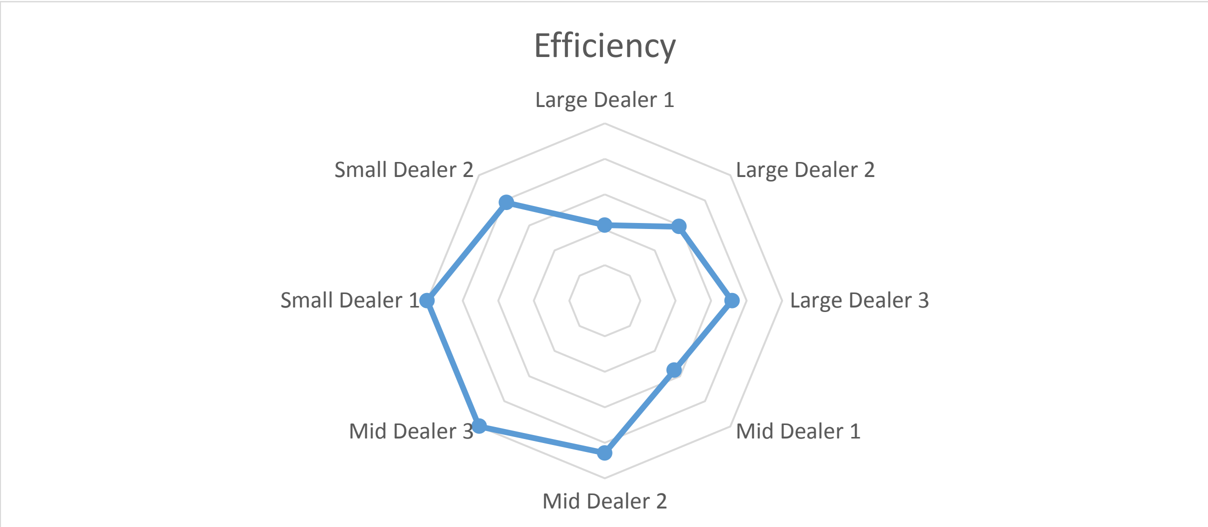
Large Dealer 1 performance is bad. To achieve output level, which is similar as others, they use a high level of inputs. This is also why their efficiency rate is the lowest. We can also see similar interpretations for Mid Dealer 1 and Large Dealer 2. Mid Dealer 2 and Small Dealer 2 uses little inputs but regarding their output level, this inputs are still too high when compared to the inputs of Small Dealer 1.

Appendix 11 – DEA Trial 1.22

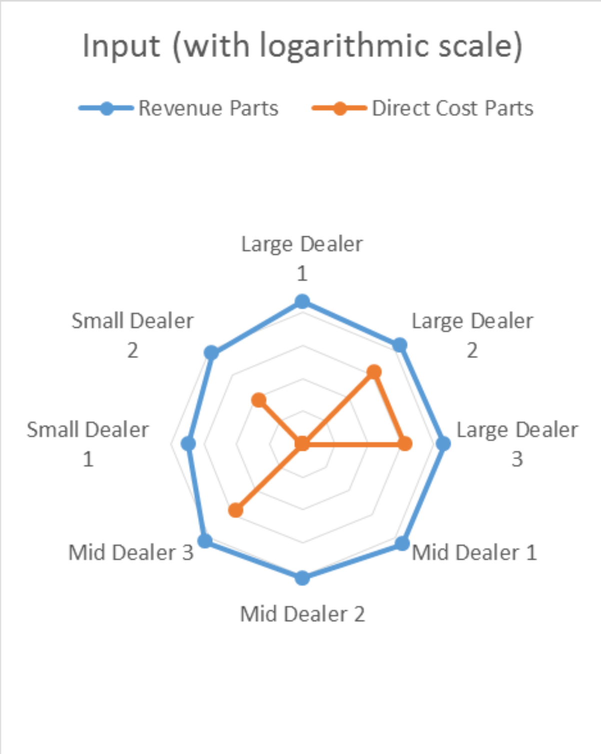
Inputs	Outputs
Revenue Parts	CM3 Parts
Direct Costs Parts	

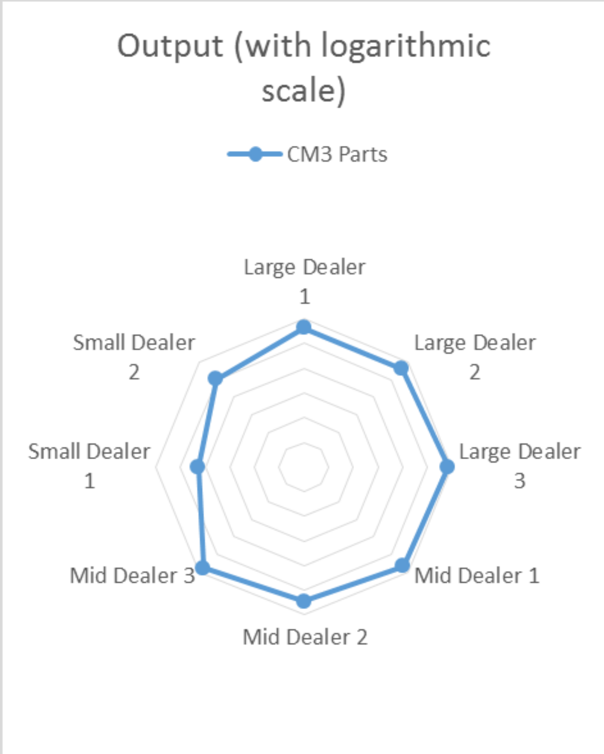
DMU No.	DMU Name	Efficiency	lambdas	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	0,42549	22,912	22,912	Small Dealer 1		
2	Large Dealer 2	0,59094	0,692	0,692	Mid Dealer 3		
3	Large Dealer 3	0,71705	1,184	1,184	Mid Dealer 3		
4	Mid Dealer 1	0,55383	25,742	25,742	Small Dealer 1		
5	Mid Dealer 2	0,85795	14,552	14,552	Small Dealer 1		
6	Mid Dealer 3	1,00000	1,000	1,000	Mid Dealer 3		
7	Small Dealer 1	1,00000	1,000	1,000	Small Dealer 1		
8	Small Dealer 2	0,78224	5,346	0,008	Mid Dealer 3	5,339	Small Dealer 1

The efficient dealers for the Revenue Parts, Direct Costs Parts inputs and CM3 Parts outputs are Mid Dealer 3 and Small Dealer 1.



Large Dealer 1 is the most ineffective dealer, having the lowest efficiency rate.





In this case it is hard to distinguish whether Mid Dealer 3 or Small Dealer 1 is dominant. While Mid Dealer 3 has higher output level, Small Dealer 1 has lower input levels also due to its business level that is lower. This is why we can conclude that both Mid Dealer 3 and Small Dealer 1 are dominant dealers.

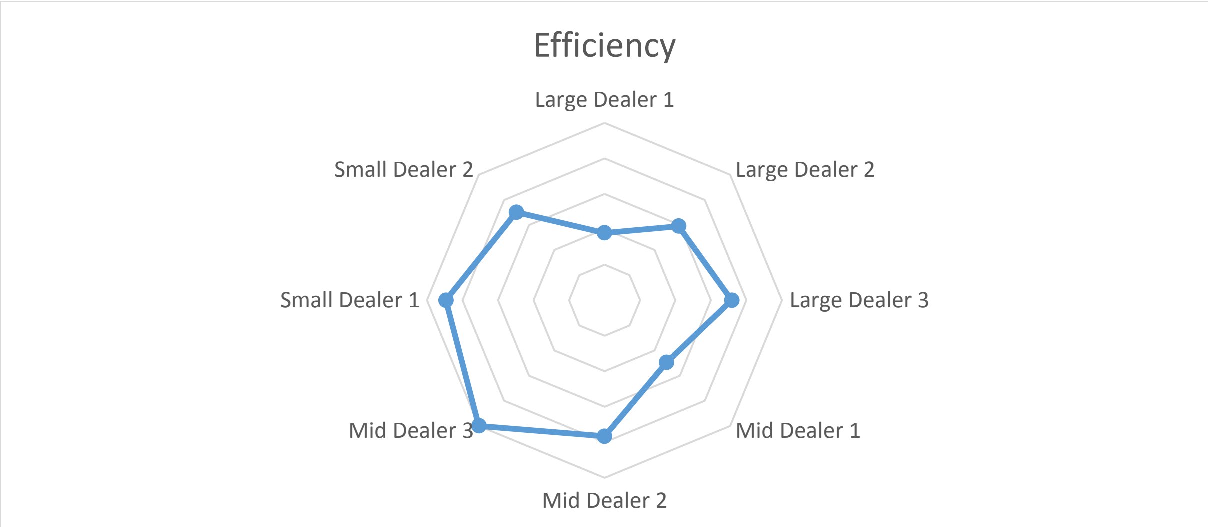
Other dealers are inefficient. For example, we see that Large Dealer 2 has both input levels quite high and also higher than Mid Dealer 3, but their output performance is worse. Similar conclusions can be traced for others. Small Dealer 2 is performing better in the output level than Small Dealer 1 but their input levels are too high to be efficient. Their input levels are much higher than from Small Dealer 1.

Appendix 11 – DEA Trial 1.23

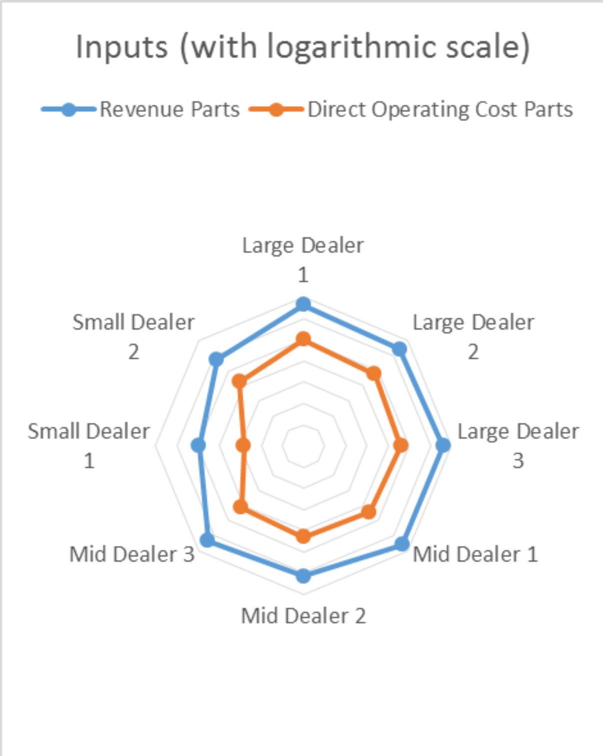
Inputs	Outputs
Revenue Parts	CM3 Parts
Direct Operating Costs Parts	

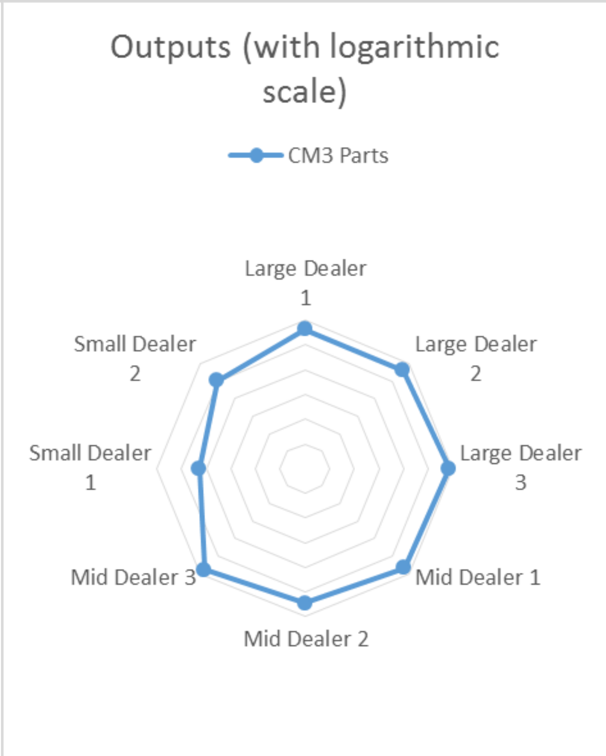
DMU No.	DMU Name	Efficiency	lambdas	Optimal Lambdas with Benchmarks	
1	Large Dealer 1	0,37999	0,729	0,729	Mid Dealer 3
2	Large Dealer 2	0,59094	0,692	0,692	Mid Dealer 3
3	Large Dealer 3	0,71705	1,184	1,184	Mid Dealer 3
4	Mid Dealer 1	0,49461	0,819	0,819	Mid Dealer 3
5	Mid Dealer 2	0,76621	0,463	0,463	Mid Dealer 3
6	Mid Dealer 3	1,00000	1,000	1,000	Mid Dealer 3
7	Small Dealer 1	0,89307	0,032	0,032	Mid Dealer 3
8	Small Dealer 2	0,70184	0,177	0,177	Mid Dealer 3

The efficient dealer for the Revenue Parts, Direct Operating Costs Parts inputs and CM3 Parts outputs is Mid Dealer 3.



We see on the above radar chart that compared to the others Large Dealer 1 has the worst performance.





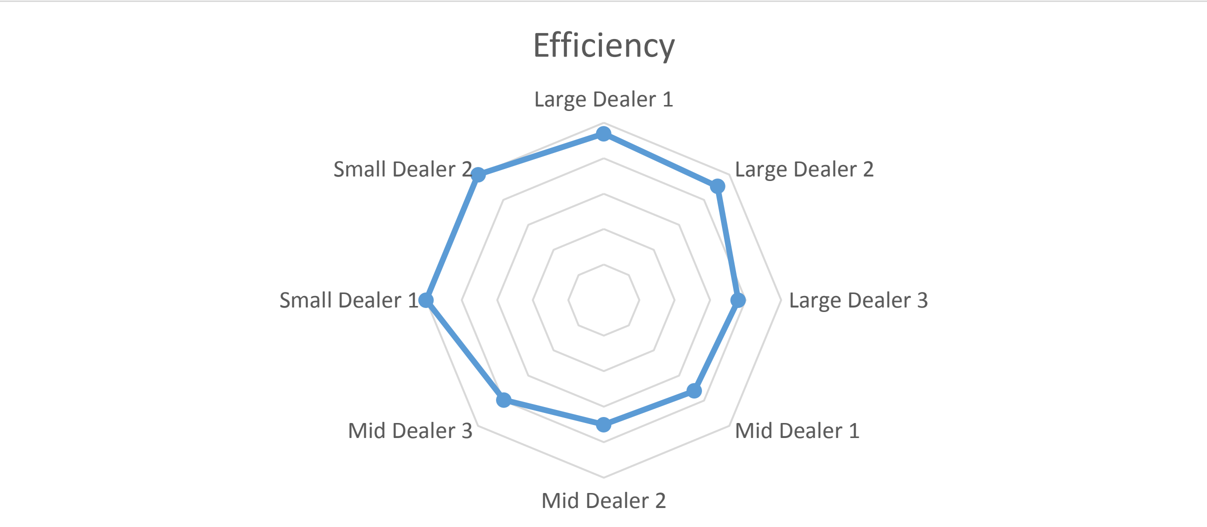
Mid Dealer 3 is the only efficient dealer and therefore also the dominant dealer. When compared to other dealers with high output level, Mid Dealer 3 uses the lowest amount of input levels. Also Small Dealer 1 and Small Dealer 2 have a lower performance than Mid Dealer 3 since their output level is lower and their input levels are either similar or little lower than Mid Dealer 3.

Appendix 11 – DEA Trial 1.24

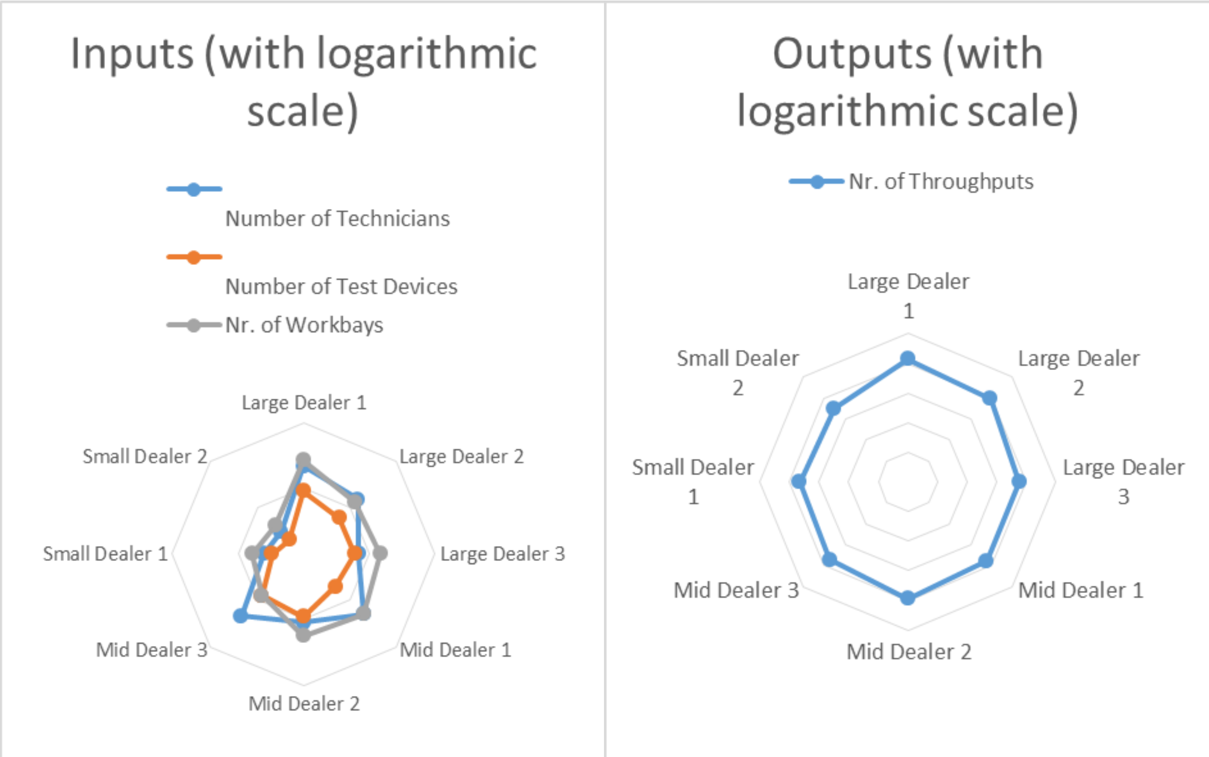
Inputs	Outputs
Number of Technicians	Nr. of Throughputs
Number of Test Devices	
Nr. of Workbays	

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks	
1	Large Dealer 1	0.93806	4.221	Small Dealer 2
2	Large Dealer 2	0.90663	2.720	Small Dealer 2
3	Large Dealer 3	0.75782	1.326	Small Dealer 1
4	Mid Dealer 1	0.72185	1.805	Small Dealer 2
5	Mid Dealer 2	0.70085	1.927	Small Dealer 1
6	Mid Dealer 3	0.79461	1.589	Small Dealer 2
7	Small Dealer 1	1.00000	1.000	Small Dealer 1
8	Small Dealer 2	1.00000	1.000	Small Dealer 2

The efficient dealers for the Number of Technicians, Number of Test Devices, Nr. of Work bays inputs and Nr. of Throughputs outputs are Small Dealer 1 and Small Dealer 2.



In the chart above we see that all the dealers are performing relatively well. Even if another dealer is not efficient, its performance is still quite high.



The dominant dealer is Small Dealer 2. In comparison with Small Dealer 1, they have lower output level, which is not that significant, but they also use less input, which appears to be the larger difference than in outputs.

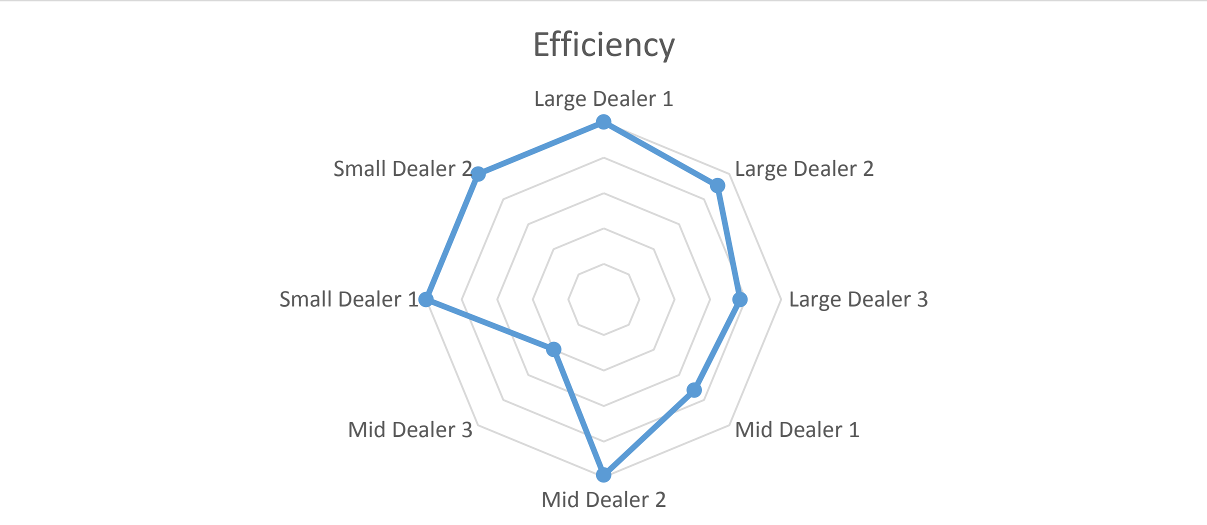
In general, other dealers have similar output levels than Small Dealer 1 and Small Dealer 2 but they use much more inputs to achieve them. That is why they are not as efficient when compared to Small Dealer 1 and Small Dealer 2.

Appendix 11 – DEA Trial 1.25

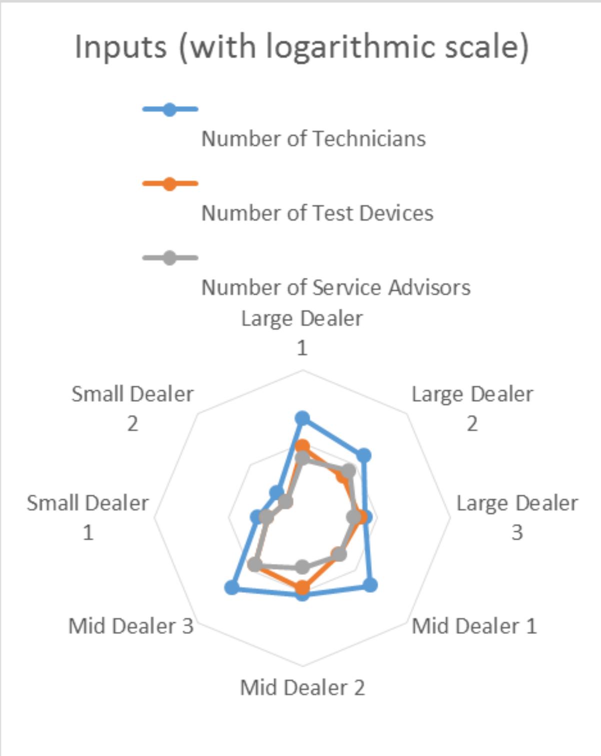
Inputs	Outputs
Number of Technicians	Nr. of Throughputs
Number of Test Devices	
Number of Service Advisors	

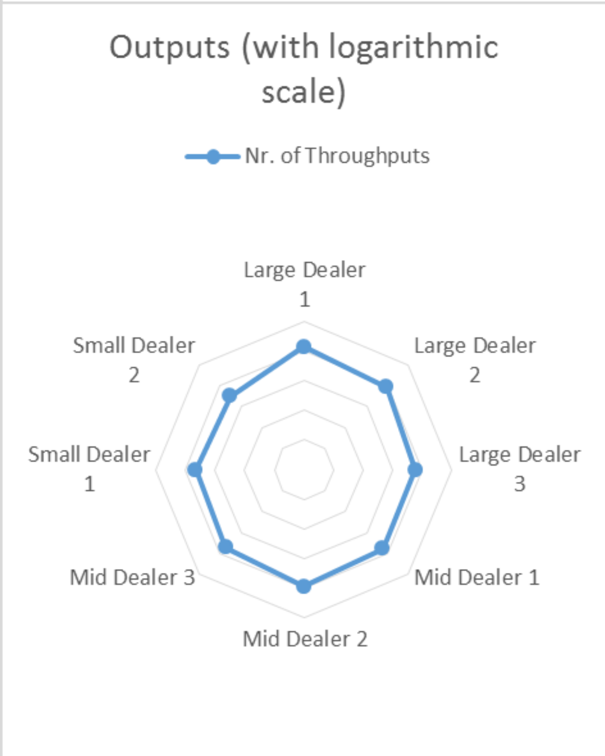
DMU No.	DMU Name	Efficiency	lambdas	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	1,00000	1,000	1,000	Large Dealer 1		
2	Large Dealer 2	0,90663	2,720	2,720	Small Dealer 2		
3	Large Dealer 3	0,76859	1,537	0,769	Small Dealer 1	0,769	Small Dealer 2
4	Mid Dealer 1	0,72185	1,805	1,805	Small Dealer 2		
5	Mid Dealer 2	0,98866	1,654	0,311	Large Dealer 1	1,343	Small Dealer 2
6	Mid Dealer 3	0,39730	1,589	1,589	Small Dealer 2		
7	Small Dealer 1	1,00000	1,000	1,000	Small Dealer 1		
8	Small Dealer 2	1,00000	1,000	1,000	Small Dealer 2		

The efficient dealers for the Number of Technicians, Number of Test Devices, Number of Service Advisors inputs and Nr. of Throughputs outputs are Large Dealer 1, Small Dealer 1 and Small Dealer 2.



Although Mid Dealer 2 is not the efficient, we see that its efficient is very close to 1. The least efficient dealers compared to all others is Mid Dealer 3.





The dominant dealers are Small Dealer 1 and Small Dealer 2. They both use small amounts of inputs and produce relatively high levels of output. Their inputs are the lowest ones but their inputs are quite close to others. This is why they are the dominant dealers.

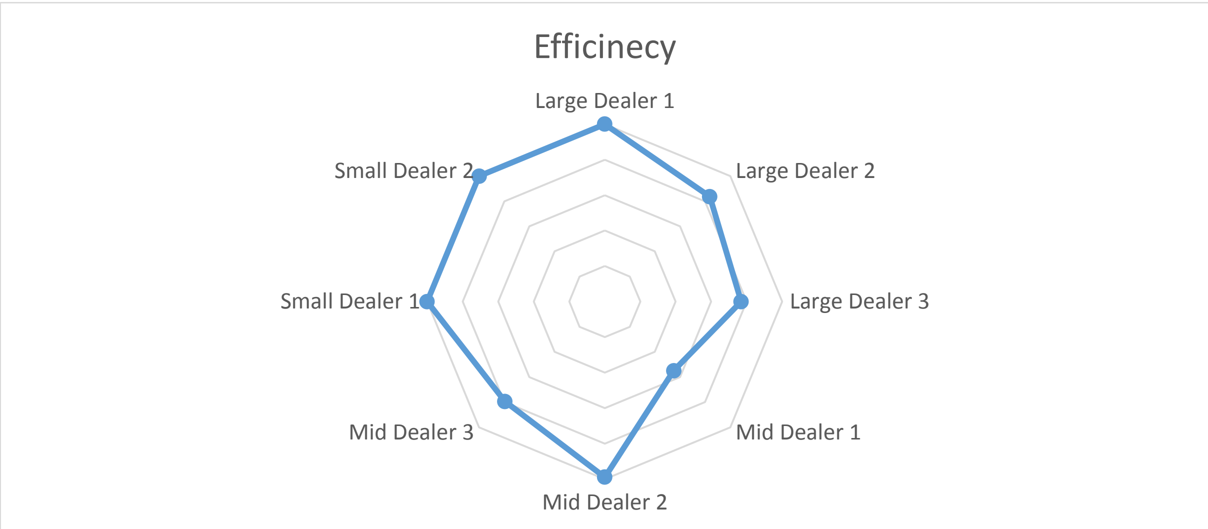
The Mid Dealer 3 has the worst performance. Their input levels are very high, especially Nr. of Technicians, which is very high. Their output performance is similar to others.

Appendix 11 – DEA Trial 1.26

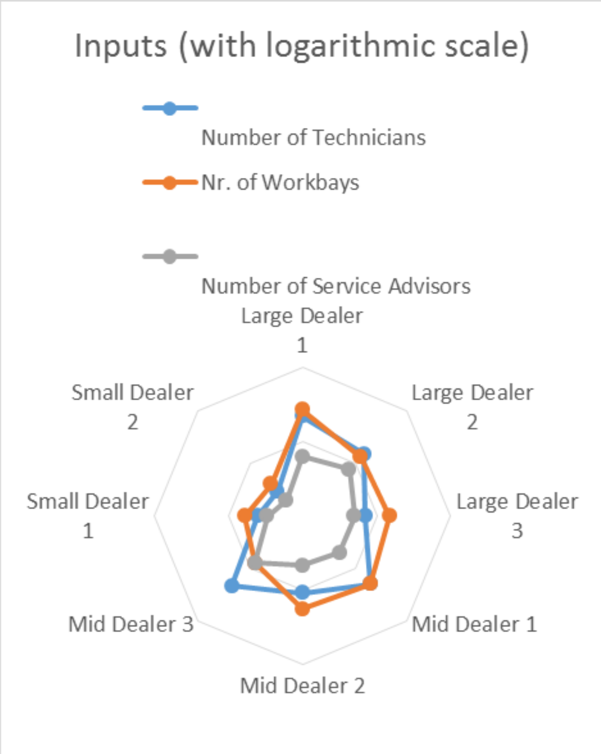
Inputs	Outputs
Number of Technicians	Nr. of Throughputs
Nr. of Work bays	
Number of Service Advisors	

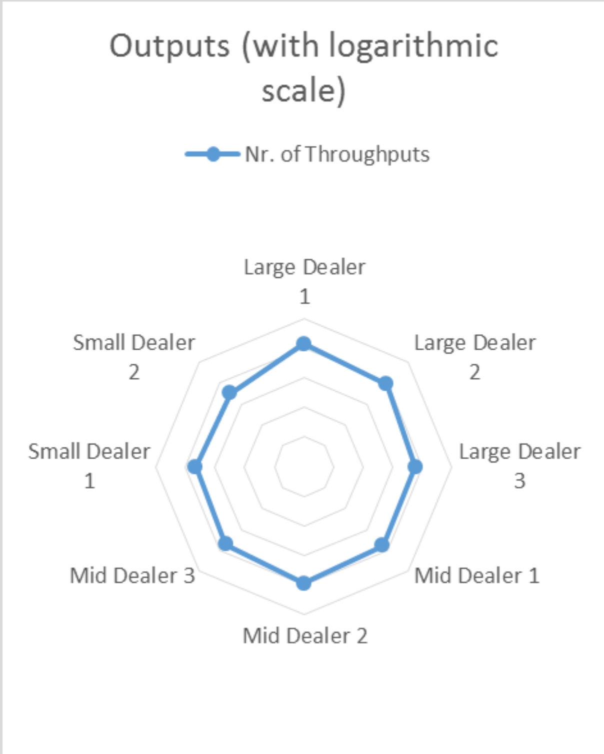
DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	1.00000	1.000	Large Dealer 1		
2	Large Dealer 2	0.83689	2.720	Small Dealer 2		
3	Large Dealer 3	0.76859	0.769	Small Dealer 1	0.769	Small Dealer 2
4	Mid Dealer 1	0.55035	0.375	Large Dealer 1	0.224	Small Dealer 2
5	Mid Dealer 2	0.98866	0.311	Large Dealer 1	1.343	Small Dealer 2
6	Mid Dealer 3	0.79461	1.589	Small Dealer 2		
7	Small Dealer 1	1.00000	1.000	Small Dealer 1		
8	Small Dealer 2	1.00000	1.000	Small Dealer 2		

The efficient dealers for the Number of Technicians, Nr. of Work bays, Number of Service Advisors inputs and Nr. of Throughputs outputs are Large Dealer 1, Small Dealer 1 and Small Dealer 2.



The most inefficient dealer is Mid Dealer 1. The efficiency rates of all other dealers are also relatively high.





The most effective and also the dominant dealer is Small Dealer 2. When compared to Small Dealer 1 they output of is quite similar outputs, a little lower. The major difference is the amount of inputs, which is higher in Small Dealer 1.

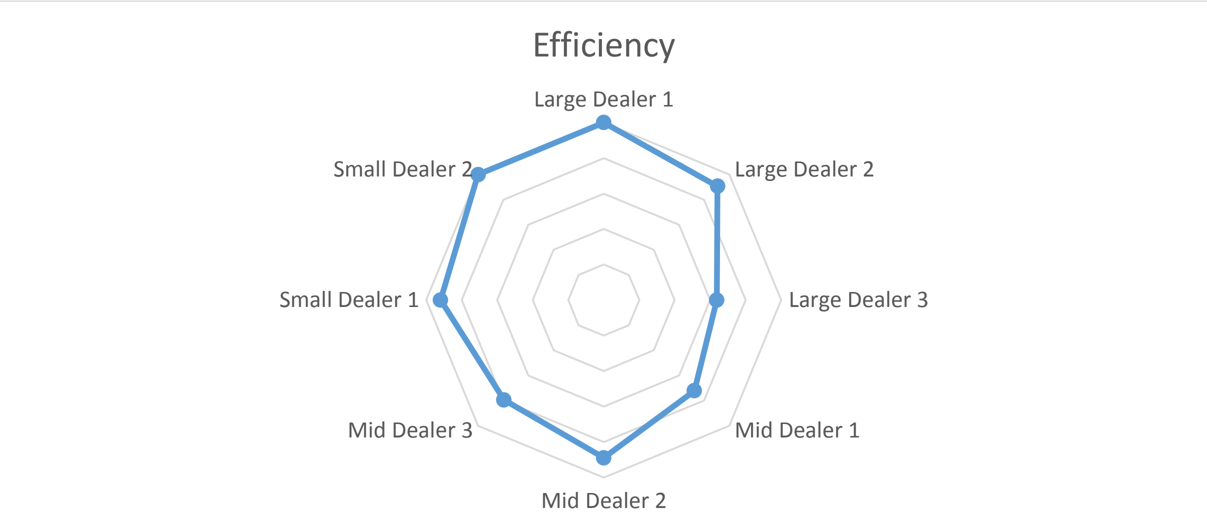
The worst performance is produced by Mid Dealer 1. If its performance is compared to the performance of Large Dealer 3 we see that at similar level of outputs, Large Dealer 3 needs less inputs.

Appendix 11 – DEA Trial 1.27

Inputs	Outputs
Nr. of Work bays	Nr. of Throughputs
Number of Test Devices	
Number of Service Advisors	

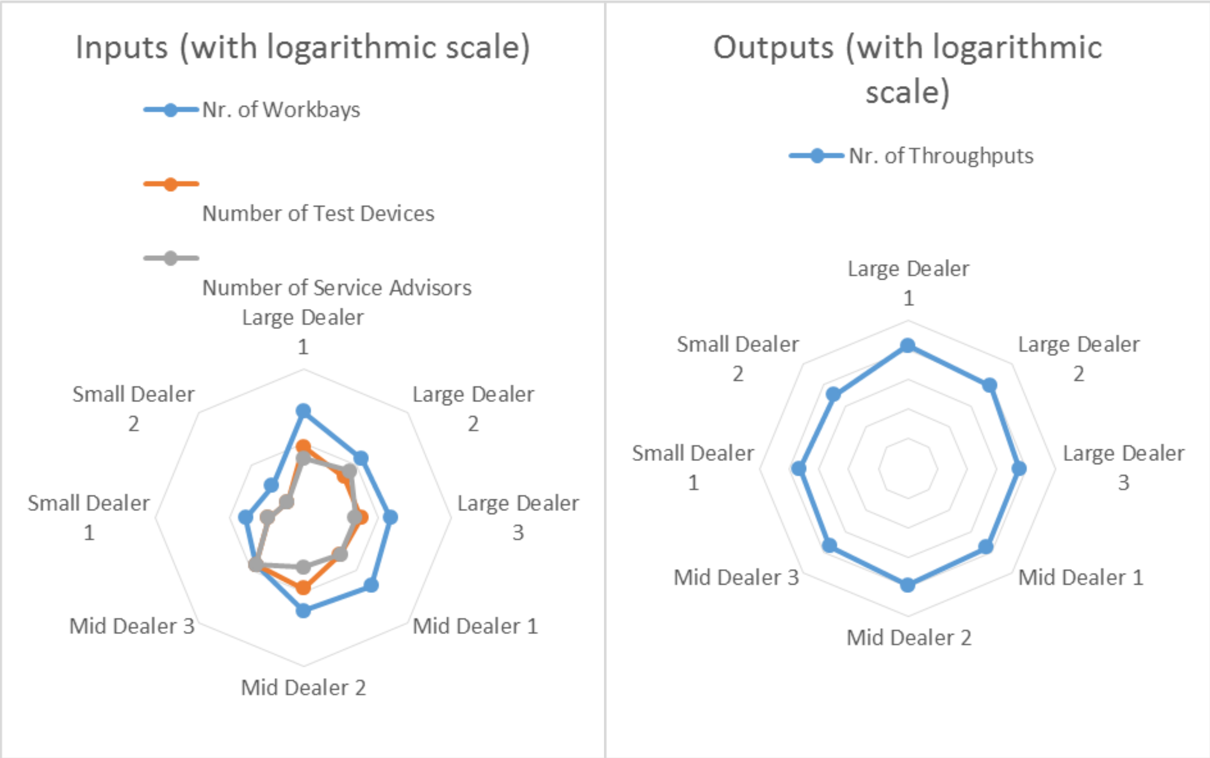
DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	1.00000	1.000	Large Dealer 1		
2	Large Dealer 2	0.90663	2.720	Small Dealer 2		
3	Large Dealer 3	0.63651	0.221	Large Dealer 1	0.895	Small Dealer 2
4	Mid Dealer 1	0.72185	1.805	Small Dealer 2		
5	Mid Dealer 2	0.88859	0.531	Large Dealer 1	0.417	Small Dealer 2
6	Mid Dealer 3	0.79461	1.589	Small Dealer 2		
7	Small Dealer 1	0.91895	1.378	Small Dealer 2		
8	Small Dealer 2	1.00000	1.000	Small Dealer 2		

The efficient dealers for the Nr. of Work bays, Number of Test Devices, Number of Service Advisors inputs and Nr. of Throughputs outputs are Large Dealer 1 and Small Dealer 2.



We can see from the radar chart that the efficiency rates of all the dealers except Large Dealer3 are also relatively high.

The dominant dealer is Small Dealer 2, which can be compared to the Large Dealer 1, who is also efficient. The only difference is that the Small Dealer 2 uses much less inputs to produce a similar level of output.



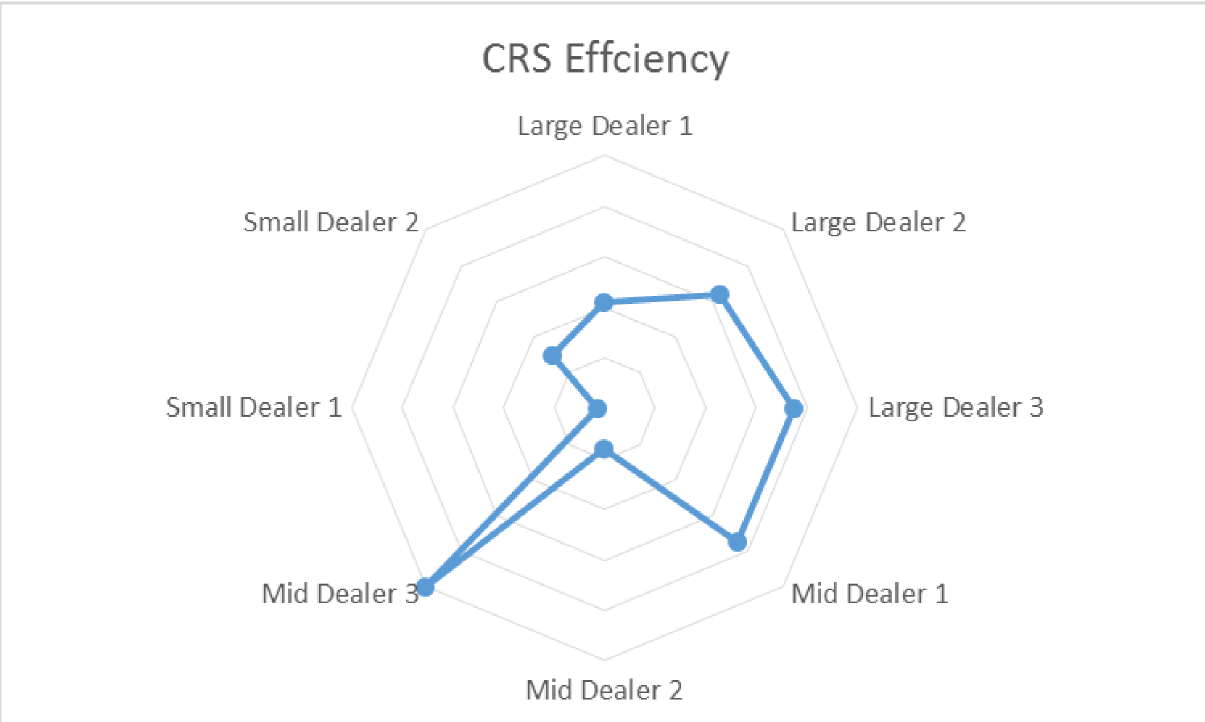
Other dealers who are not efficient use to many inputs compared to the outputs achived.

Appendix 11 – DEA Trial 1.28

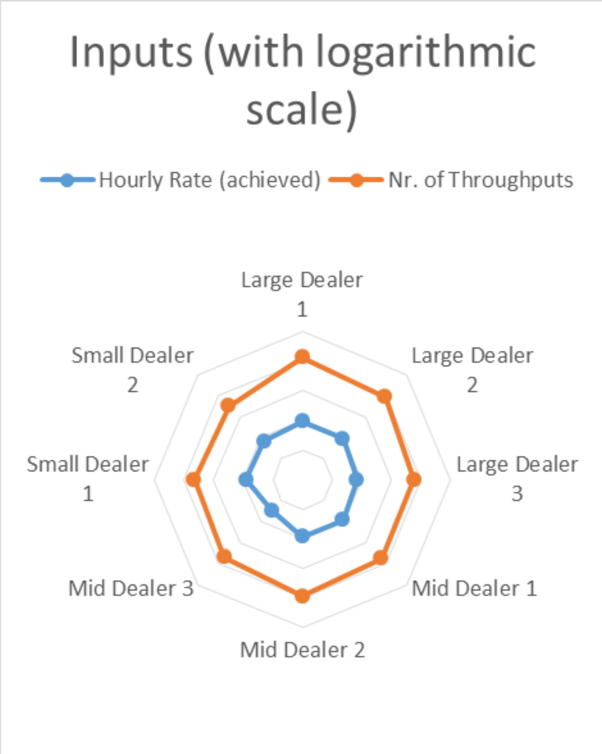
Inputs	Outputs
Hourly Rate (achieved)	(CM3 Service + CM3 Parts)
Nr. of Throughputs	

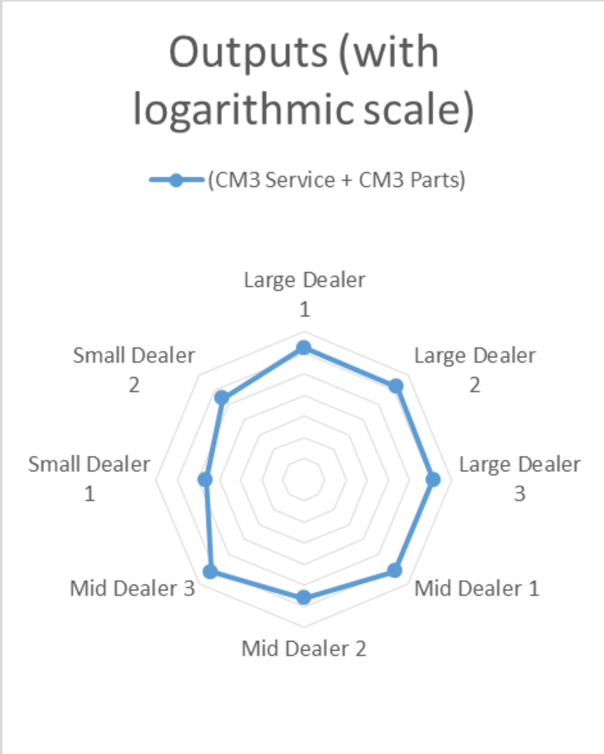
DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks	
1	Large Dealer 1	0,41950	1,114	Mid Dealer 3
2	Large Dealer 2	0,64233	1,099	Mid Dealer 3
3	Large Dealer 3	0,75146	0,864	Mid Dealer 3
4	Mid Dealer 1	0,74387	0,845	Mid Dealer 3
5	Mid Dealer 2	0,15682	0,262	Mid Dealer 3
6	Mid Dealer 3	1,00000	1,000	Mid Dealer 3
7	Small Dealer 1	0,03147	0,027	Mid Dealer 3
8	Small Dealer 2	0,29248	0,184	Mid Dealer 3

The efficient dealer for the Hourly Rate (achieved), Nr. of Throughputs inputs and CM3 Service + CM3 Parts outputs is Mid Dealer 3.



In the chart above, we see that dealers are not performing that well compared to Mid Dealer 3. Their efficiency rates are quite low. The most inefficient dealer is Small Dealer 1 with an efficiency rate very close to 0.





Since the Mid Dealer 3 is the only efficient dealer, it is also the dominant dealer. It is efficient compared to the others because the input levels are very low, especially the hourly rate and the Nr. Of Throughputs and the output level is among the highest. The explanation is that even though Mid Dealer 3 charges his customers the lowest hourly rate due to the cost management he is able to achieve good financial results.

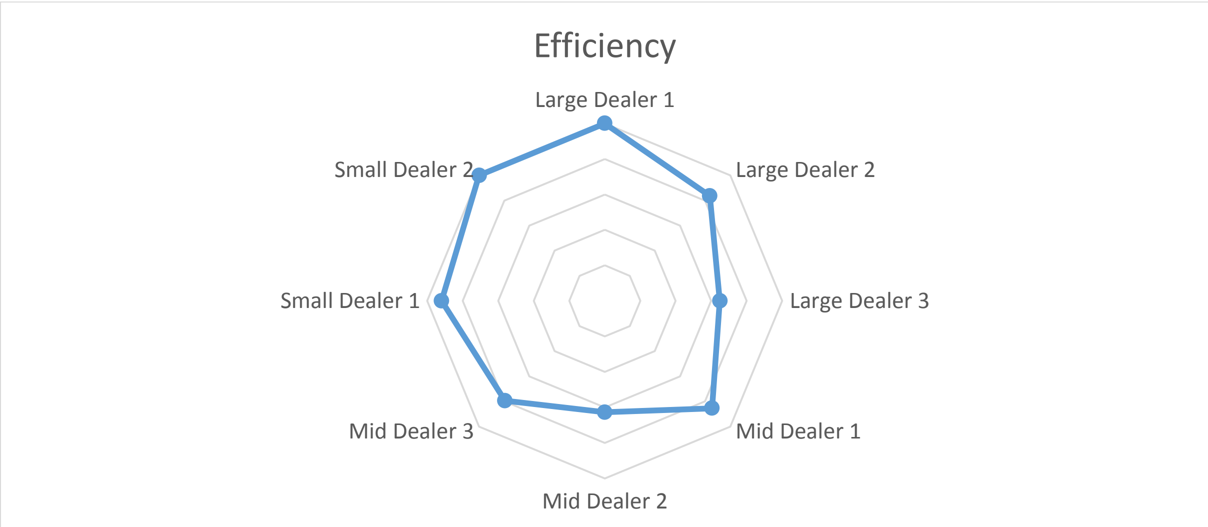
Performances of others are worse compared to the Mid Dealer 3. For example, Mid Dealer 2 uses higher input than Mid Dealer 3, but their output level is lower. Similar is also true for the other dealers.

Appendix 11 – DEA Trial 1.29

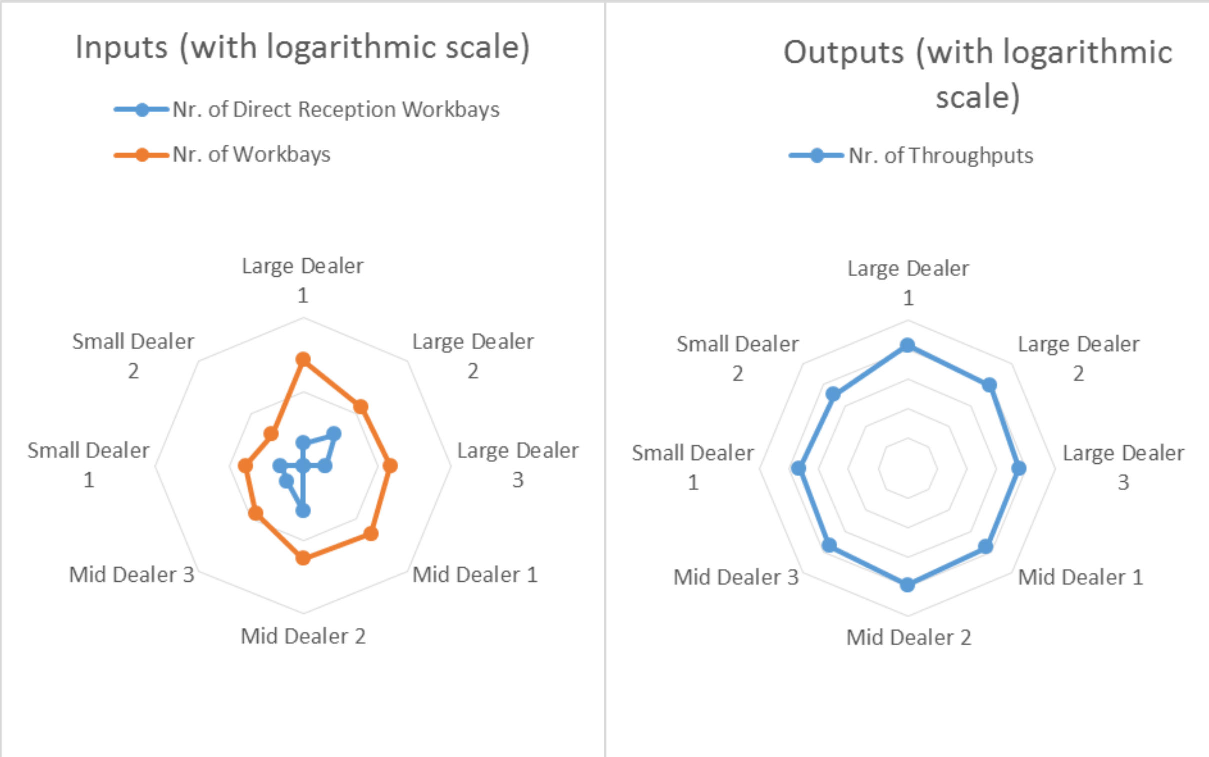
Inputs	Outputs
Nr. of Direct Reception Work bays	Nr. of Throughputs
Nr. of Work bays	

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	1,00000	1,000	Large Dealer 1		
2	Large Dealer 2	0,83689	2,720	Small Dealer 2		
3	Large Dealer 3	0,64862	0,239	Large Dealer 1	0,819	Small Dealer 2
4	Mid Dealer 1	0,85502	0,428	Large Dealer 1		
5	Mid Dealer 2	0,62750	0,066	Large Dealer 1	2,378	Small Dealer 2
6	Mid Dealer 3	0,79461	1,589	Small Dealer 2		
7	Small Dealer 1	0,91895	1,378	Small Dealer 2		
8	Small Dealer 2	1,00000	1,000	Small Dealer 2		

The efficient dealers for the Nr. of Direct Reception Work bays, Nr. of Work bays inputs and Nr. of Throughputs outputs are Lead Dealer 1 and Small Dealer 2.



From the efficiency radar chart we can see that all of the other dealer's efficiency rates are above 0.6. Small Dealer 1 is not as efficient as all of the others, but has an efficiency rate close to 1. The most inefficient dealers are Large Dealer 3 and Mid Dealer 2.



It can be said that Small Dealer 2 is the dominant dealer. Its input levels are relatively low compared to others, but their output level is close to the others.

Also, in most cases, Small Dealer 2 is the reason why other dealers are not efficient. For example Large Dealer 3 uses too many inputs to be efficient. Even though the output level is higher than Small Dealer 2, but the input level are much higher than Small Dealer 2 that it makes it inefficient. Similar is true for other less efficient dealers.

Appendix 11 – DEA Trial 2.1.

Inputs	Outputs
FTE Sales & Other Businesses	CM 3 Sales & Other Businesses
New Car Sales + Used Car Sales	

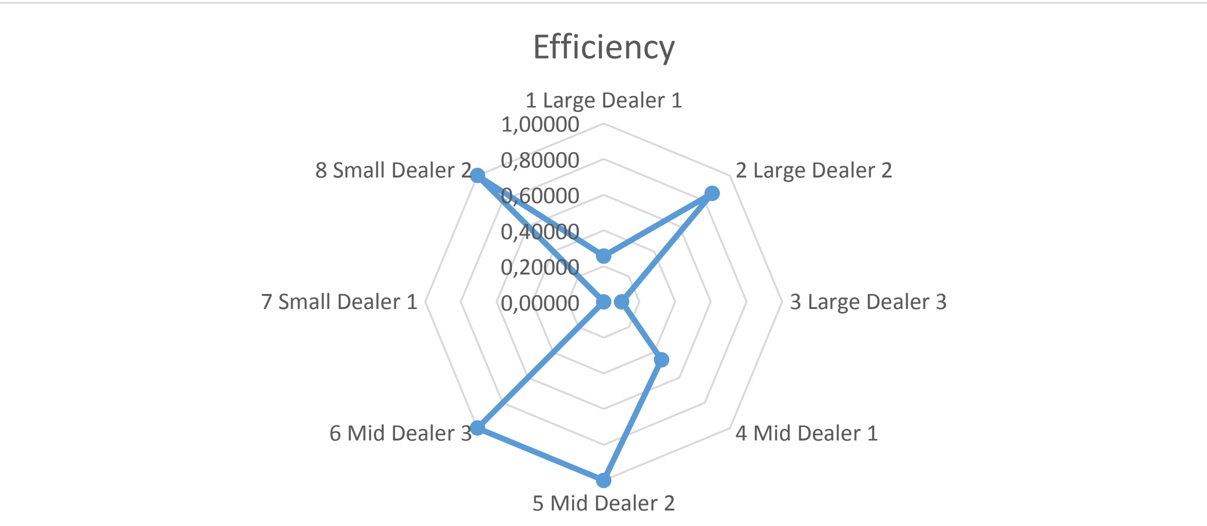
After the first trial series we noticed that we lacked combinations that could provide us with an overall picture and this was therefore corrected. In trial 2.1., we implemented a rule of thumb whereby the maximum number of input and output criteria for each category was three. In the first trial human resources, as a key resource, in Sales and Other Businesses were introduced as an input. Also introduced were the performance of the sales staff expressed by the new and used cars sold and, as outputs, financial results such as revenue and profit, expressed via the contribution margin three (CM 3).

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	0.25628	0.099	Mid Dealer 3	0.893	Small Dealer 2
2	Large Dealer 2	0.85823	0.469	Mid Dealer 3	1.831	Small Dealer 2
3	Large Dealer 3	0.10094	0.016	Mid Dealer 3	0.147	Small Dealer 2
4	Mid Dealer 1	0.45859	1.165	Mid Dealer 2	0.104	Small Dealer 2
5	Mid Dealer 2	1.00000	1.000	Mid Dealer 2		
6	Mid Dealer 3	1.00000	1.000	Mid Dealer 3		
7	Small Dealer 1	0.00000				
8	Small Dealer 2	1.00000	1.000	Small Dealer 2		

The efficient dealers for FTE Sales & Other Businesses and New and Used Car Sales as inputs versus

CM 3 Sales & Other Businesses as an output are Mid Dealers 2 and 3 and Small Dealer 2.

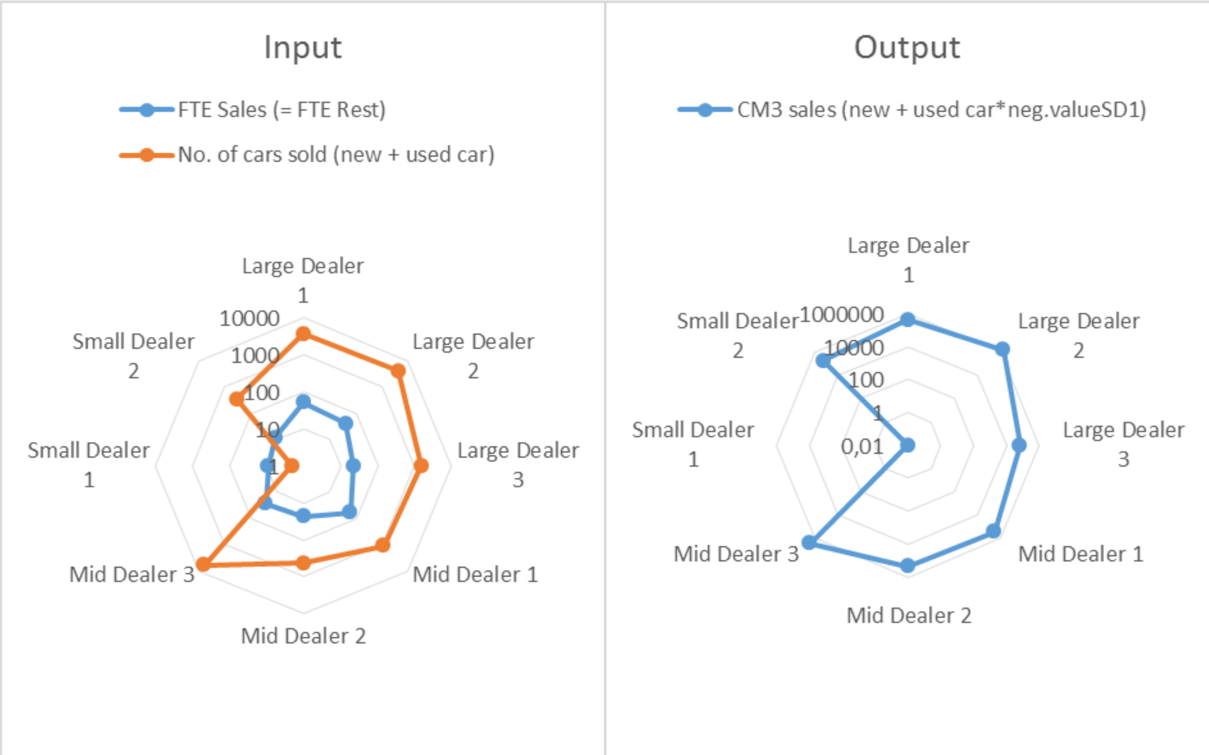
Radar Chart with overall efficiencies:



Mid Dealers 2 and 3 and Small Dealer 1 are efficient because their output is high with average inputs. Least efficient is Small Dealer 1 as it does not have any output. Small Dealer 1 has zero efficiency because he does not have a sales contract for the Volkswagen brand.

Radar Chart with inputs vs. outputs:

On the radar charts below we see the inputs and outputs for every dealer. As in the first set of trials the logarithmic scale for visualization was used.



Of the efficient dealers the dominant ones are Mid Dealer 2 and Small Dealer 2 as they generate high output with less input. The owners are also responsible for the sales functions in their respective dealerships. Mid Dealer 3 uses more input, to generate slightly higher output than Mid Dealer 2. Looking at the organizational structure we observe that he has more staff performing the same functions than Mid Dealer 2.

Furthermore, Large Dealers 1 and 3 have low efficiency as they use similar inputs to Large Dealer 2 but their output is lower.

Appendix 11 – DEA Trial 2.2.

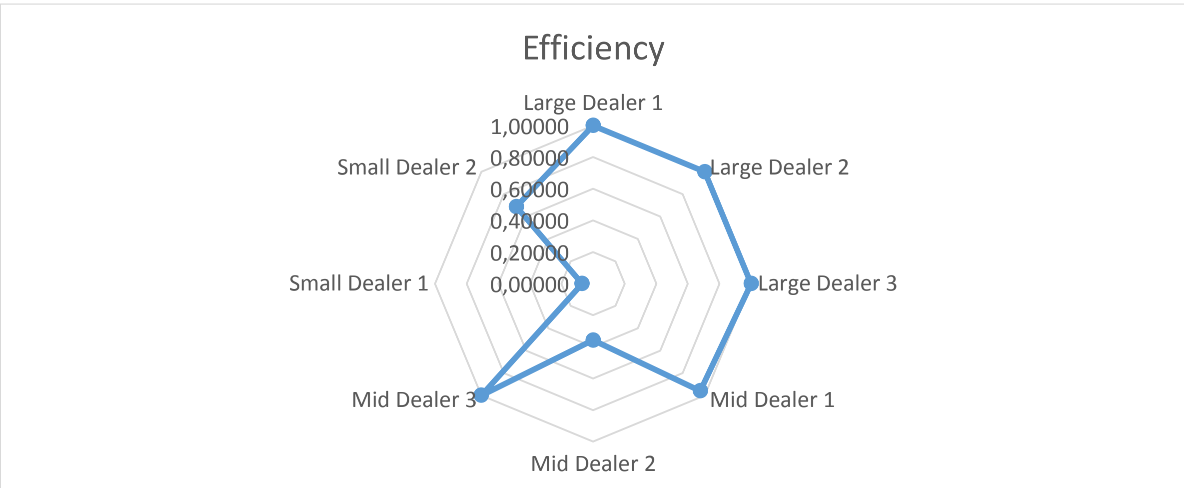
Inputs	Outputs
No. of Service Advisors	CM 3 After Sales
No. of Technicians	
No. of Work bays	
CSS Satisfaction	
Hours sold	

In this trial the goal was to identify the efficient dealerships in After Sales. The inputs chosen were therefore KPIs that are relevant for the execution of a service, such as the number of service advisors and technicians, a capacity indicator such as the number of work bays, a measurement of efficiency that translates the customer order into revenue, namely the number of hours sold and a customer satisfaction indicator. The contribution margin three (CM 3) was chosen as the output.

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks					
1	Large Dealer 1	1.00000	1.000	Large Dealer 1				
2	Large Dealer 2	1.00000	1.000	Large Dealer 2				
3	Large Dealer 3	1.00000	1.000	Large Dealer 3				
4	Mid Dealer 1	0.96001	0.650	Large Dealer 1	0.073	Large Dealer 2	0.047	Large Dealer 3
5	Mid Dealer 2	0.35802	0.082	Large Dealer 1	0.124	Large Dealer 2	0.041	Large Dealer 3
6	Mid Dealer 3	1.00000	1.000	Mid Dealer 3				
7	Small Dealer 1	0.06960	0.009	Large Dealer 2	0.020	Large Dealer 3		
8	Small Dealer 2	0.68759	0.094	Large Dealer 2	0.094	Large Dealer 3		

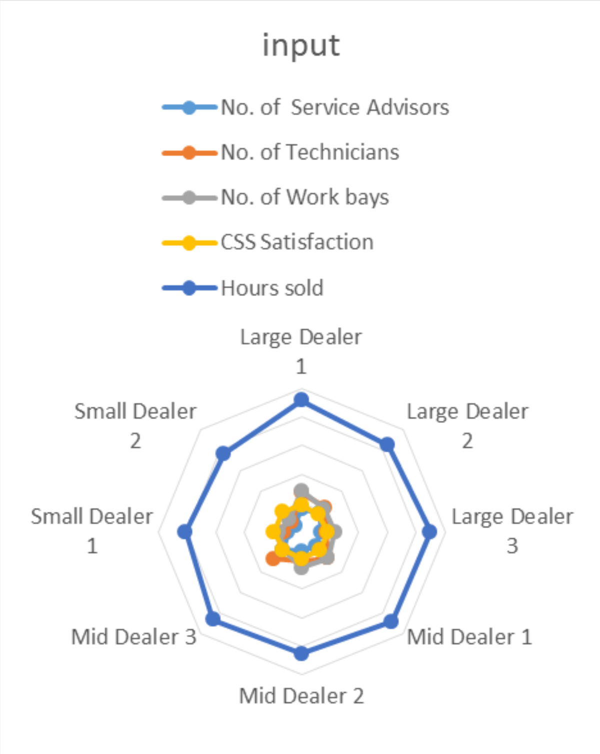
The efficient dealers for No. of Service Advisors, No. of Technicians, No. of Work bays, CSS Satisfaction and Hours sold as inputs versus CM 3 After Sales as an output are Large Dealers 1, 2 and 3 and Mid Dealer 3.

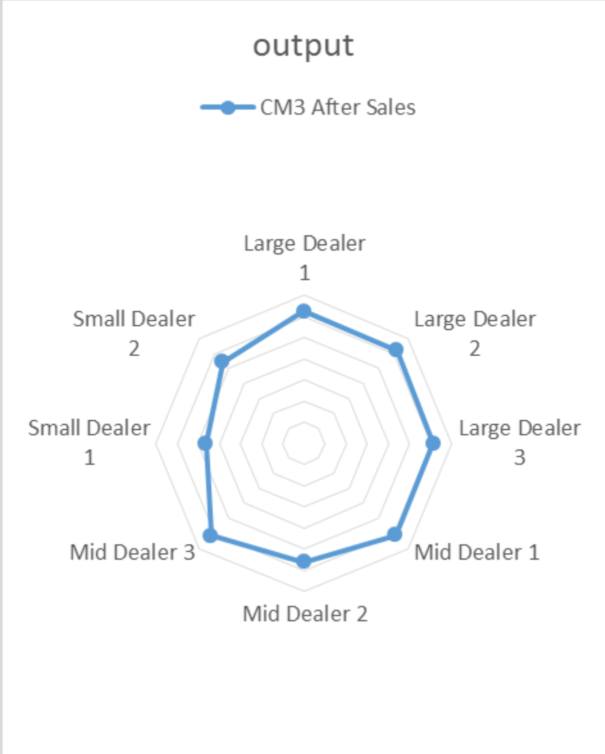
Radar Chart with overall efficiencies:



The most efficient dealers have the highest output while the inputs are similar to those of the other dealers. Therefore they can be considered dominant dealers.

Radar Chart with inputs vs. outputs:





Mid Dealer 1 with 0.96 efficiency is close to the efficient dealers – its inputs and outputs are at a similar level to the values of the most efficient dealers. Small Dealer 1 is the least efficient as its inputs are similar to those of Small Dealer 2 but its output is lower.

Appendix 11 – DEA Trial 2.4.

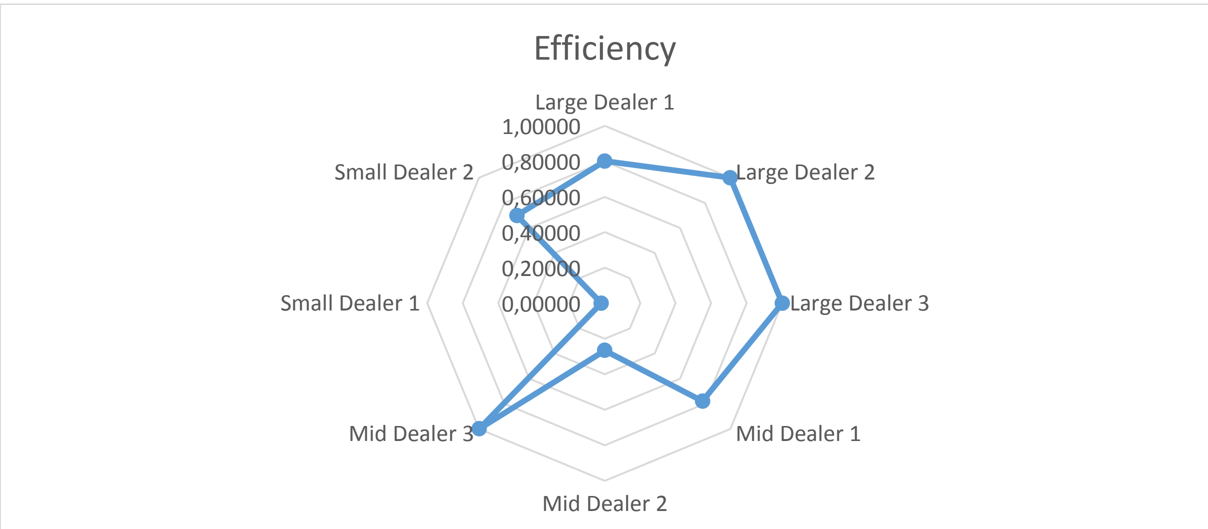
Inputs	Outputs
No. of Service Advisors	CM 3 Overall
No. of Technicians	
No. of Work bays	
CSS Satisfaction	

This trial is very similar to trial 2.2., but the number of hours sold was excluded from the inputs. The goal was to identify the efficient dealerships in After Sales. The inputs are KPIs relevant to Service such as the number of service advisors and technicians, a capacity indicator such as the number of work bays, and a customer satisfaction indicator. The contribution margin three (CM 3) was chosen as the output.

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	0.80097	0.647	Large Dealer 2		
2	Large Dealer 2	1.00000	1.000	Large Dealer 2		
3	Large Dealer 3	1.00000	1.000	Large Dealer 3		
4	Mid Dealer 1	0.77927	0.510	Large Dealer 2		
5	Mid Dealer 2	0.26595	0.160	Large Dealer 2		
6	Mid Dealer 3	1.00000	1.000	Mid Dealer 3		
7	Small Dealer 1	0.01951	0.003	Large Dealer 2	0.006	Large Dealer 3
8	Small Dealer 2	0.69937	0.089	Large Dealer 2	0.110	Large Dealer 3

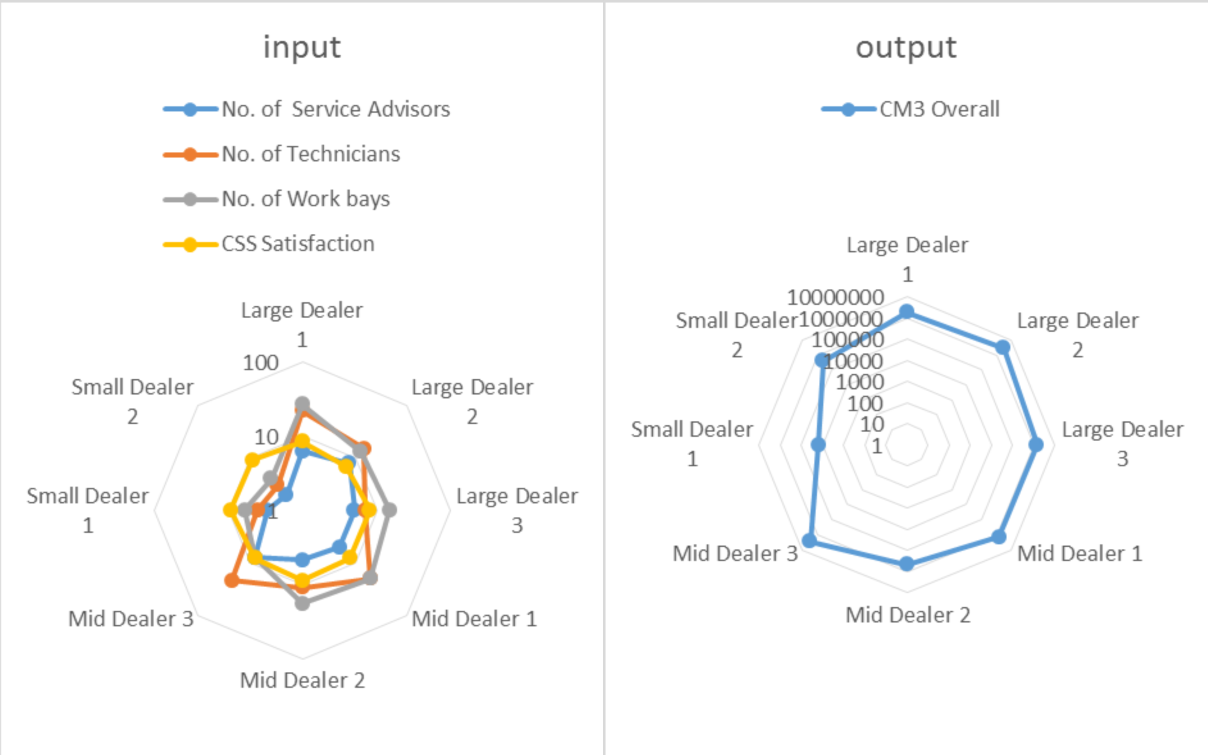
The efficient dealers for No. of Service Advisors, No. of Technicians, No. of Work bays and CSS Satisfaction as inputs versus CM 3 After Sales as an output are Large Dealers 2 and 3 and Mid Dealer 3.

Radar Chart with overall efficiencies:



Compared to the results obtained in trial 2.2., we realize that Large Dealer 1 and Mid Dealer 1 are less efficient if Hours sold is not included in the analysis as an input KPI. The dealers are less efficient in their use of resources but are good at selling hours worked to customers.

Radar Chart with inputs vs. outputs:



The dominant dealers are Large Dealer 2 and Mid Dealer 3 as their input is average but their output is the highest. Least efficient is Small Dealer 1 as its input level is similar to the input level of Small Dealer 2 but its produces less output.

Appendix 11 – DEA Trial 2.6.

Inputs	Outputs
Revenue Service	CM 3 Service
Labor Costs Service	
Direct Costs Service	
Direct Operating Costs Service	

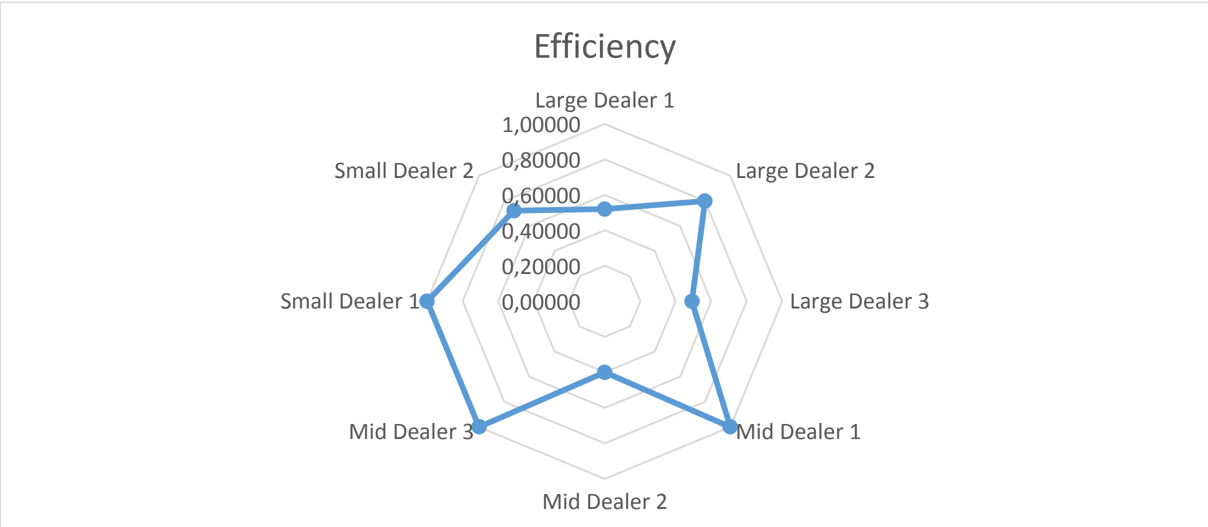
The input KPIs in this combination were not considered in the first set of trials. The costs were either taken individually, as a selection of two costs KPIs, or as the sum of all three costs KPIs.

The combination of KPIs selected in trial 2.6. reflects the ability of the dealers to manage the costs in Service by revealing the most efficient dealers.

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks	
1	Large Dealer 1	0,51983	1,361	Mid Dealer 3
2	Large Dealer 2	0,79805	1,360	Mid Dealer 3
3	Large Dealer 3	0,49125	0,660	Mid Dealer 3
4	Mid Dealer 1	1,00000	1,000	Mid Dealer 1
5	Mid Dealer 2	0,39969	0,134	Mid Dealer 3
6	Mid Dealer 3	1,00000	1,000	Mid Dealer 3
7	Small Dealer 1	1,00000	1,000	Small Dealer 1
8	Small Dealer 2	0,72224	0,188	Mid Dealer 3

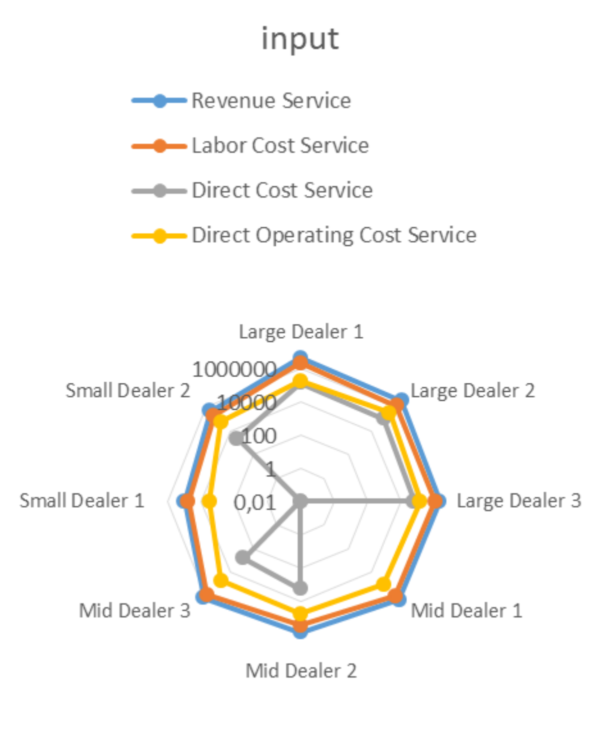
The efficient dealers for Revenue Service, Labor Costs Service, Direct Costs Service and Direct Operating Costs Service as inputs versus CM 3 Service as an output are Mid Dealers 1 and 3 and Small Dealer 1.

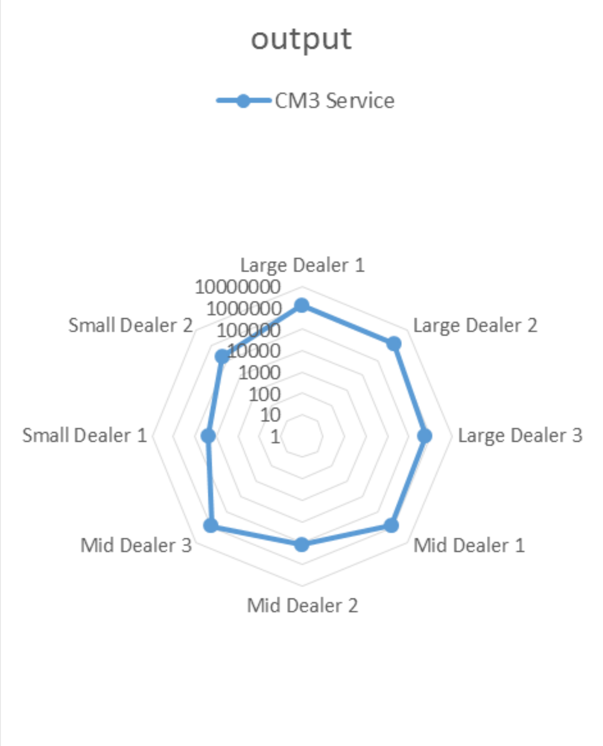
Radar Chart with overall efficiencies:



The least efficient dealers are Mid Dealer 2, whose performance is the worst, and Large Dealers 3 and 1.

Radar Chart with inputs vs. outputs:





The dominant dealers are Mid Dealer 1 and Small Dealer 1 as Mid Dealer 1 produces high output with average input and Small Dealer 1 uses little input to produce higher output when compared to others. Mid Dealer 2 performs the worst as it produces almost the same output as Small Dealer 1 but has more input. The costs of Mid Dealer 2 are comparable with the other dealers of the same category, but its service revenues are lower.

Appendix 11 – DEA Trial 2.7.

Inputs	Outputs
Revenue Parts	CM 3 Parts
Labor Costs Parts	
Direct Costs Parts	
Direct Operating Costs Parts	

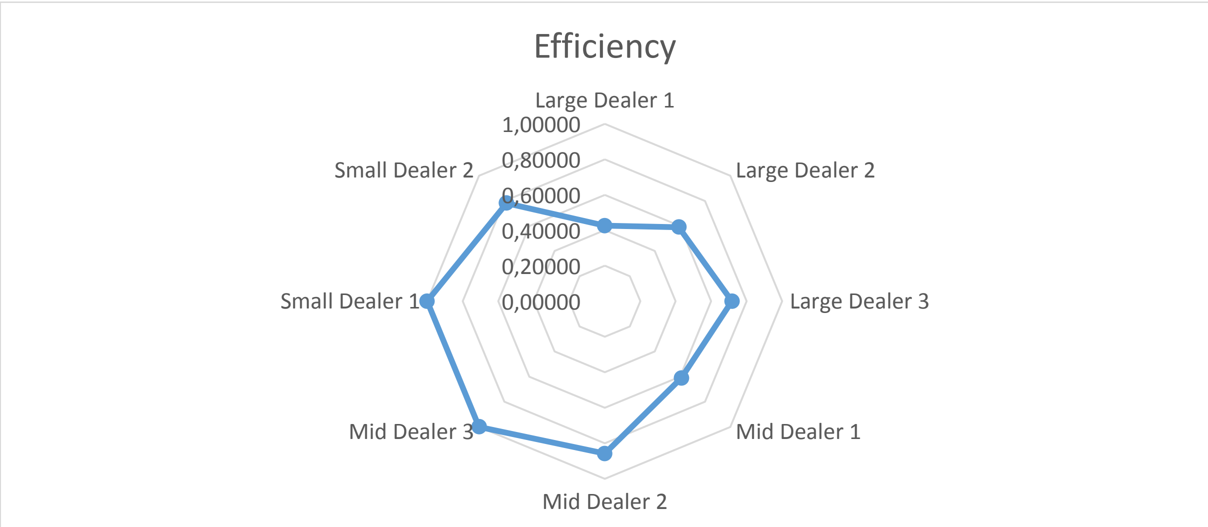
The input KPIs in this combination were not considered in the first set of trials. The costs were either taken individually, as a selection of two costs KPIs, or as a sum of all three costs KPIs.

The combination of KPIs selected in trial 2.7. reflects the ability of the dealers to manage the costs in the parts department by revealing the most efficient dealers.

DMU No.	DMU Name	Efficiency	Optimal Lambdas with Benchmarks			
1	Large Dealer 1	0.42549	22.912	Small Dealer 1		
2	Large Dealer 2	0.59094	0.692	Mid Dealer 3		
3	Large Dealer 3	0.71705	1.184	Mid Dealer 3		
4	Mid Dealer 1	0.61158	25.742	Small Dealer 1		
5	Mid Dealer 2	0.85795	14.552	Small Dealer 1		
6	Mid Dealer 3	1.00000	1.000	Mid Dealer 3		
7	Small Dealer 1	1.00000	1.000	Small Dealer 1		
8	Small Dealer 2	0.78224	0.008	Mid Dealer 3	5.339	Small Dealer 1

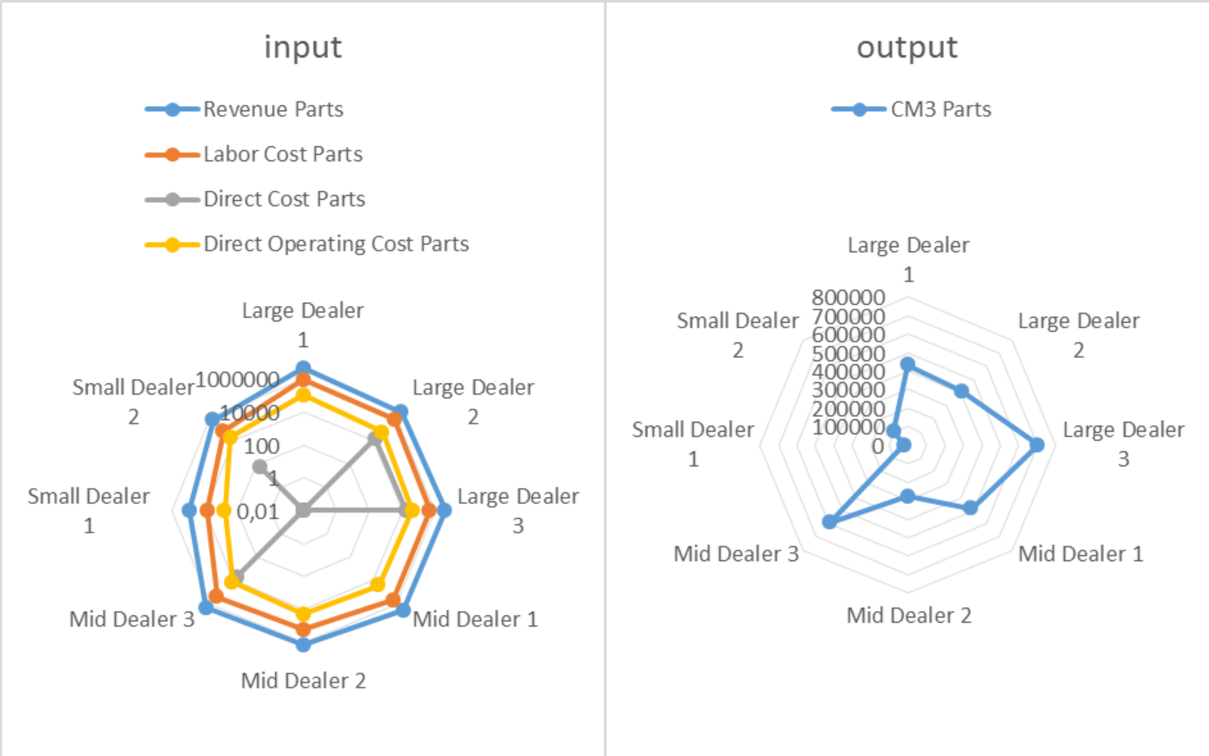
The efficient dealers for Revenue Parts, Labor Costs Parts, Direct Costs Parts and Direct Operating Costs Parts as inputs versus CM 3 Parts as an output are Mid Dealer 3 and Small Dealer 1.

Radar Chart with overall efficiencies:



The least efficient dealer is Large Dealer 1. By comparing the results of this DEA analysis with trial 2.6., we realize that Mid Dealer 2 is more efficient in parts than in service as he has lower costs than the other dealers in the same category.

Radar Chart with inputs vs. outputs:



The worst dealer is Large Dealer 1 as it produces very low output with very high input.

The dominant dealers are Mid Dealer 3 and Small Dealer 1 as Mid Dealer 3 produces high output with average input and Small Dealer 1 has little input, yet produces higher output when compared to others. Large Dealer 1 has the worst performance as it produces low output with the same input as other dealers of the same category.

Appendix 12 – List of regressions

	CM3	*Througputs*	*Technicias*	*SA*	*Test Devices*	*Workbays*	*DR*
CM3	1						
Througputs	0,611284173	1					
Technicias	0,795715384	0,560488943	1				
SA	0,840147518	0,490459833	0,802792403	1			
Test Devices	0,486025974	0,739727752	0,684339064	0,695348163	1		
Workbays	0,768492481	0,449267699	0,693301963	0,753367172	0,62741406	1	
DR	0,175991299	0,434946303	0,170659895	0,465076009	0,5143445	-0,001728787	1

	CM3 Parts	*Througputs*	*Technicias*	*SA*	*Workbays*	*DR*	*est Devices*
CM3 Parts	1						
Througputs	0,243606992	1					
Technicias	0,579243523	0,560488943	1				
SA	0,692131659	0,490459833	0,802792403	1			
Workbays	0,926074703	0,449267699	0,693301963	0,753367	1		
DR	0,075782355	0,434946303	0,170659895	0,465076	-0,00173	1	
Test Devices	0,548003718	0,739727752	0,684339064	0,695348	0,627414	0,5143445	1

	CM3 Parts	*Througputs*	*Technicias*	*SA*	*Workbays*	*DR*	*Test Devices*	*Revenue Parts*	*FTE Parts*
CM3 Parts	1								
Througputs	0,243606992	1							
Technicias	0,579243523	0,560488943	1						
SA	0,692131659	0,490459833	0,802792403	1					
Workbays	0,926074703	0,449267699	0,693301963	0,753367	1				
DR	0,075782355	0,434946303	0,170659895	0,465076	-0,00173	1			
Test Devices	0,548003718	0,739727752	0,684339064	0,695348	0,627414	0,5143445	1		
Revenue Parts	0,839946944	0,645149218	0,702411107	0,724787	0,898633	0,155513975	0,590818363	1	
FTE Parts	0,595095576	0,6333071	0,272217261	0,540122	0,547168	0,653715174	0,568781251	0,731583501	1

Appendix 13 – Interview Checklist Company 1

General Information about the business: management related:

1. Company/department size (in general and Service & Parts separately)
2. Organization structure (ask for copy)
3. How important is the service business in relation to the corporate strategy?
4. Services provided: sales new, used products, service, parts, financing, leasing, renting…
5. What is the value proposal of your company? Strengths? Areas to be improved?
6. Are spare parts procurement, sales, and logistics centralized?
7. What functions are outsourced?
8. Who are your main competitors?
9. What are currently the top drivers in your business area (price advantage, service advantage, customer demanding shorter order and cycle time, pressure to improve ROI, increase product quality, customer demanding reduced prices,…)?

Customer & Customer Segments

10. What "Customer segments" do you have?

KPIs related to the Service and Parts Business

11. What is the average order to delivery cycle time? (Do you continuously monitor and respond proactively to demand?)
12. What is the "Time to market" for new products?
13. What is the quality level?
14. How long does a customer wait until the product (hard-/software) is repaired?
15. What is the spare parts obsolescence rate? How often is the software updated?
16. How do you measure business performance (Return on assets, gross margin, market share,..)?

Detail Questions related to core Processes

17. What is the value chain? How can value be advanced for the end-customer?

Management related issues

18. Which services are procured and managed centrally, and which not?
19. What operations (to what %) are outsourced?
20. What is the constraint of the company (bottleneck)?
21. How flexible is the supply chain? How flexible is the customer support?
22. What KPIs are used to monitor the supply chain flexibility?

KPI used are divided in a few categories:

23. Financial KPIs: which are they?
24. What is: Cash cycle time, day's sales outstanding?
25. Are you able to monitor transaction costs?
26. How standardized is the supply chain? How standardized is customer support?
27. Please give some details concerning the supply chain visibility. What technology do you use?

Appendix 13 – Interview Checklist Company 1 (Cont.1)

Parts Business Process related Questions (for Hardware)

28. Do you use automated inventory planning tools? What exactly?
29. Have you implemented real-time transportation monitoring?
30. What is the storage method (cross dock, warehouses,..) and how important is it?
31. Inventory (value, inventory turns)- how do you calculate inventory? (Based on service level, lead time, demand fluctuation, supplier plan, dealer inventory management, ordering management) How do you control the level of inventory?
32. Is virtual inventory used/established in your supply chain?
33. Do you have transparency regarding parts stored in the warehouse, also in export markets?
34. Do you align inbound capacities with the delivery of parts from supplier? How? What are the critical factors in this process? (Examples: planning capabilities, stability of parts supply, supplier collaboration, information systems, data management, supply chain visibility)
35. Is there continuous flow in the inbound or are there ups and picks? How long do parts ordered lie in the inbound area (buffer of X days) in busy times?
36. What is the service degree (% of delivered orders within 24h)?
37. How do you balance workload and capacity?
38. What new technologies (web services, wireless applications, advanced software applications, RFID) do you use (especially for parts and payment tracking)?

Transport links:

39. What shipping methods do you use: plane, truck, train, boat?
40. What is the proportion of volume to express orders?

Information flow

41. Please give details of the IT systems used
42. How intuitive are the systems used, Do you use software with voice input?
43. Is there information transparency via a common data model that includes relevant customer data and support of cross-enterprise business processes, with shared metrics?
44. Do you use process modeling tools, analytics, and real-time decision support?

Forecasts

45. Forecasts; what role do forecasts play in your company (elaborate on advantages and disadvantages)? In which area do you use them? Do you use Big Data for more precise forecasts?
46. How good is the forecast accuracy?

Procurement

47. Do you have a central procurement area?
48. Do you use advanced technologies in the procurement process, please describe?
49. Innovation in Service and Supply Chain (please explain if you are innovative in this areas)

Appendix 13 – Interview Checklist Company 2

General Information about the business Management related:

1. Company/department size (in general and Service & Parts separately)
2. Organization structure (ask for copy)
3. How important is the service business in relation to the corporate strategy?
4. Services provided: sales new, used products, service, parts, financing, leasing, renting…
5. What is the value proposal of your company? Strengths? Areas to be improved?
6. Are spare parts procurement, sales, and logistics centralized?
7. What functions are outsourced?
8. Who are your main competitors?
9. What are currently the top drivers in your business area (price advantage, service advantage, customer demanding shorter order and cycle time, pressure to improve ROI, increase product quality, customer demanding reduced prices,…)?

Customer & Customer Segments

10. What "Customer segments" do you have?

KPIs related to the Service and Parts Business

11. What is the average order to delivery cycle time? (Do you continuously monitor and respond proactively to demand?)
12. What is the "Time to market" for new products?
13. What is the quality level?
14. How long does a customer wait until the product (hard-/software) is repaired?
15. What is the spare parts obsolescence rate? How often is the software updated?
16. How do you measure business performance (Return on assets, gross margin, market share,..)?

Detail Questions related to core Processes

17. What is the value chain? How can value be advanced for the end-customer?

Management related issues

18. Which services are procured and managed centrally, and which not?
19. What operations (to what %) are outsourced?
20. What is the constraint of the company (bottleneck)?
21. How flexible is the supply chain? How flexible is the customer support?
22. What KPIs are used to monitor the supply chain flexibility?

KPI used are divided in a few categories:

23. Financial KPIs: which are they?
24. What is: Cash cycle time, day's sales outstanding?
25. Are you able to monitor transaction costs?
26. How standardized is the supply chain? How standardized is customer support?
27. Please give some details concerning the supply chain visibility. What technology do you use?

Appendix 13 – Interview Checklist Company 2 (Cont.1)

Parts Business Process related Questions (for Hardware)

28. Do you use automated inventory planning tools? What exactly?
29. Have you implemented real-time transportation monitoring?
30. What is the storage method (cross dock, warehouses,..) and how important is it?
31. Inventory (value, inventory turns)- how do you calculate inventory? (Based on service level, lead time, demand fluctuation, supplier plan, dealer inventory management, ordering management) How do you control the level of inventory?
32. Is virtual inventory used/established in your supply chain?
33. Do you have transparency regarding parts stored in the warehouse, also in export markets?
34. Do you align inbound capacities with the delivery of parts from supplier? How? What are the critical factors in this process? (Examples: planning capabilities, stability of parts supply, supplier collaboration, information systems, data management, supply chain visibility)
35. Is there continuous flow in the inbound or are there ups and picks? How long do parts ordered lie in the inbound area (buffer of X days) in busy times?
36. What is the service degree (% of delivered orders within 24h)?
37. How do you balance workload and capacity?
38. What new technologies (web services, wireless applications, advanced software applications, RFID) do you use (especially for parts and payment tracking)?

Transport links:

39. What shipping methods do you use: plane, truck, train, boat?
40. What is the proportion of volume to express orders?

Information flow

41. Please give details of the IT systems used
42. How intuitive are the systems used, Do you use software with voice input?
43. Is there information transparency via a common data model that includes relevant customer data and support of cross-enterprise business processes, with shared metrics?
44. Do you use process modeling tools, analytics, and real-time decision support?

Forecasts

45. Forecasts; what role do forecasts play in your company (elaborate on advantages and disadvantages)? In which area do you use them? Do you use Big Data for more precise forecasts?
46. How good is the forecast accuracy?

Procurement

47. Do you have a central procurement area?
48. Do you use advanced technologies in the procurement process, please describe?
49. Innovation in Service and Supply Chain (please explain if you are innovative in this areas)

Appendix 13 – Interview Checklist Company 3

General Information about the business – management related:

1. Company/department size
2. Organization structure (ask for copy)
3. Customer Services provided
4. What is the value proposal of your company? Strengths? Areas to be improved?
5. What functions are outsourced?
6. Who are your main competitors?
7. What are currently the top drivers in your business area (price advantage, service advantage, customer demanding shorter delivery time, pressure to improve ROI, increase service quality, customer demanding reduced prices,…)?

Customer & Customer Segments

8. What “Customer segments” do you have?

KPIs related to the Service and Parts Business

9. What is the “Time to market” for new products?
10. What is the quality level?
11. How do you measure business performance (Return on assets, gross margin, market share,..)?

Detail Questions related to core Processes

12. What is the value chain? How can value be advanced for the end-customer?

Management related issues

13. Which services are procured and managed centrally, and which not?
14. What operations (to what %) are outsourced?
15. What is the constraint of the company (bottleneck)?
16. How flexible is the supply chain? How flexible is the customer support?
17. What KPIs are used to monitor the supply chain flexibility?

KPI used are divided in a few categories:

18. Financial KPIs: which are they?
19. Are you able to monitor transaction costs?
20. How standardized is the supply chain? How standardized is customer support?
21. Please give some details concerning the supply chain visibility. What technology do you use?

Business Process related Questions (for Hardware)

22. Have you implemented real-time transportation monitoring?
23. What is the storage method (cross dock, warehouses,..) and how important is it?
24. Do you have transparency regarding package delivery?
25. Do you align inbound capacities with the delivery of parts from supplier? How? What are the critical factors in this process? (Examples: planning capabilities, stability of parts supply, supplier collaboration, information systems, data management, supply chain visibility)

Appendix 13 – Interview Checklist Company 3 (Cont.1)

26. Is there continuous flow in the inbound or are there ups and picks? How long do parts ordered lie in the inbound area (buffer of X days) in busy times?
27. What is the service degree (% of delivered orders within 24h)?
28. What new technologies (web services, wireless applications, advanced software applications, RFID) do you use (especially for parts and payment tracking)?

Transport links:
29. What shipping methods do you use: plane, truck, train, boat?
30. What is the proportion of volume to express orders?

Information flow
31. Please give details of the IT systems used
32. How intuitive are the systems used, Do you use software with voice input?
33. Is there information transparency via a common data model that includes relevant customer data and support of cross-enterprise business processes, with shared metrics?
34. Do you use process modeling tools, analytics, and real-time decision support?

Forecasts
35. Forecasts; what role do forecasts play in your company (elaborate on advantages and disadvantages)? In which area do you use them? Do you use Big Data for more precise forecasts?
36. How good is the forecast accuracy?

Procurement
37. Do you have a central procurement area?
38. Do you use advanced technologies in the procurement process, please describe?
39. Innovation in Service and Supply Chain (please explain if you are innovative in this areas)

Appendix 13 – Interview Checklist Company 4

General Information about the business Management related:

1. Company/department size (in general and Service & Parts separately)
2. Organization structure (ask for copy)
3. How important is the service business in relation to the corporate strategy?
4. Services provided: sales new, used products, service, parts, financing, leasing, renting…
5. What is the value proposal of your company? Areas to be improved?
6. Are spare parts procurement and logistics centralized?
7. What functions are outsourced?
8. Do you remanufacture products? List the products, explain reasons, give details.
9. Who are your main competitors?
10. What are currently the top drivers in your business area (price advantage, service advantage, customer demanding shorter order and cycle time, pressure to improve ROI, increase product quality, corporate objective to reduce inventory, customer demanding reduced prices,…)?

KPIs related to the Service and Parts Business

13. What is the average order to delivery cycle time? (Do you continuously monitor and respond proactively to demand?)
15. What is the quality level (number of defects/repeat repairs)? Is quality erratic (variable, unreliable, irregular)?
16. How long does a customer wait for an (service) appointment? Are deliveries erratic?
17. What is the spare parts obsolescence rate?
18. What is the percentage of warranty revenue as a percentage of product revenue/total revenue?
19. How do you measure business performance (Return on assets, gross margin, market share,..)?
20. What is the value chain? How can value be advanced for the end-customer?
21. List the total steps, total time, the value creating steps (I asked myself if a customer would pay for it or if he would be less satisfied without it), the value creating time for the four core processes: Repair, Warranty & Goodwill, Parts Sales and Reverse logistics

Management related issues

22. Which services are procured and managed centrally, and which not?
23. What operations (to what %) are outsourced?
24. What is the constraint of the company (bottleneck)?
25. How flexible is the supply chain?
26. What KPIs are used to monitor the supply chain flexibility?
27. What about stability and agility of supply chain? How do you measure it?

KPI used are divided in a few categories:

28. Financial KPIs: which are they, what is the cost level in the warehouse?
29. What is: Cash cycle time, day's sales outstanding, days of inventory, days payables outstanding in your business?
30. Are you able to monitor transaction costs?
31. How standardized is the supply chain?
32. Please give some details concerning the supply chain visibility. What technology do you use?

Appendix 13 – Interview Checklist Company 4 (Cont.1)

Parts Business Process related Questions

33. Do you use automated inventory planning tools? What exactly?
34. Have you implemented real-time transportation monitoring?
35. What is the storage method (cross dock, warehouses,..) and how important is it?
36. Inventory (value, inventory turns)- how do you calculate inventory? (Based on service level, lead time, demand fluctuation, supplier plan, dealer inventory management, ordering management) How do you control the level of inventory?
37. Is virtual inventory used/established in your supply chain?
38. Do you have transparency regarding parts stored in the warehouse, also in export markets?
39. Do you align inbound capacities with the delivery of parts from supplier? How? What are the critical factors in this process? (Examples: planning capabilities, stability of parts supply, supplier collaboration, information systems, data management, supply chain visibility)
40. Is there continuous flow in the inbound or are there ups and picks? How long do parts ordered lie in the inbound area (buffer of X days) in busy times?
41. What is the service degree (% of delivered orders within 24h)?
42. How do you balance workload and capacity?
43. What new technologies (web services, wireless applications, advanced software applications, RFID) do you use (especially for parts and payment tracking)?

Transport links:

44. What shipping methods do you use: plane, truck, train, boat?
45. What is the proportion of volume to express orders? Do you think an increase in the % of volume orders is beneficial?
46. What type of container do you use – one way or multi way? What are the advantages/disadvantages of both? Do different markets need different container types?
47. What is the % of defective deliveries as reported by the customer and the trend (late, early, incorrect – wrong product or amount)?

Information flow

48. Please give details of the IT systems used
49. Do you use in-house IT solutions or commercial ones (How intuitive are the systems used, Do you use software with voice input?)?
50. Is there information transparency via a common data model that includes relevant customer data and support of cross-enterprise business processes, with shared metrics?
51. Do you use process modeling tools, analytics, and real-time decision support?

Appendix 13 – Interview Checklist Company 4 (Cont.2)

Forecasts

52. Forecasts; what role do forecasts play in your company (elaborate on advantages and disadvantages)? In which area do you use them? Do you use Big Data for more precise forecasts?
53. Do you use modern IT technology for forecasting? How good is the forecast accuracy?

Procurement

54. Do you have a central procurement area?
55. Do you use advanced technologies in the procurement process, please describe?

56. Innovation in Service and Supply Chain (please explain if you are innovative in this areas)

Appendix 13 – Interview Checklist Company 5

General Information about the business – management related:

1. Company/department size
2. Organization structure (ask for copy)
3. Customer Services provided
4. What is the value proposal of your company? Strengths? Areas to be improved?
5. What functions are outsourced?
6. Who are your main competitors?
7. What are currently the top drivers in your business area (price advantage, service advantage, customer demanding shorter delivery time, pressure to improve ROI, increase service quality, customer demanding reduced prices,…)?

Customer & Customer Segments

8. Do you have customer segments and if yes what "Customer segments" do you have?

KPIs related to the Service and Parts Business

9. What is the average delivery time?
10. What is the quality level?
11. How do you measure business performance (Return on assets, gross margin, market share,..)?

Detail Questions related to core Processes

12. What is the value chain? How can value be advanced for the end-customer?

Management related issues

13. Which services are procured and managed centrally, and which not?
14. What operations (to what %) are outsourced?
15. What is the constraint of the company (bottleneck)?
16. How flexible is the supply chain? How flexible is the customer support?
17. What KPIs are used to monitor the supply chain flexibility?

KPI used are divided in a few categories:

18. Financial KPIs: which are they?
19. Are you able to monitor transaction costs?
20. How standardized is the supply chain? How standardized is customer support?
21. Please give some details concerning the supply chain visibility. What technology do you use?

Appendix 13 – Interview Checklist Company 5 (Cont.1)

Business Process related Questions (for Hardware)

22. Have you implemented real-time transportation monitoring?
23. What is the storage method (cross dock, warehouses,..) and how important is it?
24. Do you have transparency regarding package delivery (worldwide)?
25. How long do you store packages, what are the critical factors in the process? (Examples: planning capabilities, supplier collaboration, information systems, data management, supply chain visibility)
26. Is there continuous flow in the system or are there ups and picks?
27. What is the service degree (% of delivered orders within Xh)?
28. How do you balance workload and capacity?
29. What new technologies (web services, wireless applications, advanced software applications, RFID) do you use (especially for package and payment tracking)?

Transport links:

30. What shipping methods do you use: air, road, rail, sea?
31. What is the proportion of volume to express orders?

Information flow

32. Please give details of the IT systems used
33. How intuitive are the systems used, Do you use software with voice input?
34. Is there information transparency via a common data model that includes relevant customer data and support of cross-enterprise business processes, with shared metrics?

Forecasts

35. Forecasts; what role do forecasts play in your company (elaborate on advantages and disadvantages)? In which area do you use them? Do you use Big Data for more precise forecasts?
36. If you use forecasts how good is the forecast accuracy?

Procurement

37. Do you have a central procurement area?
38. Do you use advanced technologies in the procurement process, please describe?
39. Innovation in Service and Supply Chain (please explain if you are innovative in these areas)

Appendix 13 – Interview Checklist Company 6

General Information about the business Management related:

1. Company/department size (in general and Service & Parts separately)
2. Organization structure (ask for copy)
3. How important is the service business in relation to the corporate strategy?
4. Services provided: sales new, used products, service, parts, financing, leasing, renting…
5. What is the value proposal of your company? Strengths? Areas to be improved?
6. Are spare parts procurement, sales, and logistics centralized?
7. What functions are outsourced?
8. Do you remanufacture products? List the products, explain reasons, give details.
9. Who are your main competitors?
10. What are currently the top drivers in your business area (price advantage, service advantage, customer demanding shorter order and cycle time, pressure to improve ROI, increase product quality, corporate objective to reduce inventory, customer demanding reduced prices,…)?

Customer & Customer Segments

11. What “Customer segments” do you have?
12. Do you have processes defined for customers that deliver products outside the business opening hours? Please give details.

KPIs related to the Service and Parts Business

13. What is the average order to delivery cycle time? (Do you continuously monitor and respond proactively to demand?)
14. What is the “Time to market” for new products?
15. What is the quality level (number of defects/repeat repairs)? Is quality erratic (variable, unreliable, irregular)?
16. How long does a customer wait for an (service) appointment? Are deliveries erratic?
17. What is the spare parts obsolescence rate?
18. What is the percentage of warranty revenue as a percentage of product revenue/total revenue?
19. How do you measure business performance (Return on assets, gross margin, market share,..)?

Detail Questions related to the core Processes (Parts Business has additional questions due to the importance)

20. What is the value chain? How can value be advanced for the end-customer?
21. List the total steps, total time, the value creating steps (I asked myself if a customer would pay for it or if he would be less satisfied without it), the value creating time for the four core processes: Repair, Warranty & Goodwill, Parts Sales and Reverse logistics

Appendix 13 – Interview Checklist Company 6 (Cont.1)

Management related issues

22. Which services are procured and managed centrally, and which not?
23. What operations (to what %) are outsourced?
24. What is the constraint of the company (bottleneck)?
25. How flexible is the supply chain?
26. What KPIs are used to monitor the supply chain flexibility?
27. What about stability and agility of supply chain? How do you measure it?

KPI used are divided in a few categories:

28. Financial KPIs: which are they, what is the cost level in the warehouse?
29. What is: Cash cycle time, day's sales outstanding, days of inventory, days payables outstanding in your business?
30. Are you able to monitor transaction costs?
31. How standardized is the supply chain?
32. Please give some details concerning the supply chain visibility. What technology do you use?

Parts Business Process related Questions

33. Do you use automated inventory planning tools? What exactly?
34. Have you implemented real-time transportation monitoring?
35. What is the storage method (cross dock, warehouses,..) and how important is it?
36. Inventory (value, inventory turns)- how do you calculate inventory? (Based on service level, lead time, demand fluctuation, supplier plan, dealer inventory management, ordering management) How do you control the level of inventory?
37. Is virtual inventory used/established in your supply chain?
38. Do you have transparency regarding parts stored in the warehouse, also in export markets?
39. Do you align inbound capacities with the delivery of parts from supplier? How? What are the critical factors in this process? (Examples: planning capabilities, stability of parts supply, supplier collaboration, information systems, data management, supply chain visibility)
40. Is there continuous flow in the inbound or are there ups and picks? How long do parts ordered lie in the inbound area (buffer of X days) in busy times?
41. What is the service degree (% of delivered orders within 24h)?
42. How do you balance workload and capacity?
43. What new technologies (web services, wireless applications, advanced software applications, RFID) do you use (especially for parts and payment tracking)?

Appendix 13 – Interview Checklist Company 6 (Cont.2)

Transport links:
44. What shipping methods do you use: plane, truck, train, boat?
45. What is the proportion of volume to express orders? Do you think an increase in the % of volume orders is beneficial?
46. What type of container do you use – one way or multi way? What are the advantages/disadvantages of both? Do different markets need different container types?
47. What is the % of defective deliveries as reported by the customer and the trend (late, early, incorrect – wrong product or amount)?

Information flow
48. Please give details of the IT systems used
49. Do you use in-house IT solutions or commercial ones (How intuitive are the systems used, Do you use software with voice input?)?
50. Is there information transparency via a common data model that includes relevant customer data and support of cross-enterprise business processes, with shared metrics?
51. Do you use process modeling tools, analytics, and real-time decision support?

Other questions
Forecasts
52. Forecasts; what role do forecasts play in your company (elaborate on advantages and disadvantages)? In which area do you use them? Do you use Big Data for more precise forecasts?
53. Do you use modern IT technology for forecasting? How good is the forecast accuracy?

Procurement
54. Do you have a central procurement area?
55. Do you use advanced technologies in the procurement process, please describe?
56. Innovation in Service and Supply Chain (please explain if you are innovative in this areas)

Appendix 14 – General Criteria of Company 1

Company 1 General Criteria	
1	**Industry sector** • IT Services & Consulting
2	**Products** • Hardware, software and services • IT Financing • Offers main frame and high-end storage products • No consumer products such as PCs • Trade with used products plays a minor role in the business **Value proposal/strengths** • The product portfolio, combined with research • Research capabilities resulting in a high number of patents • The ability to connect new technologies with the systems currently running today's enterprises, resulting in integrated solutions • Broad ecosystem of partners and alliances • High levels of security to ensure privacy and integrity of action • The company would like to help transform industries and professions with data • Remodel enterprise IT for the cloud era • Reconceive work by helping clients build systems of engagement, underpinned by the imperative of security, simultaneously addressing significant challenges in hardware
3	**Position in industry sector** • The company is a global player, operating and leading in five business segments
4	**Business trends** • Sales of complete solutions and services such as: cloud, business analytics, platforms for mobile technologies and social media • Strategic cooperation and development of ecosystems
5	**Top business drivers** • Performance, pricing and portfolio
6	**Number of employees** • 379,000 in total and more than 5,000 in Germany
7	**Customer segments** • Business customers from all industries • Segmentation occurs according to company size, differentiating between enterprise (large corporations) and mid-market (mid-sized companies)
8	**Product development strategies** • The company invests 6% of revenue in research • The sale of services and not products; for example, the cloud enables customers to transform their IT and business processes into digital services • By enforcing higher standards up and down the technology value chain, new products and services, and even entire business models, can be created in weeks rather than months or years • Building platforms in cooperation with former competitors and creating ecosystems in order to enlarge the product portfolio
9	**Organizational strategies**

Company 1 General Criteria	
	• In Germany the company is largely decentralized, branches are often located near to customers • Functions such as sales, service, training and administration are not combined, but organized in centers distributed around the country • Future business such as cloud, analytics, etc. is organized independently • All customer related work, including service, is considered equally important; only internal functions are rated differently • Global solutions are sought for bottlenecks; the process is aided by high transparency • Functions such as logistics and, in part, warehousing are outsourced
10	**Production facilities** • No information was provided
11	**Forecasts** • Are used extensively • Due to precise forecasts, resource planning covers demand and, for example, parts obsolescence does not occur
12	**HR strategy** • Investments in personnel in the form of training are an important factor in meeting the rising and changing demands of the market on the know-how of the employees • In 2014 all employees were required to spend a minimum of 40 of their annual working hours specifically for the improvement of their skills, e.g. to expand their knowledge of the company's solutions portfolio in new strategic business fields such as cloud computing and smarter analytics • Particular importance was placed on the "Think Friday" training offers carried out by the company and by selected business partners
13	**Improvement programs / Benchmark** • Optimization processes in general; this means making compromises in order to find the best solution suitable for the needs of the system, as there are various constraints such as budget, service level etc. • Simulations are carried out in the case of the main frame in which the importance of the individual constraints can be adjusted to find the best compromised solution
14	**KPIs overall** • Financial KPIs: revenue, profit, customer satisfaction • Transaction cost monitoring • All KPIs required by the international accounting reporting standards
15	**Supplier strategy** • No information was provided
16	**Procurement** • Centrally organized
17	**Advanced technology in procurement** • Neither implemented nor used
18	**IT** • Standardized work environment worldwide, e.g. printer access or travel expense accounting • If new companies are acquired their processes and systems are drafted onto the existing ones to ensure consistency; interfaces are developed to the software that is the main product of the acquired company

Company 1 General Criteria	
	• Software with voice recognition is not usually used • In warehousing and custom development SAP solutions are used • Process modeling tools, analytics and real-time decision support are used extensively
19	**Business Model** • To provide service solutions and not to sell individual products • For internal financing, cash-pooling agreements are used • To sell licenses, not software • The company has reinvented core franchises and provides cloud services, analytics and mobile services by building platforms that are used by competitors • Development of an ecosystem for the power technology to reduce costs
20	**Transaction costs** • Are monitored
21	**Profit margin (After Sales, Parts)** • The following information from 2014 was provided: total consolidated gross margin worldwide 50%, including global technology services, 38.3% and global business services, 30.8% • No information concerning parts margin was provided
22	**Legal regulations** • No information was provided
23	**Environmental issues** • No information was provided

Appendix 14 – After Sales Criteria of Company 1

Company 1 After Sales Criteria	
1	**Profit share from After Sales business** • Gross margin, global technology services 38.3%
2	**Supply chain planning** • The supply chain is planned using optimization processes; this means making compromises in order to find the best solution suitable for the needs of the system, as there are various constraints such as budget, service level etc. • A simulation is always carried out in the case of the main frame in which the importance of the individual constraints can be adjusted to find the best compromised solution • Spare parts procurement, sales, and logistics are partially centralized. Virtual Global Supply Chain Management is implemented. Global solutions are sought for bottlenecks. The process is aided by high transparency. • Parts / components warehousing is conducted worldwide, but centralized according to function / division • The serial parts warehousing is kept distinct from the spare parts warehousing • The flexibility depends on the service level • Should supply bottlenecks loom, international teams are formed to solve the problem. This is called “Transparent Supply Chain”. The same applies to software problems, in which case virtual teams are formed using telephone conferences and social media functions to solve the problems • Inventory planning is implemented extensively, using the company’s own optimization software employing supply chain algorithms • Real-time transportation monitoring is implemented
3	**Share of employees in After Sales** • In Germany the share was 44% in 2014
4	**After Sales KPIs** • Only information related to overall KPIs was provided
5	**Standardization of supply chain activities** • Processes are standardized worldwide
6	**Supply chain improvement programs** • Warehousing has been optimized with the help of Business Analytics • Continuous use of process optimization programs and simulations
7	**Supply base strategy** • No information was provided
8	**Customer demand** • Can be planned due to the advanced forecast methods applied
9	**Supply network details** • Supply chain visibility is very high, all parts stocks are visible
10	**Customer data** • No information was provided
11	**Availability in service (no. of shifts)** • For every service contract there is a hotline or call center which manages problems • Hotlines are available worldwide 24/7 and have 3 levels

Company 1 After Sales Criteria	
	• In order to solve problems immediately, the company utilizes its global position to pass the processing from a hotline in one time zone to a hotline in a different time zone • Service is organized locally and capacity problems are otherwise solved using matrix organization and shared services
12	**Preventive maintenance** • The company is in the fortunate position of being able to sell many products with service contracts because it is the only supplier in this segment • In the event of problems / errors, the computer reports the problem / error itself using the Call-Home function
13	**Bottlenecks vs. risks** • Availability of financial resources
14	**Parts strategy** • Some parts are stored centrally, some locally, depending on the demand forecasts
15	**Second parts line** • Not applicable
16	**Number of parts codes** • No information was provided
17	**Parts ordering process** • Besides forecast demand and planning no further information was provided
18	**Value of inventory share compared to revenue** • This was 2012: 481m $ and reduced to 380 m $ in 2013 due to maintenance transfer to a supplier
19	**Use of parts kits for repair** • Not applicable
20	**Use of cross docking operations** • Cross docking is used; parts are stored according to different criteria
21	**Delivery quality** • No information was provided
22	**Inventory turns** • No information was provided
23	**Use of virtual inventory** • Yes, for warehousing itself SAP, and custom developed applications are also used
24	**Payment regulation** • No information was provided
25	**Service degree** • 95% - 100%; 100% for parts stored at the respective locations
26	**Technologies used in warehousing** • RFID

Appendix 14 – General Criteria of Company 2

Company 2 General Criteria	
1	**Industry sector** • IT Services & Consulting
2	**Products** • Hardware, software and services for end-users and enterprises • End-user products include notebooks, desktop PCs, thin client products, tablets, third-party software, and client-related peripherals • The product portfolio for enterprises includes: servers, networking, storage, converged infrastructure offerings, and peripherals • Software: systems management, security, and information management • IT and business services, including support and deployment services, infrastructure, cloud, security services, applications and business process services • Leasing through not only its own leasing company, but also through a cooperation with an external company • Used products are sold by retailers that buy leasing returns and sell the products on Ebay or other online channels, but service support for used products is offered by the company and can be bought • Parts sales **Value proposal/strengths** • Product portfolio • The majority of services provided are in-house and not outsourced; good communication in-house between sales and technical support • Good, award-winning hard- and software products (some of the servers offered are benchmark in their respective category), specialized software • The company makes advanced IT technology accessible to organizations of all sizes • Investments in end-to-end solutions and the enhancement of customers' software capabilities result in investments that increase R&D and sales capacity • Aim to minimize the environmental impact of their products while helping customers to further reduce the impact of their IT • Drives social and environmental responsibility in the IT industry and the supply chain
3	**Position in industry sector** • The company is a global player, a full product and service provider for IT technology from notebooks to data centers, even for large companies • Areas for improvement: tablets and smart phones are a highly competitive area where it is difficult to maintain a leading position
4	**Business trends** • Sales of end-to-end solutions and services and the enhancement of software capabilities resulting in investments that increase R&D and sales capacity • Industry collaboration • Acquisitions in order to increase agility, efficiency and scalability
5	**Top business drivers** • The strategic acquisitions in hard- and software are the top sales driver, especially in the high-margin segments (complex hardware systems, administration software for large companies, switches that control big data centers etc.)
6	**Number of employees**

Company 2 General Criteria	
	• 95,000 in total and about 2,000 in Germany
7	**Customer segments** • Private customers who either buy directly from the web store or from retail through big distributors • Business customers. Here segmentation occurs according to company size, we distinguish four categories: - SMB (small and mid-sized business), - PE (preferred accounts – bigger businesses), - Public Sector (from small churches up to big organizations) and - G 500 (500 global player customers – these are the only customers able to order products across borders)
8	**Product development strategies** • The company has realized that in the sales of commercial IT solutions the margins are continually decreasing, there are fewer possibilities to protect innovation, fewer patents and a fierce competition with Asian companies that are able to produce the equipment more cheaply. It is very difficult to defend a competitive advantage in the commodity business sector • The company will concentrate in future on business activities that are more profitable in the long term, such as complex hardware products, switches, special storage products and software • The above mentioned products need service support for hard-/ and software as well as for the databases installed. The target is to offer all products and support to customers and to achieve higher margins and avoid a rapid replication of the business model by the competition • Time to market for new products: • - For notebooks and desktops, generally 18 to 24 months, because this is the development cycle of a major supplier • - For consumer products, generally 1 year and • - For complex products 2 to 3 years • Innovations are mainly in the domain of software solutions for complex technical problems
9	**Organizational strategies** • It is a holding company that conducts its business worldwide through its subsidiaries • The company operates in four segments: - End-User Computing, - Enterprise Solutions, - IT Services, - Software Group, and is the - Largest tech recycler • There are operational segments with the following functions: sales, consulting, technical support for hard- and software. There is no central service department, but every segment has employees who undertake service tasks: about 25% of employees in Germany are involved in service operations • Sales per market/country are centralized • The company is in a reorganization phase after a carefully orchestrated acquisition strategy in order to increase agility, efficiency, scalability, and to ensure sustained economic growth • The reorganization of services includes the function Technical Account Manager (TAM) which is similar to the function Account Manager but with the goal of coordinating all the technical requests and problems of a client until these are solved • The company sells the products through 4,300 certified partners worldwide (because of different partnerships and pricing levels) and 165,000 channel partners, mainly system integrators

Company 2 General Criteria	
	• Regarding sales channels in Germany, the company sells about 70% of its simple products directly, either through the web shop or through its own field force (internal and external) and the rest are sold through distributors. There are about ten distributors in Germany, often specialized in products (servers, notebooks, desktops, etc.) • The company has set up web shops in other countries too. The strategy is to sell simple products through distributors or web shops and the complex ones (servers, services, storage etc.) through its own staff • Of the entire product range in Germany, about 75% of sales are frictionless, with no consultancy necessary, and 25% of sales are made by the sales force, including the field force • For larger customers the company sets up individual websites, that can be accessed by the client, on which new products and their sales conditions are listed and the client can simply order the simple products which require no further explanation or consultancy • Parts sales are covered by service support, and there is also a department which specializes in parts • Forecasting is decentralized, but procurement is centralized. Sales teams in each country are also centralized but each team has specialists for servers, switches, notebooks etc., and consultants for services • Products sold via distributors and retailers should be serviced by them, but Dell also assists these customers if they have service tags
10	**Production facilities** • In the last ten years about 80% of the production has been outsourced • Complex, built to order products (BTO products) are produced in China
11	**Forecasts** • Forecasts are made based on historical data, such as an operation plan, and by considering the launching of new products, seasonality and market data (external). Big data is used only sporadically. • Forecasts are made regularly every second week (more often only if changes occur in the market or system), monthly, yearly. • The company even made forecasts weekly for a time, but an analysis conducted by a renowned consultant revealed that this is not necessary and the 14-day frequency is sufficient
12	**HR strategy** • No information was provided
13	**Improvement programs / Benchmark** • No information was provided
14	**KPIs overall** • Market share per product • Free cash flow generated • Net promoter score (NPS), a customer loyalty metric developed by Fred Reichheld, Bain & Company, and Satmetrix
15	**Supplier strategy** • To work with suppliers by sharing expertise and best practices and striving to improve the suppliers' capabilities • To make it possible for suppliers to uphold the same high standards as set for their own company • The supply chain is a shared network of interconnected companies and industries, and high importance is allocated to industry collaboration, to set strong supplier standards that create positive change

Company 2 General Criteria	
	• Suppliers are instructed to responsibly source the materials used in products, so called Conflict-Free Minerals • Suppliers have to ensure that they operate responsibly and ethically • Supplier Diversity: The benefits of working with diverse suppliers are immense and include strengthening the ability to more effectively reach a diverse marketplace
16	**Procurement** • Centralized management per subsidiary • The company invests in recycling, not only because of a future shortage in rare metal earths but also due to corporate social responsibility related to buying these products from conflict regions
17	**Advanced technology in procurement** • No
18	**IT** • Mainly own developments and Oracle database • No software with voice recognition in use
19	**Business Model** • There are different service levels that can be contacted – the shorter the reaction time the more expensive the service • The company solves 98% of customer issues using social media platforms and online communities • The leasing business volume has increased since the Euro has lost value against the US $ because pricing is in US $. When companies have difficulties buying products because of the more expensive Dollar it is suggested that they lease devices as it is less expensive
20	**Transaction costs** • Are not internally reported; no further information was provided
21	**Profit margin (After Sales, Parts)** • The goal is to offer all products and support to customers and achieve higher margins, 30-40% instead of 6%
22	**Legal regulations** • No information was provided
23	**Environmental issues** • Yes, recycling and supplier labor principles

Appendix 14 – After Sales Criteria of Company 2

Company 2 After Sales Criteria	
1	**Profit share from After Sales business** • Only overall profit margins were provided
2	**Supply chain planning** • In the supply chain Dell follows industry best practice examples • The alignment of inbound capacities with the delivery of parts from suppliers runs smoothly because of good forecasting and planning • Incoming supplies are delivered by air, road, rail and sea; for problems air freight is used, and otherwise 80% is delivered by sea and road • Delivery to customers is carried out by DHL
3	**Share of employees in After Sales** • In Germany in 2014/2015 the share was 25%
4	**After Sales KPIs** • There is a difference between high rolling products that are in stock and complex built to order products. The lead time for high rolling products is a maximum of three days, whereas for the BTO products it is ten days. • Service levels depend on the service contracts bought by the customer and range from basic services that last 90 days up to next business day service with software upgrades and support for software configurations. In addition, installation of software and hardware replacement that and support up to a period of five years.
5	**Standardization of supply chain activities** • Generally more service is offered than agreed in the service contract, and the strategy is to have standardized service contracts for private customers up to mid-sized businesses, whereas for larger companies (key account customers) individualized service contracts are defined together with the customer and approved by the legal department • The customer support is standardized
6	**Supply chain improvement programs** • No process modeling tools, analytics, and real-time decision support in use; process visualization done with Visio
7	**Supply base strategy** • No information was provided
8	**Customer demand** • No information was provided
9	**Supply network details** • BTO products are produced in China and transported mainly by air • Sea and rail freight are also used, but the storage capacity is generally compensated for by using air freight • The central warehouse for Germany, France, the UK, the Netherlands and Belgium is in the Netherlands, because of low warehousing costs • Another four warehouses are in the US, Russia, Dubai, and South Africa • Flexibility is not a paramount goal; the strategy is long-term planning based on good prognoses so that products can be bought and sold at economically acceptable prices and logistics is not expensive. If flexibility is requested the customer has to pay a premium

Company 2 After Sales Criteria	
10	**Customer data** • No information was provided
11	**Availability in service (no. of shifts)** • No information was provided
12	**Preventive maintenance** • No information was provided, the share of products repaired is low
13	**Bottlenecks vs. risks** • IT systems that are not networked; planning, ordering and billing systems are not networked, plus the acquired companies have different systems in use
14	**Parts strategy** • For older products a certain number of parts are stored, but they are relatively expensive due to warehousing costs, or because they are disassembled from products not sold • The parts supply for customer PCs is guaranteed for 5 years, and for up to 7 years for servers, • Cross border parts delivery is also used, therefore the obsolescence rate is not very high
15	**Second parts line** • Not applicable
16	**Number of parts codes** • No information was provided
17	**Parts ordering process** • The software used for ordering are an internal product and the Oracle database. There is no SAP standardized ordering system in use
18	**Value of inventory share compared to revenue** • No information was provided
19	**Use of parts kits for repair** • Not applicable as the company does not usually repair products; when a field technician visits a customer he takes the necessary parts to be replaced with him
20	**Use of cross dock operations** • Depending on the part type both classic warehousing and cross dock are used
21	**Delivery quality** • Regarding correctly delivered items, 99% • Regarding delivery time: 95% for products in stock with a lead time of up to 3 days, 80% for complex, BTO products. The lead time is 10 days, but if producers have capacity they build the products in 1-2 days.
22	**Inventory turns** • 30.7 inventory turns p.a.
23	**Use of virtual inventory** • Yes
24	**Payment regulation** • The company is paid sooner by the customer than it pays its supplier, especially for the BTO products

Company 2 After Sales Criteria	
25	**Service degree** • On average 90%
26	**Technologies used in warehousing** • No information was provided

Appendix 14 – General Criteria of Company 3

Company 3 General Criteria	
1	**Industry sector** • Automated Manufacturing & Robots
2	**Products** • Automation solutions ranging from components and cells to fully automated systems • The focus is on the core component for automation, the robot. The company develops, assembles and sells industrial and service robots together with robot controllers, software and services • The systems division offers customized solutions for the automation of production processes, plans and builds automated systems as well as individual production cells and upgrades existing systems • It is the partner for process- and customer-oriented cells and solutions for general industry • Automation solutions for hospitals, warehouses and distribution centers **Value proposal/strengths** • In Customer Service it is the quick reaction times; missing parts are sent within 2 hours to solve the problem. This is the highest standard • Parts availability and its logistics, which is also ensured abroad because this process, which is organized in cooperation with the local company, functions better than that of the competition's which have no parts warehousing on location and cannot react as quickly • Innovation and technology leadership • Trustworthiness and reliability
3	**Position in industry sector** • A globally active automation company, internationally represented with about 100 companies • One of the world's leading suppliers in the fields of robotics, automation and systems engineering • The company operates in four business segments: robotics, systems, industrial solutions, and automation solutions for hospitals, warehouses and distribution centers
4	**Business trends** • Because the company delivers parts quickly, the trend for clients is to maintain smaller inventories, thereby lowering their warehousing costs
5	**Top business drivers** • Investments in new technologies, developed in cooperation, and pricing
6	**Number of employees** • Global workforce of about 12,000 of which 2,500 employees work in Germany
7	**Customer segments** • There are four customer segments: - Automotive - Aircraft - Solar industry - Medicine - Order volume
8	**Product development strategies** • The company sets trends in robot-based automation. There are three strategies: • Expansion of innovation and technology leadership • Diversification of business operations in new markets and regions

Company 3 General Criteria	
	• Optimization of cost structure and continuous improvement of efficiency • 90% of the parts in robots are original parts, and are very specific, having been developed together with suppliers and then produced, resulting in less competition • Time to market for new products is two to five years
9	**Organizational strategies** • Utilizing resources efficiently and continuously seeking to improve processes, reducing employee stress and minimizing the environmental footprint • Trustworthiness and reliability which ensure the enduring success of all stakeholders • The company has subsidiaries in foreign countries which are independent businesses with their own CEOs and belong, in the majority, to the company. Only in isolated cases does the company deal with partners, and system partners who buy the robots and have the know-how to build systems for clients – e.g. handling applications • The client is not able to do much with the robot itself; it is the system partners who combine the individual robots to make one system in order to develop the particular application for the client • The company works with several system partners as the client applications can vary greatly • The system partners are also supported by Customer Service • The end-customer can get parts from both the system partner and from the company itself • The service of facilities is carried out by system partners but, because the robots are the main components, the client can also contact the company directly • The sales business consists of the following divisions: automotive, products and systems for welding, consumer goods, electronics, machine automation and customer service • The sales organization is flatter than that of the automotive industry • The Customer Service Parts, Repairs & Used Department consists of the following departments: spare parts and repairs, used robots for resale, field service, training and engineering • Due to its profitability, customer service has a corresponding position in the company as does the willingness to invest in new products as customer service is seen as the differentiating quality to the competition • The trade with used robots is an additional market in which the company sells robots that are obsolete and similar in quality to the new ones. However, there are dealers who buy robots and resell them cheaply • The engineering team customizes robots according to customers’ wishes; the standard development of robots takes place in another division • Customer Service is responsible for the global strategic focus and for operations in Germany • The parts warehousing and logistics is outsourced • In 2014 the production logistics in Augsburg was separated from the sales logistics as their individual requirements varied too greatly; the service logistics is outsourced
10	**Production facilities** • The company has four production facilities: one in Germany, two in Hungary, and one in China
11	**Forecasts** • The company is currently looking for solutions to making more accurate forecasts
12	**HR strategy** • No information was provided
13	**Improvement programs / Benchmark** • The project “Power On” aims to standardize IT solutions • Participates in the Program Industry 4.0. of the German government which promotes the computerization of manufacturing

Company 3 General Criteria	
14	**KPIs overall** • All KPIs required by the international accounting reporting standards
15	**Supplier strategy** • No information was provided
16	**Procurement** • Not centralized, but the goal is to centralize this function. E.g. procurement at headquarters also negotiates the parts which are needed for the production in China
17	**Advanced technology in procurement** • Not used
18	**IT** • The company uses SAP; the various companies abroad have differing, less standardized IT solutions • The major SAP solution is planned for the headquarters, the larger companies abroad and large new acquisitions • The smaller companies and acquisitions will take over Business One from SAP • No software with voice recognition is used
19	**Business Model** • No information was provided
20	**Transaction costs** • Not used
21	**Profit margin (After Sales, Parts)** • No exact information was provided
22	**Legal regulations** • No information was provided
23	**Environmental issues** • No information was provided

Appendix 14 – After Sales Criteria of Company 3

Company 3 After Sales Criteria	
1	**Profit share from After Sales business** • Regarding turnover and profit, the parts business also tops the list in this industry, followed by service as this is also carried out by the company itself
2	**Supply chain planning** • The warehousing (receipt of goods, storage, commissioning, packaging) in Europe and China has been outsourced, and a contract is currently out to tender in the USA • Parcel services – air freight or transport companies are used for deliveries by air, road and rail. Sea freight is very seldom used because it takes too long • For parcel services real-time transportation monitoring is implemented • There is 100% transparency regarding package delivery for parcel services. For air freight and road transport an email is sent to customers informing them that the goods have been dis-patched
3	**Share of employees in After Sales** • In Germany 2%
4	**After Sales KPIs** • Incoming orders • Turnover • Margins • Warehouse value • Stock turnover (approx. 3 years as the parts availability is guaranteed for 10 years) • Missing parts are delivered in 2 to 24 hours • Transaction costs are measured in logistics, e.g. receipt of goods/delivery note or receipt of goods/entry position; analog with consignment
5	**Standardization of supply chain activities** • Processes are standardized; e.g. in logistics, an order placed by 17.30 is dispatched on the same day • The company has the necessary transparency as transport in the EU is ensured by good logis-tics providers; as soon as the consignment has been booked an email is sent to the customer and to the company. • The above mentioned service providers work with the company's systems and are bound to them
6	**Supply chain improvement programs** • IT Integration
7	**Supply base strategy** • No information was provided
8	**Customer demand** • The proportion of volume to express orders is: 80% volume orders / 20% express orders
9	**Supply network details** • For cheaper, standardized parts VMI (vendor management inventory) is used, by means of which the supplier can see the stock and deliver independently. An extension to other parts is not considered worthwhile
10	**Customer data** • No information was provided

Company 3 After Sales Criteria	
11	**Availability in service (no. of shifts)** • No information was provided except that employees in customer support are available at set hours
12	**Preventive maintenance** • The company also sells service contracts except to the automotive industry, as this industry has its own specialists who are on location to solve problems, but in other industries service contracts are marketed as this saves the customers the costs of training • The warranty depends on the customer and business volume and ranges between 1 and 3 years • Goodwill is customer specific
13	**Bottlenecks vs. risks** • Exact forecasts for parts stock are required, especially for the parts which are so numerous that they cannot be warehoused. For example: cables (working parts) which provide the robots with power
14	**Parts strategy** • The disadvantage of self produced specific parts is the industrial standard in engineering, as customers expect the producer to have spare parts available for a period of up to 10 years after the end of production. This means having the necessary number of parts available in stock. The scrapping of parts is always an issue, as it is carried out regularly. • The remainder are catalogue parts – often electronic parts which can be obtained through the manufacturers' catalogues, although the problem here is that the validity periods are shorter and it often happens that the parts break during storage or are defective
15	**Second parts line** • Not used, contrary to the company's genuine parts strategy
16	**Number of parts codes** • No information was provided
17	**Parts ordering process** • No information was provided
18	**Value of inventory share compared to revenue** • No information was provided
19	**Use of parts kits for repair** • The set consists of a main component and attachment parts; it does not consist of several main components • A logistic supplier compiles parts sets for repairs as this is economically more feasible
20	**Use of cross dock operations** • As logistics operations are outsourced, no insights can be provided
21	**Delivery quality** • Quality level is based on the number of software errors (ideally none), stand still periods, precision and the speed of the robot
22	**Inventory turns** • No information was provided
23	**Use of virtual inventory** • No

Company 3 After Sales Criteria	
24	**Payment regulation** • No information was provided
25	**Service degree** • No information was provided
26	**Technologies used in warehousing** • No information was provided as the operation is outsourced

Appendix 14 – General Criteria of Company 4

Company 4 General Criteria	
1	**Industry sector** • Aircraft maintenance and engineering
2	**Products** • Service and parts; parts are bought from the components producers (not from the OEM as in the automotive industry) • The majority of the customers have service contracts. There are different service level offers; the higher the degree of service, the higher the price for the contract. • The lowest level is service/repair on demand • Service is the core business; the company provides technical solutions for airlines worldwide. Services are provided either directly to the airline or through other parties such as aircraft leasing companies, OEMs (Original Equipment Manufacturers) or component trading companies. • The company offers services for Airbus and Boeing aircraft and their associated engines and components • As one of the largest independent providers of these services in the world, this independence ensures that every customer receives the same high-quality service and treatment under one service umbrella. After all, no airline wants to take second place to the parent airline of a group that also offers third-party services. • An airplane is either bought or leased by an airline. The maintenance contract for the airplane can be provided separately and, in general, the customer has a flat rate and incurs no additional costs when the airplane is serviced or repaired (for the contracted parts). There will always be parts not covered, such as structural parts, for which there is no sense pooling them in a service contract. • The share of service contracts sold is high, which is also a result of the legal regulations in the aircraft industry which put safety first. **Value proposal/strengths** • Qualitative service • Integration capabilities as it subcontracts a few hundred other service suppliers
3	**Position in industry sector** • A leading, independent airline technical solutions provider with capabilities covering most Airbus and Boeing aircraft types • Diversified global customer base – major airlines, aircraft leasing companies and OEMs • Around 1,069 aircraft supported • Seven hangars totaling 68,950 m^2 • Growing number of partnerships, acquisitions and joint ventures worldwide • Extensive network of line stations at 16 airports world wide as well as logistics centers at London-Heathrow, and in Zurich, Geneva, Malta, Abu Dhabi, Singapore, Melbourne and Kuala Lumpur
4	**Business trends** • The trend is that the OEM suppliers, the components developers and producers also carry out maintenance because the suppliers do a lot of R&D work compared to Boeing and Airbus, so in order to compensate the high development costs the suppliers take over maintenance activities and are not willing to give technical repair information to MROs. This is the case with the newest airplanes such as the Boeing 787. • Until now, the OEMs earned their money with products and parts, but are now entering the After Sales business more and more because they see opportunities there. But airlines are not interested in closing maintenance contracts with 500 and more companies for the diverse

Company 4 General Criteria	
	components; therefore integrators like the company interviewed are necessary. However, the top 5 component OEMs have a significant market. Rolls Royce is the market leader regarding sales of service contracts. 90% of products sold are done so with service contracts, which is a very high penetration rate for contract sales. In contrast, GE only has a 50% share of service contracts • Moreover, the so-called traders have been growing in the market recently by using aggressive pricing strategies. In consequence, prices in Service & Parts have decreased by 30%. One very aggressive trader, intending to rapidly gain market share, is A.J. Walter • The pressure to further decrease maintenance/repair costs will increase; predictive maintenance is considered a factor that can help reduce the costs • In the near future digitization can help increase process efficiency
5	**Top business drivers** • Service quality, tailor-made solution packages, business efficiency
6	**Number of employees** • About 3,200 employees
7	**Customer segments** • No information was provided
8	**Product development strategies** • Outsourced maintenance supports improved business efficiency • The company has shaped its capabilities to fit a growing worldwide trend among airlines: to have some or all of their aircraft, engine or component maintenance services bundled together in tailor-made packages, provided by experienced partners • As the company offers total solution packages to airlines, it takes over the technical management and technical operation of the entire fleet. In addition, it provides many types of services tailored to each customer's individual requirements. This individual service package can include any of a number of elements such as aircraft checks, engine overhaul or component management and repair. • The slogan is: "We are with you in the right place at the right time" • In addition to many years of experience, one of the key enabling factors, allowing the offer of a unique service portfolio, is the powerful proprietary IT system. It is through this system that the company is able to manage aircraft and component data online and in real-time wherever the customer's aircraft is located. Goal: Keep the customer airworthy and in flight around the clock and around the globe.
9	**Organizational strategies** • Three main departments: - Air Frame, - Components (shows the most similarities to automotive logistics) and - Engines • The company also acts as an integrator as it subcontracts a few hundred other service suppliers • Spare parts procurement and logistics are currently being restructured to be centralized across the business • Functions outsourced are logistics and services for different components depending on the airplane – the company is an integrator. For different airplane types, different services are outsourced. • A key difference to the automotive industry is that when servicing an airplane 50 to 80 specialists work on one plane at the same time. In contrast, one car is usually repaired by one technician. Therefore MROs need detailed planning processes supported by IT systems • Good coordination is necessary; the employees are split into small teams. Every step has to be

Company 4 General Criteria	
	documented and double checked by licensed technicians, and there is somebody responsible for each airplane segment per shift and another person responsible for the maintenance/repair process. To speed up processes the documentation is done using hand-scan-devices and tablet PCs in order to minimize the amount of paperwork.
10	**Production facilities** • The company develops its own repair methods and guidelines but does not have any production facilities
11	**Forecasts** • Forecasting is carried out based on historical experience of the detail level of components; every important component of an airplane is tracked. It is known how many flight hours this component has completed. These data form the basis of predictive maintenance studies. • An airplane has, on average, 10,000 components and around 30% of those are tracked via a serial number. In general, the expensive parts are tracked
12	**HR strategy** • No information was provided
13	**Improvement programs / Benchmark** • No information was provided
14	**KPIs overall** • Revenue, profit
15	**Supplier strategy** • No information was provided
16	**Procurement** • No information was provided
17	**Advanced technology in procurement** • No information was provided
18	**IT** • No information was provided
19	**Business Model** • No information was provided
20	**Transaction costs** • Not used
21	**Profit margin (After Sales, Parts)** • Operating revenue of CHF 1.1bn in 2013 • The airplane, engine and parts production are profitable but the service is not; the average EBIT is 7-8%. Rolls Royce, GE and UTC produce and sell parts themselves
22	**Legal regulations** • No information was provided
23	**Environmental issues** • No information was provided

Appendix 14 – After Sales Criteria of Company 4

Company 4 After Sales Criteria	
1	**Profit share from After Sales business** • Maintenance costs in the aircraft industry are high. As an example, the price for a new engine is between \$10m and \$30m. • The maintenance costs for the engine are between \$1.5 and \$2m. • The average profit margin in maintenance is 7%. • The profit made with parts in the aircraft industry is, on average, 30%.
2	**Supply chain planning** • The company has five big logistic centers and keeps consignment stock at customers in order to have the necessary parts in time.
3	**Share of employees in After Sales** • 100%
4	**After Sales KPIs** • KPI used in logistics: Delivery performance, service degree of 92-95% • In Service: Service contract fulfillment – service provided in the time span agreed and at the agreed costs • The average EBIT is 7-8%
5	**Standardization of supply chain activities** • No information was provided
6	**Supply chain improvement programs** • RFID in planning • This is, unfortunately, not a very innovative industry, but the company has now created and filled the position of a vice president for innovation. • There are discussions about introducing RFID chips to improve parts tracking, and about predictive maintenance in order to be able to supply better service and parts and to identify parts that can no longer be serviced and need to be replaced. Further, to provide optimal parts stock levels in order to fulfill the service level agreed, while simultaneously not tying up too many financial resources.
7	**Supply base strategy** • No information was provided
8	**Customer demand** • No information was provided
9	**Supply network details** • No information was provided
10	**Customer data** • No information was provided
11	**Availability in service (no. of shifts)** • No information was provided
12	**Preventive maintenance** • In planning
13	**Bottlenecks vs. risks** • A bottleneck for the company: OEMs do not easily provide MROs with technical repair infor-

Company 4 After Sales Criteria	
	mation. MROs have to cooperate closely with OEMs and pay license fees.
14	**Parts strategy** • Spare parts obsolescence is not a problem as the lifetime of an airplane is about 20 years and parts have a similar lifetime
15	**Second parts line** • A similarity to the automotive business is that there is a second parts line, in which parts have the same characteristics as the genuine parts but are not produced by the OEM supplier
16	**Number of parts codes** • No information was provided
17	**Parts ordering process** • A major difference to the automotive industry is that parts are sold directly by the component producers and not exclusively by Boeing or Airbus
18	**Value of inventory share compared to revenue** • No information was provided
19	**Use of parts kits for repair** • No information was provided
20	**Use of cross dock operations** • No information was provided
21	**Delivery quality** • No information was provided
22	**Inventory turns** • No information was provided
23	**Use of virtual inventory** • No information was provided
24	**Payment regulation** • No information was provided
25	**Service degree** • Service degree of 92-95%
26	**Technologies used in warehousing** • No information was provided as the operation is outsourced

Appendix 14 – General Criteria of Company 5

Company 5 General Criteria	
1	**Industry sector** • Freight transportation, warehousing and distribution, supply chain solutions
2	**Products** • The interview concentrated on the company for national and international parcel shipping and professional and global express services as well as customized logistics solutions • Standardized logistics operations up to individualized services • Express transport of urgent documents and goods • Warehousing, managed transport and value-added services at every link in the supply chain for customers in a variety of industries **Value proposal/strengths** • Global presence • The service portfolio: the company offers the entire range of logistics • Financial stability due to the fact that the company belongs to a large and powerful group and has a good shareholder structure • Very good company culture, attracting good people in the market; it is a slick and lean company
3	**Position in industry sector** • One of the world's largest logistics specialists • Conducting business in 220 countries and territories across the globe, it can be considered one of the most international companies in the world • One of Europe's leading road freight providers
4	**Business trends** • A holistic view across industries reveals a change in B2C deliveries as, due to E-commerce, more products are being delivered to customers' homes • In the automotive business merchandising and lifestyle articles are sent home to the customer because they are bought online • A trend towards a cut in lead time cannot be identified because there are physical constraints due to speed limits • The total lead time from ordering to delivery also depends on the ordering process, and on how quickly the company can make products available
5	**Top business drivers** • Rationalization regarding the way in which inventories are carried out
6	**Number of employees** • Worldwide 489K employees, in Germany 171K
7	**Customer segments** • There are many ways to segment customers, the foremost being: - by centers: automotive, energy, technology, etc. and - by size: large global customers, medium-sized, small • The large global customers must be managed differently than smaller ones Fast growing companies that have the potential to become global players are also important
8	**Product development strategies** • Simplify the lives of customers • Make customers, employees and investors more successful • Make a positive contribution to the world

Company 5 General Criteria	
	• Demonstrate respect when achieving results • Reduce climate-damaging CO^2 emissions and other environmental impacts of the transportation and storage of goods • Green solutions include optimized transport routes, alternative drive vehicles and energy-efficient warehouses • Climate neutral service • The company offers their customers the option of fully neutralized greenhouse gas emissions
9	**Organizational strategies** • The company has five divisions - National and international parcel shipping - Express transports urgent documents and goods reliably and on time from door-to-door - Global Forwarding - Freight - Supply Chain • The company does not own all its hubs and offices. The decision to invest in own assets is financially driven; where there is high density, high load, constant volume, and stability in terms of costs the company invests in its own assets. By contrast, when flexibility and adaptability because of volatile volumes are necessary, the operations are subcontracted. • Centralized areas in order to ensure global consistency and efficiency are: Procurement, Legal Services and HR; other services are outsourced when not financially feasible
10	**Production facilities** • Not applicable
11	**Forecasts** • Big Data is used but forecasts are based primarily on experience and historical data • A problem lies more in the imprecise forecasts of customers • Forecast accuracy is estimated to be somewhere between 70 and 80%
12	**HR strategy** • No information was provided
13	**Improvement programs / Benchmark** • The company works with customers in order to identify areas for improvement and ways to achieve a reduction of greenhouse gas emissions and improve their overall environmental performance • Minimize the impact of the company's business activities on the environment • Improve own carbon efficiency and that of the subcontractors
14	**KPIs overall** • Besides financial KPIs required by the stock exchange reports there are internal KPIs such as: fill rate, delivery time, compliance KPIs, etc. • Adherence to schedule is between 98-99%
15	**Supplier strategy** • No information was provided
16	**Procurement** • Centralized, but there are also some local purchasing functions that allow flexibility
17	**Advanced technology in procurement** • Partially yes, a common platform is shared with airlines, but the telephone is still in use
18	**IT**

Company 5 General Criteria	
	• There are many IT Systems in use: IBM, Oracle, and the IT backbone is standard, but does not limit flexibility • The company uses and tests many technologies, and also makes these available to customers. The customer can choose between RFID (packages with RFID provide very precise monitoring), transponders, web services, wireless applications etc., depending on the situation and the customer's budget. RFID is precise but has a higher cost impact. • Software with voice recognition is used • Finally, augmented reality is used in warehouses for selection (Google glasses)
19	**Business Model** • The company tries to be asset light. If it makes sense financially the company owns the assets. Sometimes there is a combination, such as joint ventures, or there are contractual partners dedicated to the company that take over the company's branding
20	**Transaction costs** • Are important, since the fixed costs have to be added to all transactions. This is monitored by an internal auditing department.
21	**Profit margin (After Sales, Parts)** • No information was provided
22	**Legal regulations** • Centralized function
23	**Environmental issues** • No information was provided

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Appendix 14 – After Sales Criteria of Company 5

Company 5 After Sales criteria	
1	**Profit share from After Sales business** • Not applicable
2	**Supply chain planning** • The design of the supply chain and the “End-to-End” supply chain management is the key. It starts with the design of the supply chain which must be lean and efficient, and is the result of team work in different disciplines. • The several disciplines have to be considered and orchestrated, correctly located, synchronized and managed so that the result is a continuous flow • The hub structure is the best solution, matching the customer needs expressed by cut-off time and the financial feasibility of the business (business volume vs. costs) • Contingency planning for any possible disruptions determines the flexibility of the supply chain. This includes, for example, contracts with other carriers that allow re-routing of goods if an airplane has a technical problem • By using a highly configurable tool, the company can deliver customized solutions for customers without the need to change the code base of the core Oracle product • The company works with a combination of managers, supervisors, permanent and temporary staff for peak times. The temporary employees provide flexibility and the opportunity to adapt to peaks and enable contingency planning in routing. • Processes are monitored and deviations are subject to review meetings and supplier meetings. This works in both ways: the company also has review meetings with customers and vice versa. • Real-time transportation monitoring is partially implemented; truck drivers have cell phones and geo-fencing. GPS technology also allows for good tracking and information flow
3	**Share of employees in After Sales** • Not applicable
4	**After Sales KPIs** • The average delivery time depends on the customer’s service requirement; the customer defines the KPIs and the company adapts to them - examples: transit time, cut-off time • The service degree (% of delivered orders within Xh) depends on the customer’s contract; for VW in Express it is 98,5%
5	**Standardization of supply chain activities** • The company has standard operating procedures for everything, but at the request of customers it deviates from them and uses customer operating procedures • The company has its own standards and additional customer standards • There were some problems with IT as some applications could not accommodate customer procedures
6	**Supply chain improvement programs** • The company runs an innovation center and invests in trending research and solution development • To enable collaboration, the company brings together customers, research and academic institutions, industry partners, and logistics experts within the business divisions • The Innovation Center provides a central platform where customers and business stakeholders can engage with company experts on innovation-related topics and issues • Every new technology is tested and projections on demographic development up to 2050 are made. For example, drones were tested for every possible situation: airports, warehouses, or ports, together with customers. The results show that drones cannot be used in every situa-

Company 5 After Sales criteria	
	tion. They need fixed landing sites and must be operated from a central point. Drones can be used inside a plant to move things from A to B. • Furthermore Augmented Reality, Big Data, Internet of Things, Self Driving Vehicles etc. are used
7	**Supply base strategy** • All shipping methods – air, road, rail and sea are used
8	**Customer demand** • Holistically it can be said that customers tend to rationalize the way in which inventories are carried out • There is no clear tendency, especially in the automotive industry, towards express/emergency shipments and deliveries • The tendency is to regular, planned shipments for stability in the supply chain; express shipments are part of planning and are used mainly for slow movers that are not stored locally and must be delivered on time
9	**Supply network details** • The Active Tracing for Road Freight can provide a summary of all shipments for a customer, both in-transit and historically, and can be sorted and filtered by various criteria including status, departure/arrival dates, destinations etc. • Another interactive tool provides visibility of air and sea shipments. All major milestones from pick-up to delivery are available. There are 3 basic modules to the interactive set of tools for shipment visibility: Booking, tracking and reporting. Other features include alerting, document attachments and exception reporting. • The third tool for enhancing visibility of the supply chain allows the viewing or downloading of shipment and status information for up to 2,000 account numbers. It further allows real-time notification via email or SMS text messaging
10	**Customer data** • No information was provided
11	**Availability in service (no. of shifts)** • No information was provided
12	**Preventive maintenance** • No information was provided
13	**Bottlenecks vs. risks** • Cut-off time, in the express business the size of the tube, capacity (Christmas time) – here valid forecasts from customers are necessary as the company can rely only on historical data. Contingency planning is therefore necessary in the express service
14	**Parts strategy** • Not applicable
15	**Second parts line** • Not applicable
16	**Number of parts codes** • Not applicable
17	**Parts ordering process** • Not applicable
18	**Value of inventory share compared to revenue**

Company 5 After Sales criteria	
	• No information was provided
19	**Use of parts kits for repair** • No information was provided
20	**Use of cross dock operations** • Cross dock is used extensively, including, for VW, the consolidation of the inbound flow of products from vendors to plants
21	**Delivery quality** • No information was provided
22	**Inventory turns** • No information was provided
23	**Use of virtual inventory** • No information was provided
24	**Payment regulation** • No information was provided
25	**Service degree** • This depends on the contractual agreement with the customer
26	**Technologies used in warehousing** • No information was provided

Appendix 14 – General Criteria of Company 6

Company 6 General Criteria	
1	**Industry sector** • Technology (high tech)
2	**Products** • Another source of income is branding. The company orchestrates the design of products and these are sold with the company's branding, but are not produced in its own factories • Sales of new products: MRIs (magnetic resonance scanners) interventional X-ray machines, diagnostic X-ray machines, CT (computer technology) scanners, patient monitoring equipment, ultrasound equipment, nuclear medicine • Sales of used products: refurbished systems – equipment bought back from customers, refurbished on the production line and sold more cheaply with service contracts • Service • Parts • Financing • Leasing (increasingly being explored, for example, for printers such as Xerox) • Renting **Value proposal/strengths** • Providing good quality service within the time agreed in the service contract. The company offers several types of contracts, distinguished primarily by the time required to repair a machine
3	**Position in industry sector** • A global player with headquarters in Europe/Netherlands, it is an innovative and diversified technology company, focused on the fields of healthcare, consumer lifestyle and lighting • With sales and services in more than 100 countries • The company is a leader in: - cardiac care, acute care and home healthcare, - energy efficient lighting solutions and new lighting applications - electric shavers and male grooming category globally, including oral healthcare - one of the leading flat-TV brands globally
4	**Business trends** • The company is investing heavily in healthcare systems, having discovered that demand will increase significantly in the coming years • The development of end-to-end solutions for customers, allowing better management of the value chain • The supply chain is currently not a competitive advantage. It is a "must have"
5	**Top business drivers** • Products reliability • Innovation (8% of sales is invested in R&D in new products – the average in other companies is 2%) • In service the partnership is key – interaction with people, with the customer is important • Some customers become innovation partners • Relationships with customers are of great importance
6	**Number of employees** • 114,000 employees worldwide
7	**Customer segments** • In general, After Sales does not differentiate customers by segments, only doing so when decisions must be taken, for example, when a large deal must be negotiated with a certain customer, or when parts are obsolete, or involving contracts for rapid parts delivery (same-day-parts-

Company 6 General Criteria	
	delivery)
8	**Product development strategies** • The company earns money with product sales, and parts and service sales. The strategy is to develop and produce products that can be repaired. The sales margin is low, in order to acquire customers so that the money can be made in service. • Products are generally produced every 5 years, and service/parts are guaranteed for 10 years • For very reliable products management decisions can be extended, and for other products the contracts can be cancelled if a part is not available – the "Best-Efforts-Contracts" • The sales of service contracts depend on the product and the market: for premium (expensive) products such as the MP scanner the contract penetration is higher, at 80-90%; for ultrasound or smaller equipment the service contract penetration is lower, at about 50 %. • For premium products the service contract penetration is higher than for less expensive products • There are also differences among markets. For example, China, which works with distributors that deliver the service, has a lower penetration. The company also hopes that the distributors will buy genuine parts from the company • The "time to market" for new products depends on the product, taking as many as 4-5 years for complex products, although in this case it was a breakthrough innovation. Other products generally need a shorter time (usually not more than 1 year) • Very reliable products are kept by customers for more than 10 years • The warranty for new systems is 1 year. If a supplier delivers defective parts he will be charged for these
9	**Organizational strategies** • The company is organized in seven main Business Units – according to the main product lines: Magnetic resonance scanner, Interventional X-Ray machine, Diagnosis X-Ray machine, CT Scanner, Patient Monitoring Equipment, Ultra Sound Equipment and Nuclear Medicine Equipment • The company is currently in a restructuring phase • Supply Chain Organization is a part of service, and sells service contracts to customers as well as parts • It ensures all the required logistics for parts; not every service requires parts • Supply chain is a cost and not a profit organization as the parts profit/revenue is reported at service level • The branding process is controlled by the company • High-tech products are produced by the company itself • Outsourced functions: warehouse management, packaging, transportation (all by UPS as it is not a core competency of the company and other companies are better) • The contract with the logistic supplier is long-term, which stimulates a partnership, and as UPS has to further improve and reduce costs, it results in a partnership, as both companies seek improvements together • The company philosophy is that long-term contracts stimulate partnerships • The parts are refurbished in repair centers which are separated from the production lines
10	**Production facilities** • The company has an international culture, with a global footprint. The production facilities are all abroad (Europe, USA, South America, India, China)
11	**Forecasts** • SAP and PCT are used for forecasts since many parts (up to 60%) are internally produced and forecasts are needed to process order confirmations • In After Sales forecasts are concentrated on the parts level in order to understand when a part must be replaced in the system. The primary intention is to better understand the technical and qualitative aspects and less, the economic issues. Other departments are responsible for the economic aspects as many service contracts must be calculated in such a way as to avoid any losses
12	**HR strategy**

Company 6 General Criteria	
	• No information was provided
13	**Improvement programs / Benchmark** • Benchmarking, internal and external, is extensively used for topics or processes. Examples in the Service Logistics: Life Cycle Management, Parts Obsolescence Management, Backorder Management for Customers • A program called "Accelerate" aims to define lean, efficient processes. The parts supply department has the strength to rapidly change • As the fluctuation on demand in service is higher than in production, the company is currently pursuing this topic. IT is one of the major issues to be solved – supplier managed inventory that has proved to be beneficial in production • An ongoing major IT project over the last 3 years has the goal of aligning the various SAP modules (to increase standardization) as many companies have been acquired since the founding, and because of the customization of products • There is a permanent goal of reducing logistics costs, inventory, obsolescence, procurement costs or of increasing performance • The goal is to achieve the "perfect customer order" in which the parts delivery is only one aspect to be perfectly integrated with the other customer interactions; here prediction is key
14	**KPIs overall** • All financial KPIs required by the stock exchange reports
15	**Supplier strategy** • Foster partnerships, close long-term contracts
16	**Procurement** • There is now a central procurement department, since a recent reorganization, which is responsible for the entire chain, both for parts for new products and for service parts
17	**Advanced technology in procurement** • No
18	**IT** • Mainly commercial solutions, no voice recognition • The goal is to create a more open, standardized and, consequently, more cost-effective IT landscape • SAP software. RFID technology is not used in the service division • For planning inventory level optimization PTC software is used. PTC is also the name of the IT company that has developed this software • In Service, the engineers use SAP for parts ordering and IMS for scheduling customer visits to fulfill the service contracts. • There is a strong IT interface to UPS, the main logistics provider • For process modeling, reporting and analytics BO (Business Objects from SAP) is used
19	**Business Model** • No information was provided
20	**Transaction costs** • Only tracked punctually; the focus is on tracking total costs and the number of transactions
21	**Profit margin (After Sales, Parts)** • No information was provided
22	**Legal regulations** • No information was provided
23	**Environmental issues** • No information was provided

Appendix 14 – After Sales Criteria of Company 6

Company 6 After Sales Criteria	
1	**Profit share from After Sales business** • The contribution percentage of service & parts to the overall revenue and profitability of the company is approximately 50%
2	**Supply chain planning** • The supply chain's goal is to deliver the correct, good quality part to the customer, quickly, punctually and cost effectively • The supply chain planning department is centralized and plans and organizes the warehouses: network of warehouses, the warehouse and the stock/inventory • The inventory on the market is centrally planned by headquarters, but owned by the market; customers do not hold inventory on their financial books • The central department controls the inventory worldwide • The parts department becomes involved approx. 1 year before sales, with parts procurement beginning 6 months before sales begin. Shipment tracking starts 3 months before sales and all parts are entered into stock • In this industry there are no dealers as in the automotive industry and therefore parts are stocked at customers or in parts stocking points • The company does not have brands like the VW Group, but it has product lines, e.g. Interventional X Ray, Diagnostic X- Ray, with different strategies for the different product lines, but a common, unique supply chain • The service level for the various products is different • The customer does not own parts stock, which is a major difference to the automotive retail organization • 50-60% of parts in terms of value are produced by the company, primarily the expensive ones • The parts obsolescence rate is 17% • In the case of same-day-delivery the parts are stored close to the customer. The company works with small warehouses in a dense network. These stocks are dedicated to certain customers and the information is transparent to employees, but these parts may not be delivered to other clients that do not have a service contract with same-day-delivery of parts. • The company offers 5 types of contracts. This has historical reasons as some companies were bought and the existing contracts were also acquired. The contracts allow individualization; the content is stored in the SAP system and many steps are automated • Supply chain visibility has increased through the use of SAP technology • A process performed at a periodic base, in order to avoid stagnation, is capacity alignment; forecasts are communicated to suppliers who can then align capacities (human resources, materials etc.). Monthly sessions are held with critical suppliers to discuss forecasts and capacities, changes in the road maps or life cycles of parts and additional topics that can influence capacity, while the other suppliers' forecasts are shared monthly in an Excel file • In order to ensure continuous flow in inbound logistics, planning simulations are undertaken monthly. If the simulation shows exceptions the plan must be changed. Planning is a key issue because it is a factor that can be influenced by the company. Customer orders cannot be influenced, but the cut-off time with UPS is a major influence • The parts remain in inbound from 30 minutes to a few hours during busy periods • In order to balance workload and capacity and control stock levels, inventory plans are released and communicated once a week. There are days and weeks that are much busier than others, especially Mondays at 8:00 a.m. when there is a peak in volume orders. Therefore, new working hours were organized and the employees now start at 6:00 a.m. in order to cope with the Monday peak. UPS also needs to plan additional capacities, in order to cope with peaks.
3	**Share of employees in After Sales** • More than 5% • The service field engineers represent the major share • Additionally, a service unit with, on average, 30-40 employees is integrated in every Business Unit

Company 6 After Sales Criteria	
	• The supply chain has 200 employees, plus 200 in outsourced operations; a total of 400 people
4	**After Sales KPIs** • Downtime of the product • The reaction time of the engineers when a product is defective – this is agreed in the contract • Up-time of the system • Regarding logistics, the In-Net performance is key (how much is delivered on time) • The company allows UPS different service levels in order to obtain different price positions. UPS can batch as much as possible for the USA – the average time of delivery to the USA is 2 weeks. If something must be delivered the following day it is sent by air and this is expensive • The average order to delivery cycle time for the largest volume: next business day (<24h). There is some same-day delivery in the USA and Japan • Customer KPIs: customer metrics, fill rates, defective parts on arrival, net promoter score • Shareholder KPIs: inventory, obsolescence • Focus area of KPIs to improve operational performance: On-time-delivery (for suppliers), stock-out for critical parts • Defective deliveries are measured as default parts / all parts delivered. The ratio to all parts is 1% and for critical parts 2, 1% • Financial KPI: Net inventory as a percentage of sales and supply chain aging (the length of time parts are in the supply chain, measured in days; the two positions are considered as cash not available to the company) • Regarding costs, the main KPI is the total freight costs; warehousing costs, transport costs and other services provided by UPS are consolidated (package price) to one figure and reviewed in detail with the logistics provider
5	**Standardization of supply chain activities** • High standardization level. The initiative started 6 years ago with the introduction of standardized SAP and sales orders were standardized, with sales orders being filled automatically and rules developed for routing parts not in stock. Alternatives were defined and standards for ETA (expected time of arrival) established, for when parts are not in stock (a highly standardized process) • Standardization is always the first step before moving to the next level and it implies working with suppliers
6	**Supply chain improvement programs** • Described under point 13 of the general criteria
7	**Supply base strategy** • Vendor managed inventory is not applicable as customers do not stock/own inventory • The goal is to create a leaner supply base with fewer suppliers, while maintaining dual / multiple sourcing strategies where possible. This strategy requires very close cooperation with suppliers to enhance, among other things, time to market and quality • In addition, the company is continuing its initiatives to reduce assets through outsourcing
8	**Customer demand** • Fluctuates, especially in After Sales
9	**Supply network details** • There are three big distribution centers in Europe, the USA and Singapore, all owned by UPS, 20 local distribution centers: 7 in Japan, some in China, Australia, Korea, India, Taiwan, Indonesia, France, Italy and Spain, and about 80 small locations hired by UPS for critical parts; in total about 100 locations • The company uses primarily air fright • In order to reduce logistics costs, many service levels are allowed, enabling the logistics provider to batch as much as possible oversees. On average the product remains in the USA for 2 weeks. If a part is ordered express it is delivered the following day – in cases of customer escalation, or for critical parts in cases of shortages • The different price levels influence the prices for the service contracts

Company 6 After Sales Criteria	
10	**Customer data** • No information was provided
11	**Availability in service (no. of shifts)** • There is currently only one shift, but the company exploits its position as a global player and makes use of the different time zones – resulting in 24/5 availability. Weekend work is only done in warehouses in the USA. • In the rest of the world the part is delivered on Monday, but the engineer might already arrive on the weekend (supported by the SAP systems and the fact that the majority of the orders are automated). Employees are involved only if an order cannot be processed automatically (for example, a part is not available, or a customer is listed and has to pay before delivery)
12	**Preventive maintenance** • No information was provided
13	**Bottlenecks vs. risks** • Inability to determine in advance the ultimate effect that new solutions and product creations will have on the financial conditions and operating results • A failure to accelerate its innovation-to-market processes and to ensure that end-user insights are fully captured and translated into solutions and product creations that improve the product mix • Commodity price volatility • A global increase in IT security threats and higher levels of sophistication in computer crime, posing a risk to the confidentiality, availability and integrity of data and information • Any damage to the company's reputation could have an adverse effect on its businesses • The company is dependent on its personnel for leadership and specialized skills; the loss of its ability to attract and retain such personnel would have an adverse effect on its business
14	**Parts strategy** • The company is seeking standardization and the use of common parts/fewer individual configurations as these are expensive • It is difficult to find a balance or an optimum between standardization and customization vs. individualization • Customization does not play the same role as in the automotive industry. Examples for customization are: the PC type used, screen size, or the number of screens installed. Customization does not play a role at all in the supply chain • Parts and service are available for 10 years and "Best Effort Service" contracts allow the company to refund a customer for the remaining time contracted if the company cannot deliver and/or service a product • The product strategy is to repair as much as possible. Of the entire product range 70% is reparable and 30% is consumables. Of the 70%, 80/90% are returned for repair, of which 95% are successfully repaired and 5% are scrapped
15	**Second parts line** • No information was provided
16	**Number of parts codes** • There are about 300,000 parts codes, 60,000 active parts, other parts which are still in the system but out of service, slow or non-moving parts, out of service parts and obsolete parts
17	**Parts ordering process** • The reverse logistics process adds value because it reduces parts prices, which is beneficial to the customer. The autopsy and defective analysis in the repair process reveals quality problems which are then communicated to R&D, raising the product quality in the long run
18	**Value of inventory share compared to revenue** • The value of inventory is about 21% of revenue

Company 6 After Sales Criteria	
19	**Use of parts kits for repair** • For clients who have 24h contracts, the company created kits at factory level in order to speed up the total repair process. Kits are assembled in the EU, North America and the Far East (Taiwan)
20	**Use of cross dock operations** • Yes
21	**Delivery quality** • Defective deliveries for all parts is 1%, and for critical parts, 2, 1%
22	**Inventory turns** • Between 4 and 5 (closer to five) as the company has a high mixture of non- and fast-moving parts. Another distinction is that all parts transactions, including internally produced parts, are tracked
23	**Use of virtual inventory** • Due to the central planning approach and the density of the distributors (the network) the company is better able to control the inventory levels, having more planning opportunities • A dense distribution network allows planning flexibility and does not require the back-up collaboration between distribution locations
24	**Payment regulation** • No information was provided
25	**Service degree** • Service degree: 95% off the shelves, 98% for critical parts in the system. Time agreements stipulate the speed at which a part must be available, and the down time for a product
26	**Technologies used in warehousing** • No information was provided

Appendix 15 – Business case 3DP

	Unit	Conventional manufacturing			Additive manufacturing		Δ
(01) **Stockage period**	*years*	10			0	*no stock required, on demand production*	-10
(02) **Demand / year**	*pcs.*	500			500		0
(03) **Weighted avg. cost of capital (WACC)**		9%			9%		0%
Tooling							
(05) **Specific tooling costs (total)**	*EUR*	50.000	*average depreciated value for relevant time period*		0	*no part specific tools required*	-50.000
(06) **Unspecific tooling costs (total)**	*EUR*				500.000		500.000
(07) **Time to manufacture**	*h*	0,1			30		29,9
(08) **Specific tool productivity**		0,6%			n/a		
(09) **Unspecific tool productivity**		n/a			100,0%	*Tool is productive irrespectively of specific parts demand*	
(10) **Unproductive working capital**	*EUR*	49.715			0		-49.715
(11) **Opportunity costs for (10) p.a.**	*EUR*	4.474			0		-4.474
(12) **Opportunity costs for (10) for stocking period**	*EUR*	**44.743**			**0**		**-44.743**
Manufacturing							
(13) **Changeover costs / year (avg.)**	*EUR*	5.000			0		-5.000
(14) **Total changeover costs**	*EUR*	50.000			0		-50.000
							0
(15) **Manufacturing costs / part**				(a)	154,11	*Tool usage only [based on (07)] → pro rata depreciation*	
				(b)	80,00	*other costs*	
				©	50,00	*Raw materials and supplies*	
	EUR	125,00	*incl. raw materials and supplies*		284,11	*Total*	159,11
(16) **Post-processing**	*EUR*	5,00			5,00		0,00
(17) **Quality control**	*EUR*	2,00			2,00		0,00
(18) **Total / part**	*EUR*	132,00			291,11		159,11
(19) **Overproduction**	*EUR*	30%			0%		-30%
(20) **Parts manufactured**	*pcs.*	650			500		-150
(21) **Total manufacturing costs**	***EUR***	**135.800,00**	***incl. over production***		**145.554,79**		**9.754,79**
Logistics							
(22) **Process costs / part**	*EUR*	8			12	*slightly higher process costs due to on-demand character*	4
(25) **Total process costs**	*EUR*	5.200			6.000		800
(23) **Average stocking period / part**	*years*	2,0			0,0		-2,0
(24) **Stockage cost / part and year**	*EUR*	10			0		-10
(25) **Total stockage costs**	*EUR*	13.000			0		-13.000
(25) **Capital lockup costs**	*EUR*	15.444			0		-15.444
(26) **Total Logistics**	***EUR***	**33.644**			**6.000**		**-27.644**
(100) **Grand Total**	***EUR***	**214.187**			**151.555**		**-62.632**

Bibliography

3D Printing Industry (2016). Who Owns History When It is Made of 3D Printed Lego? Available at: http://3dprintingindustry.com/news/owns-history-made-3d-printed-lego-25392/

Aberdeen Group (2004). *The Lean Strategies Benchmark Report - Closing the Reality Gap*

Aberdeen Group (2005a). *The Manufacturing Performance Management Strategies Benchmark Report*

Aberdeen Group (2005b). *Winning with Global Manufacturing Networks*

Aberdeen Group (2006a). *Global Supply Chain Benchmark Report: Industry Priorities for Visibility, B2B Collaboration, Trade Compliance, and Risk Management*

Aberdeen Group (2006b). *Supply Chain Finance Benchmark Report: The New Opportunity to Improve Financial Metrics and Create a Cost-Advantaged Supply Chain*

Aberdeen Group (2006c). *The Employee Performance Management Benchmark Report - Managing Human Capital for a Competitive Edge*

Aberdeen Group (2006d). *The Manufacturing Intelligence Benchmark Report - Bridging the ERP and Shop Floor Divide*

Aberdeen Group, (2006e). *The Technology Strategies for Inventory Management Benchmark Report: How to Convert Inventory From Cost to a Competitive Advantage*

Accenture, (2010). *Refocusing on the aftersales market: Increase Revenues and Reduce Costs to Achieve High Performance*

ACSI, http://theacsi.org/index.php?option=com_content&view=article&id=147&catid=&Itemid=212&i=Automobiles+and+Light+Vehicles. Available at: http://theacsi.org/index.php?option=com_content&view=article&id=147&catid=&Itemid=212&i=Automobiles+and+Light+Vehicles

ACSI, http://www.theacsi.org/about-acsi/the-science-of-customer-satisfaction. Available at: http://www.theacsi.org/about-acsi/the-science-of-customer-satisfaction

ACSI, http://www.theacsi.org/customer-satisfaction-benchmarks/benchmarks-by-sector. Available at: http://www.theacsi.org/customer-satisfaction-benchmarks/benchmarks-by-sector

ACSI, http://www.theacsi.org/news-and-resources/customer-satisfaction-reports/reports-2015/acsi-automobiles-report-2015/acsi-automobiles-report-2015-download. Available at: http://www.theacsi.org/news-and-resources/customer-satisfaction-reports/reports-2015/acsi-automobiles-report-2015/acsi-automobiles-report-2015-download

aia Canada (2010). *2010 Canadian Automotive Service & Repair Shop Survey*
Anon, *Benchmarking construction technology transfer in Thailand*

Antony, J. & Kumar, M. (2011). *Lean Six Sigma : Research and Practice*

APQC, https://www.apqc.org. Available at: https://www.apqc.org/

APQC & IBM (2014). *Automotive Process Classification Framework*

APQC & Raytheon Aircraft Company, 2007. *Reverse Logistics "Backwards " Practices That Matter*, Available at: http://www.werc.org/assets/1/workflow_staging/Publications/680.PDF

Armistead, C. & Clark, G. (1991). A Framework for Formulating After-sales Support Strategy. *International Journal of Operations & Production Management*, 11(3), pp.111–124

Arthur D. Little, *Cutting the Profitability Gordian Knot*

Ashayeri, J. (2007). Development of computer-aided maintenance resources planning (CAMRP): A case of multiple CNC machining centers. *Robotics and Computer-Integrated Manufacturing*, 23(6), pp.614–623

Ashayeri, J. & de Booy, R. (2008). *Workload Balancing Based Warehouse Management in a Central European Distribution Center*

ASUG & SAP (2006). *Supplier Relationship Management and Procurement: DRIVING VALUE THROUGH BEST PRACTICES*

Automotive Insight & Arthur D. Little (2008). *Automotive After Sales 2015 - Are you ready for the battle?*

Baines, T., Lightfoot, H., Peppard, J., Johnson, M., Tiwori, A., Shebab, E., et al. (2009). Towards an operations strategy for product-centric servitization. *International Journal of Operations & Production Management, 29*(5), pp.494–519

Bardhan, I., Bagchi, S. & Sougstad, R. (2004). Prioritizing a Portfolio of Information Technology Investment Projects. *Journal of Management Information Systems*, 21(2), pp.33–60

Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, 17(1), pp.99–120

Barney, J. B. (2001). Resource-based theories of competitive advantage: A ten-year retrospective on the resource-based view. *Journal of Management*, 27(2001), pp.643–650

Blumenfeld, D. et al. (1987). Reducing Logistics Costs at General Motors. *Interfaces*, 17(1) January-February 1987, pp.26–47

Boon, J. & Trew, D. (2002). *Effective Benchmarking Strategies*

Bovet, D. & Martha, J. (2000). Value Proposition: Crafting the Offer. *Value Nets: Breaking the Supply Chain to Unlock Hidden Profits*, 2000

Bradach, J. (1996). Organizational Alignment: The 7-S Model. *Harvard Business School*, Rev. November 19, 1996

Brewer, G. et al. (2000). *Creating a Benchmarking Service to Measure ICT Uptake for the Australian Construction Industry*

Campbell, A., Goold, M. & Alexander, M. (1995). The Value of the Parent Company. *California Management Review*, 38(1), pp.79–97

Capgemini Consulting, *Profiting From Improved Automotive Accessories Forecasting and Planning*

Capgemini Consulting & University of St. Gallen (2010). *The Aftermarket in the Automotive Industry - How to Optimize Aftermarket Performance in Established and Emerging Markets*

Capsresearch. http://www.capsresearch.org/. Available at: http://www.capsresearch.org/

Cavalieri, S., Gaiardelli, P. & Ierace, S. (2007). Aligning strategic profiles with operational metrics in after-sales service. *International Journal of Productivity and Performance Management*, 56(5/6), pp.436–455. Available at: http://www.scopus.com/inward/record.url?eid=2-s2.0-34547144785&partnerID=tZOtx3y1

Chan, F.T.S. et al. (2006). An AHP approach in benchmarking logistics performance of the postal industry. *Benchmarking: An International Journal*, 13(6), pp.636–661

Chen, M-J. & Miller, D. (2011). The Relational Perspective as a Business Mindset: Managerial Implications for East and West. *Academy of Management Perspectives*, pp.6–18

Chaniotakis, I.E. et al. (2008). After-sales service quality as an antecedent of customer satisfaction: The case of electronic appliances. *Managing Service Quality*, 18(5), pp.512–527

Christensen, C. M. (1997). Making Strategy: Learning by Doing. *Harvard Business Review*, 75(6) November-December 1997, pp.141–160

Cohen, M. A., & Agrawal, V. (1999). After Sales Service Supply Chains: a Benchmark Update of the North American Computer Industry

Cohen, M. A. et al. (2000). Saturn's Supply-Chain Innovation: High Value in After-Sales Service. *MIT Sloan Management Review*, 41(4), p.9

Collins, J. C. & Porras, J. I. (1996). Building Your Company´s Vision. *Harvard Business Review*, 74(5) September-October 1996, pp.65–77

Collis, D. J. & Montgomery, C. A. (1995). Competing on Resources: Strategy in the 1990s. *Har-*

vard Business Review, 73(4) July-August 1995, pp.118–128

Collis, D. J. & Rukstad M.G. (2008). Can you say what your strategy is? *Harvard Business Review*, 86(4) April 2008, pp.82–90

Cornwell (2006). *Supply Chain Risk Forum - Benchmarking*

Coronado Mondragon, A. E., Lyons, A. C., Michaelides, Z., & Kehoe, D. F. (2006). Automotive supply chain models and technologies: a review of some latest developments. *Journal of Enterprise Information Management, 19*(5), pp.551–562

Deloitte Consulting (2013a). *Motor Industry Services - Dealership benchmarks*

Deloitte Consulting (2013b). *Driving Aftermarket Value: Upgrade Spare Parts Supply Chain - Deloitte China Auto Industry Spare Parts Management Benchmark Survey White Paper*

Deloitte Consulting (2007). *The Service Revolutionin Global Manufacturing Industries*, Available at: http://dupress.com/articles/the-service-revolution/

Demeter, K., Gelei, A. & Jenei, I. (2006). The effect of strategy on supply chain configuration and management practices on the basis of two supply chains in the Hungarian automotive industry. *International Journal of Production Economics*, 104(2), pp.555–570

Dierickx, I. & Cool, K. (1989). Asset Stock Accumulation and Sustainability of Competitive Advantage. *Management Science*, 35(12), pp.1504–1511

Dunleavy, P. (2003). *Authoring a PhD How to plan, draft, write and finish a doctoral thesis or dissertation*, Available at: http://www.mendeley.com/research/authoring-a-phd-how-to-plan-draft-write-and-finish-a-doctoral-thesis-or-dissertation/

Ehinlanwo, O. O. & Zairi, M. (1996a). Best Practice in the Car After-Sales Service: An Empirical Study of Ford, Toyota, Nissan and Fiat in Germany - Part 1. *Business Process Re-engineering & Management Journal*, 2(2), pp.39–56

Ehinlanwo, O. O. & Zairi, M. (1996b). Best Practice in the Car After-Sales Service: An Empirical Study of Ford, Toyota, Nissan and Fiat in Germany - Part 2. *Business Process Re-engineering & Management Journal*, 2(3), pp.39–53

Eisenhardt, K. M. & Galunic, D.C. (2000). Coevolving: At Last, a Way to Make Synergies Work. *Harvard Business Review*, January-February 2000, pp.91–101

EisnerAmper (2011). http://www.eisneramper.com/dealer-insights/auto-dealers-KPIs-1210.aspx. Available at: http://www.eisneramper.com/dealer-insights/auto-dealers-KPIs-1210.aspx

Ellram, L. M., Tate, W. L., & Billington, C. (2004). Understanding and Managing the Services Supply Chain. *Journal of Supply Chain Management, 40*(4), pp.17–32

Feder, B. (1991). Moving the Pampers Faster Cuts Everyone's Costs. *New York Times*, pp.1–3

Fetzinger, E., & Lee, H.L. (1996). Mass Customization at Hewlett-Packard: The Power of Postponement. *Harvard Business Review*, Reprint 97101 January-February 1996, pp.115–122

Fine, C. H., Golany, B. & Naseraldin, H. (2005). Modeling tradeoffs in three-dimensional concurrent engineering: A goal programming approach. *Journal of Operations Management*, 23(3-4), pp.389–403

Finne, M. (2009). *The design of industrial service offerings in indirect channels*

Fisher, M. L. (1997). What is the Right Supply Chain for Your Product? *Harvard Business Review*, Reprint 97205 March-April 1997, pp.105–116

Fisher, M. L. et al. (1994). Making Supplay Meet Demand in an Uncertain World. *Harvard Business Review*, May-June 1994, pp.83–93

Fordham (2008). *The retail automotive industry is an excellent barometer of the economic health of the consumer*

Francis, J. (2008). Benchmarking: Get the Gain Without the Pain. *Supply Chain Management Review*, (April), pp.22–29

Fraser, K., Tseng, B. & Hvolby, H. (2013). TQM in new car dealerships: a study from the firms' perspective. *The TQM Journal*, 25(1), pp.5–17. Available at: http://www.emeraldinsight.com/doi/abs/10.1108/17542731311286397

Gaiardelli, P., Saccani, N. & Songini, L. (2007a). Performance measurement of the after-sales service network-Evidence from the automotive industry. *Computers in Industry*, 58(7), pp.698–708

Gaiardelli, P., Saccani, N. & Songini, L. (2007b). Performance measurement systems in after-sales service: an integrated framework. *International Journal of Business Performance Management*, 9(2), pp.145–171

Gannage, G.J. & University, N., (2009). *Assessing SERVQUAL and the Automotive Service Quality Model: A Comparative Study*, Northcentral University. Available at: https://books.google.nl/books?id=fShmFO45gCAC

Grean, M. & Shaw, M.J. (2000). Supply Chain Integration through Information Sharing: Channel Partnership between Wal-Mart and Proctor & Gamble. *Working Paper, Department of Business Administration, University of Illinois at Urbana Champaign*, pp.1–21

Ghemawat, P. (2002). Competition and Business Strategy in Historical Perspective. *Business History Review*, 76 (Spring 2002), pp.37–74

Goland, A. R. et al. (1998). First National Toyota. *The McKinsey Quarterly*, 4, pp.59–66

Golany, B. & Roll, Y. (1989). An Application Procedure for Dea. *Omega*, 1(3), pp.237–250. Available at: http://deazone.com/en/golany-b-and-y-roll-1989-an-application-procedure-for-dea-omega-13-237-250

Goldratt, E. M. (1997). Critical Chain. *America*, 8, p.246. Available at: http://www.amazon.com/Critical-Chain-Eliyahu-M-Goldratt/dp/0884271536

Hamel, G. (1996). Strategy as Revolution. *Harvard Business Review*, 74(4) July-August 1996, pp.69–82

Hamel, G. & Välikangas, L. (2003). The Quest for Resilience. *Harvard Business Review*, 82 (9) September 2003, pp.1–13

Hertz, P., Finke, G., & Verhasselt, S. (n.d.). *A Process Reference Model for Service Delivery in After-Sales Field Service Networks.* Retrieved October 22, 2012, from http://www.asplanned.ethz.ch/research/APMS_2011_FP_Hertz_Finke_Verhasselt.pdf

Heskett, J. (1977). Logistics - Essential to Strategy. *Harvard Business Review*, pp.85–96

Hines, P. & Rich, N. (1997). The seven value stream mapping tools. *The International Journal of Operations & Production Management*, 17(1), pp.46–64

Inaganti, S. & Behara, G.K. (2007). Service Identification: BPM and SOA Handshake. *BPTrends*. Available at: http://mixlhho.bptrends.com/publicationfiles/THREE 03-07-ART-BPMandSOAHandshake-InagantiBehara-Final.pdf

Iyer, A. & Jain, A. (2003). The logistics impact of a mixture of order-streams in a manufacturer-retailer system. *Management Science*, 49(7) July 2003, pp.890–906

Iyer, A. & Jain, A. (2004). Modeling the impact of merging capacity in a production-inventory System. *Management Science*, 50(8) August 2004, pp.1082–1094

J. D. Power & McGraw Hill Financial (2014). *U . S . 2014 Automotive Solutions Guide*

Jafar, E., Mejos, T.N.C. & Yang, C. (2006). *Process Improvement at the Aircraft Intermediate Maintenance Detachment (AIMD) at Naval Air Station Whidbey Island*

Johansson, P. (2006). *Adapting manufacturing strategy to industrial after-sales service operations*

Johnson, M. W., Christensen, C. M. & Kagermann, H. (2008). Reinventing Your Business Model. *Harvard Business Review*, 86(12) December 2008, pp.50–59

Jones, D., & Womack, J. (2003). *Seeing the Whole - mapping the extended value stream.* Cambridge, MA USA: Lean Enterprise Institute

Kaplan, R. S. & Norton, D. P., (1996). *The Balanced Scorecard*

Kaplan, R. S. & Norton, D. P., (2000). Having Trouble With Your Strategy? Then Map It. *Harvard Business Review*, 78(5) September-October 2000, pp.167–176

Kaplan, R. S. & Norton, D. P. (2004). *Strategy Maps – Converting Intangible Assets Into Tangible Outcomes*

KEMA, (2004). *Bonneville Power Administration Process Improvement and Benchmarking Prioritization*

Kim, S. et al. (2007). Performance Contracting in After-Sales Service Supply Chains. *Management Science*, 53(12), pp.1843–1858. Available at: http://mansci.journal.informs.org/content/53/12/1843.short

Kim, W. C. & Mauborgne, R. (1997). Value Innovation: The Strategic Logic of High Growth. *Harvard Business Review*, 75 (1), January-February 1997, pp.103–112

Knight, C. F. (1992). Emerson Electric: Consistent Profits, Consistently. *Harvard Business Review*, January-February 1992, pp.57–70

Kumar, N., & Linguri, S. (2006). Fashion: Spanish Retailer Zara. *Business Strategy Review*

Kurata, H. & Nam, S.H. (2010). After-sales service competition in a supply chain: Optimization of customer satisfaction level or profit or both? *International Journal of Production Economics*, 127(1), pp.136–146. Available at: http://dx.doi.org/10.1016/j.ijpe.2010.05.005

Labib, A. W. (1999). A framework for benchmarking appropriate productive maintenance. *Management Decision*, 37(10), pp.792–799

Laseter, T. M., et al. (2000). Amazon Your Industry: Extracting the Value From the Value Chain. *Strategy & Business*, February 2000

Leachman, R. C. & Hodges, D. A. (1997). *Benchmarking semiconductor manufacturing*

Ledet, W. J. & Ledet, W.P., *Dynamic Benchmarking : Experiencing the Best Practices of Others in Your Plant*

Lee, H. L. & Billington, C. (1995). *The Evolution of Supply-Chain-Management Models and Practice at Hewlett-Packard*

Lee, H. L. & Kopczak, L. (2001). Hewlett-Packard DeskJet Printer Supply Chain (A). *Harvard Business Review*, Reprint GS3A

Lee, H. L. & Whang, D. (1997). The Bullwhip Effect in Supply Chains. *Sloan Management Review*, Spring 1997, pp.93–102

Lele, M.M. (1997). After-sales service—necessary evil or strategic opportunity? *Managing Service Quality*, 7(3), pp.141–145

De Leone, R. (2009). Data envelopment analysis. In A. C. Floudas & M. P. Pardalos, eds. *Encyclopedia of Optimization*. Boston, MA: Springer US, pp.597–600. Available at: http://dx.doi.org/10.1007/978-0-387-74759-0_107

McCormack, K. & DRK Research and Consulting, *SCM Best Practices Benchmarking - A quantitative assessment based upon integration factors and best practices*

Magretta, J. (1998). Fast, Global, Entrepreneural, Supply Chain Management Hong Kong Style. *Harvard Business School Case R0605H*

McCormack, K. & Kasper, K. (2002). The extended supply chain: A statistical study. *Benchmarking: An International Journal*, 9(2), pp.133–145

McGahan, A. M. (2004). How Industries Change. *Harvard Business Review*, 82(10) October 2004, pp.87–94

Mintzberg, H. & Lampel, J. (1999). Reflecting on the Strategy Process. *Sloan Management Review*, 40(3), pp.21–30

Moore, J. F. (1993). Predators and Prey: A New Ecology of Competition. *Harvard Business Review*, 71(3) May-June 1993, pp.75–86

Naspo Benchmarking (2007). *Benchmarking Cost Savings & Cost Avoidance*
Nets, V. et al. (2000). *Value Proposition: Crafting the Offer*. pp.34–73

Nielsen, A. (2008). Getting Started with Value Stream Mapping. *American Journal of Scientific Research*, 3(3), p.45

Oliver Wyman Group, http://www.oliverwyman.com/index.html. Available at: http://www.oliverwyman.com/index.html

OSONO, SHIMIZU & TAKEUCHI (2008). *Extreme Toyota : radical contradictions that drive success at the world's best manufacturer*, Available at: http://www.lavoisier.fr/livre/economie/extreme-toyota-radical-contradictions-that-drive-success-at-the-world-s-best-manufacturer/osono/descriptif_1343891

Oswaldo Morales-Matamoros Flores-Cadena, M., Tejeida-Padilla, R. & Lina-Reyes, I. (1999). *After-Sales Service Parts Supply Chain System in OEM Telecom Firms*

Pande, P. & Holpp, L. (2005). *What Is Six Sigma?*

Pascoe, S. et al., 2003. *Measuring and assessing capacity in fisheries. 2. Issues and methods*, Available at: http://www.fao.org/docrep/006/y5027e/y5027e00.HTM.

Porter, M. E. (1996). What Is Strategy? *Harvard Business Review*, 74(6) November-December 1996, pp.61–78

Porter, M. E. (2008). The five competitive forces that shape strategy. *Harvard Business Review*, 86(1) January 2008, pp.79–93

Prahalad, C. K. & Hart, S. (2006). *Fortune at the Bottom of the Pyramid*

pwc (2012). *Rethinking the business operating model - Corporate simpli cation in the automotive sector*

Ramana, A. V. (2013). *Customer Relationship Management*, Available at: http://searchcrm.techtarget.com/definition/CRM

Ramesh, V., Sreenivasa Prasad, K. V & Srinivas, T.R. (2008). Implementation of a Lean Model for Carrying out Value Stream Mapping in a Manufacturing Industry. *Journal of Industrial and Systems Engineering*, 2(3), pp.180–196

Repenning, N.P. & Sterman, J.D. (2001). Nobody Ever Gets Credit for Fixing Problems that Never Happened: Creating and Sustaining Process Improvement. *California Management Review*, 43(4), pp.64–88

Ross, A. & Droge, C. (2002). An integrated benchmarking approach to distribution center performance using DEA modeling. *Journal of Operations Management*, 20(1), pp.19–32

Roulstone, D.B. & Phillips, J.J. (2008). *ROI for Technology Projects*, Available at: http://www.sciencedirect.com.proxy.lib.fsu.edu/science/article/B8NRK-4X7YFD0-6/2/e6a75636773a6028ada2fc5d749b0e2b

Saccani, N., Johansson, P. & Perona, M. (2007). Configuring the after-sales service supply chain: A multiple case study. *International Journal of Production Economics*, 110(1-2), pp.52–69

Sambasivan, M., Nandan, T. & Mohamed, Z.A. (2009). Consolidation of performance measures in a supply chain environment. *Journal of Enterprise Information Management*, 22(6), pp.660–689. Available at: http://dx.doi.org/10.1108/17410390910999576

Sanchez-Rodriguez, C., Lorente, A.R.M. & Clavel, J.J.G., *Benchmarking inpurchasing function:impact on purchasing performance and business performance*

Segel, A., Chu, M. & Herrero, G. (2006). Patrimonio Hoy. *Harvard Business School*, Case 9-805-064 July 2006, pp.1–18

Seitz, M.A. & Peattie, K. (2004). Meeting the Closed-Loop Challenge: THE CASE OF REMANUFACTURING. *California Management Review*, 46(2), pp.74–89. Available at: http://www.redi-bw.de/db/ebsco.php/search.ebscohost.com/login.aspx?direct=true&db=bth&AN=12391599&site=ehost-live

Senge, P.M. (2004). *The Fifth Discipline: The Art and Practice of the Learning Organization. New York: Doubleday.* Available at: *http://books.google.com/books?id=uPAMkK118OcC&pgis=1*

Shapiro, C. & Varian, H. R. (1999). The Art of Standards Wars. *California Management Review*, 41(2), pp.8–32.

Shaw, N.C., Meixell, M.J. & Tuggle, F.D. (2002). *A Case Study of Integrating Knowledge Management into the Supply Chain Management Process*

DA Silveira, G. (1999). A methodology of implementation of cellular manufacturing. *International Journal of Production Research*, 37(2), pp.467–479

Simatupang, T.M. & Sridharan, R. (2004). A benchmarking scheme for supply chain collaboration. *Benchmarking: An International Journal*, 11(1), pp.9–30

Simons, R. (1994). How New Top Managers Use Control Systems as Levers of Strategic Renewal. *Strategic Management Journal*, 15(3), pp.169–189

Sprague, B.M. & Accenture (2005). An End-to-End Strategy for Improved Warranty Management Capabilities. *Accenture. High performance. Delivered*, pp.1–8

Spring, M., & Aranjo, L. (2009). Service, services and products: rethinking operations strategy. *International Journal of Operations & Production Management, 29*(5), pp.444-467

Stock J. & Lambert, D. (1993). Channels of Distribution. *Strategic Logistics Management*, pp.70–109

T.M.a, S. & R.b, S. (2004). *Benchmarking supply chain collaboration: An empirical study*, Available at: http://www.scopus.com/inward/record.url?eid=2-s2.0-23744509790&partnerID=40&md5=73a97b1bae8ef04b68fa0627da23ee9b

The Benchmarking Exchange, http://www.benchnet.com/. Available at: http://www.benchnet.com/

The Benchmarking Network, http://www.benchmarkingnetwork.com/. Available at: http://benchmarkingnetwork.com/

Tjaden, G.S. (1999). *Business Process Structural Analysis*

Unzicker, D., Harrity, C. & APQC (2006). *Service After Sales: Getting the biggest bang for your buck in after-sales solutions through benchmarking*

Virtos, H., http://opensourcedea.org/dea/. Available at: http://opensourcedea.org/dea/

Vitasek, K. & Manrodt, K. (2007). *ProLogis Supply Chain Review - Trends from the World's Supply Chain Leaders*

Voss, C. A., & Hsuan, J. (2009). Service Architecture and Modularity. *Decision Sciences, 40*(3), pp.541–569

Wad, P. (2009). *Impact of the Global Economic and Financial Crisis over the Automotive Industry in Developing Countries.* Retrieved November 14, 2012, from unido.org: http://www.unido.org/fileadmin/user_media/Publications/Research_and_statistics/Branch_publications/Research_and_Policy/Files/Working_Papers/2009/WP

Whitney, D. E. (1988). Manufacturing by Design. *Harvard Business Review*, July-August 1988, pp.83–90

Wise, R. & Baumgartner P. (1999). Go Downstream: The New Profit Imperative in Manufacturing. *Harvard Business Review*, Reprint 99512 September-October 1999, pp.133–141

Wohlers Associates, Wohlers Report 2015. Available at: https://www.wohlersassociates.com/2015report.htm

Womack, J. P. & Jones, D. T. (1996). Beyond Toyota: How to Root Out Waste and Pursue Perfection. *Harvard Business Review*, Reprint 96511 September-October 1996, pp.4–16

Yan, B. & McLaren, P.A. (2010). Measuring after-sales service quality in automobile retails: An application of the SERVQUAL instruments. *Industrial Engineering and Engineering Management (IEEM), 2010 IEEE International Conference on*, pp.2090–2094