An evaluation of demand and capacity planning processes – A qualitative case study on completely-knocked-down vehicles at Mercedes-Benz Cars

by

Natascha Chemendy

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Supervisor: Prof JJ Louw

Co-Supervisor: Mr AE de Swardt

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Declaration

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Abstract

Sales and operations planning (S&OP) describes an integrated business management process, enabling management to achieve cross-functional focus and alignment throughout an organisation. This process plays a critical role in managing external demand and internal capacities. Specifically in times of demand volatility, S&OP has the potential to improve supply chain performance. Successful S&OP requires integrated and effective processes as well as appropriate external collaborative processes with key channel partners to enhance supply chain performance in a sustainable manner.

As a globally operating business, Daimler Aktiengesellschaft also requires effective S&OP. The business unit for passenger vehicles, Mercedes-Benz Cars (MBC), follows two import strategies to increase market potential, namely completely-built-up (CBU) and completely-knocked-down (CKD) vehicles. Demand and capacity planning is a crucial component of supply chain management at MBC, both for CKD- and CBU-vehicle management. The CKD-vehicle business only accounts for a small portion of MBC however with continuously increasing production output.

The increasing production volumes of CKD-vehicles stress the significance of effective demand and capacity planning processes. In order to remain competitive, the company identified the need to gain deeper insight and to investigate potential improvement opportunities for demand and capacity planning processes for CKD-vehicles. The aim of this study was to provide a foundation for MBC to improve the processes for demand and capacity planning for CKD-vehicles. Further, the study aims to provide recommendations towards appropriate performance metrics to track the improvements mentioned.

This research followed an intra-case, cross-sectional case study design in an exploratory manner. The combination of primary and secondary data provided a comprehensive foundation for this study. Data were collected through observations, interviews and a focus group. The qualitative analysis of primary unstructured textual data took place in the form of content analysis.

The results of this study consist of the identification of key planning processes for demand and capacity management for CKD-vehicles, followed by an evaluation of these processes and recommendations on suitable metrics to measure the performance of these processes. Main findings indicated that MBC operates cross-functional processes that lack system integration and availability of information. These factors lead to uncertainty regarding CKD-vehicle planning processes, increased lead times and forecasting inaccuracy. The main improvements recommended include the advancement from manual data processing to more computerised data processing, availability of information throughout the supply chain and the implementation of metrics to measure the performance of demand and capacity planning processes. The implementation of these recommendations could enable MBC to improve subsequent processes, such as shortfall management.

In conclusion, the demand and capacity planning processes for CKD-vehicles at MBC provide a solid basis for S&OP with potential for improvement. In order to manage growing vehicle production output, it is recommended that MBC enhances demand and capacity planning processes further, aiming at an alignment with the equivalent processes for CBU-vehicles. Additionally, the monitoring of process performance guides the business further in process development by identifying further improvement areas. The incorporation of recommended improvements could allow MBC to significantly enhance their performance, and overcome the shortcomings identified in this study.

Key words: Sales and operations planning; Supply chain performance; Process improvement; Process management; Performance management; Automotive industry; Daimler AG; Completely-knocked-down vehicles.

Opsomming

Verkope en bedryfsbeplanning (S&OP) beskryf 'n geïntegreerde sakebestuursproses wat bestuur in staat stel om kruis-funksionele fokus en belyning regdeur 'n organisasie te bereik. Hierdie proses speel 'n kritieke rol in die bestuur van eksterne vraag en interne vermoëns.

Spesifiek in tye van vraagvolatiliteit, het S&OP die potensiaal om die voorsieningskettingprestasie te verbeter. Suksesvolle S&OP vereis geïntegreerde en effektiewe prosesse asook gepaste eksterne samewerkingsprosesse met sleutelkanaalvennote om die voorsieningskettingprestasie op 'n volhoubare wyse te verbeter.

As 'n wêreldwye operasionele onderneming vereis Daimler Aktiengesellschaft ook effektiewe S&OP. Die besigheidseenheid vir passasiersvoertuie, Mercedes-Benz Cars (MBC), volg twee invoerstrategieë om die markpotensiaal, naamlik "completely-built-up" (CBU) en “completely-knocked-down” (CKD) voertuie, te verhoog. Vraag- en kapasiteitsbeplanning is 'n belangrike komponent van voorsieningskettingbestuur by MBC, beide vir CKD- en CBU-voertuigbestuur. Die CKD-voertuigbesigheid is egter slegs verantwoordelik vir 'n klein gedeelte van MBC, maar met voortdurend toenemende produksie-uitset.

Die toenemende produksievolumes van CKD-voertuie beklemtoon die belangrikheid van effektiewe vraag- en kapasiteitsbeplanningsprosesse. Om mededingend te bly, het die maatskappy die behoefte geïdentifiseer om dieper insig te verkry en potensiële verbeteringsgeleenthede vir vraag- en kapasiteitsbeplanningsprosesse vir CKD-voertuie te ondersoek. Die doel van hierdie studie was om 'n grondslag vir MBC te bied om die prosesse vir vraag- en kapasiteitsbeplanning vir CKD-voertuie te verbeter.

Verder streef die studie daarna om aanbevelings te maak oor toepaslike prestasie statistieke om die verbeteringe na te gaan. Hierdie navorsing het op 'n ondersoekende wyse 'n intra-saak, dwarsdeursnee gevallestudie-ontwerp gevolg. Die kombinasie van primêre en sekondêre data het 'n omvattende grondslag vir hierdie studie verskaf. Data is ingesamel deur middel van waarnemings, onderhoude en 'n fokusgroep. Die kwalitatiewe analise van primêre ongestruktureerde tekstuele data het plaasgevind in die vorm van inhoudsanalise.

Die resultate van hierdie studie bestaan uit die identifisering van sleutelbeplanningsprosesse vir vraag- en kapasiteitsbestuur vir CKD-voertuie, gevolg deur 'n evaluering van hierdie prosesse en aanbevelings oor geskikte statistieke om die prestasie van hierdie prosesse te meet. Belangrikste bevindings het aangedui dat MBC kruis-funksionele prosesse bedryf wat die stelselintegrasie en beskikbaarheid van inligting ontbreek. Hierdie faktore lei tot

onsekerheid rakende CKD-voertuigbeplanningsprosesse, verhoogde loodstye en voorspellings-onakkuraatheid. Die belangrikste verbeteringe wat aanbeveel word, sluit in die bevordering van handige dataverwerking tot meer gerekenariseerde dataverwerking, beskikbaarheid van inligting regdeur die voorsieningsketting en die implementering van statistieke om die prestasie van vraag- en kapasiteitsbeplanningsprosesse te meet. Die implementering van hierdie aanbevelings kan MBC in staat stel om daaropvolgende prosesse, soos tekortbestuur, te verbeter.

Ten slotte bied die vraag- en kapasiteitsbeplanningsprosesse vir KKD-voertuie by MBC 'n stewige basis vir S&OP met potensiaal vir verbetering. Om die groeiende voertuigproduksie-uitset te bestuur, word dit aanbeveel dat MBC verdere vraag- en kapasiteitsbeplanningsprosesse verder bewerkstellig, met die oog op 'n belyning met die ekwivalente prosesse vir CBU-voertuie. Daarbenewens lei die monitering van prosesverrigting die besigheid verder in prosesontwikkeling deur verdere verbeteringsareas te identifiseer. Die inkorporering van aanbevole verbeterings kan MBC toelaat om hul prestasie aansienlik te verbeter en die tekortkominge wat in hierdie studie geïdentifiseer is, te oorkom.

Sleutelwoorde: Verkope en bedryfsbeplanning; Voorsieningskettingprestasie; Proses verbetering; Prosesbestuur; Prestasiebestuur; Motorbedryf; Daimler AG; “Completely-knocked-down”

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3PL	Third party logistics (logistics service provider)
AG	Aktiengesellschaft (joint-stock company)
AMG	Division for sports cars of Daimler AG, acronym of founder's last names *Aufrecht* and *Melcher* and the city *Großaspach* where AMG was founded)
APICS SCC	American Production and Inventory Control Society Supply Chain Council
BM	Baumuster (Type of construction)
BPR	Business Process Reengeneering
CAQDAS	Computer Assisted Qualitative Data Analysis Software
CASE	Connected, autonomous, shared & services, electric
CBU	Completely-built-up
CC	Consolidation centre
CIF	Cost, Insurance, Freight
CKD	Completely-knocked-down
CoRe	Coderestriktion (Code restriction)
CSCMP	Council of Supply Chain Management Professionals
DFS	Daimler Financial Services
DMG	Daimler Motoren Gesellschaft (Daimler engine coorporation)
EPV	Einplanungsvorgabe (programme scheduling guideline)
EXW	Ex Works
FOB	Free on Board
G.M.	General Motors
GO	Global Ordering (Sales programme)
GOP	Ganzobjektplanung (Sales data used for material forecast)
IBP	Integrated Business Planning
ICC	International Chamber of Commerce
Incoterms	International commerce terms
ISP4D	Integrated Sales Planning for Daimler
JPP	Jahresprogrammplanung (annual programme planning)
KPI	Key Performance Indicators
LAB	Lieferabruf (delivery call-off)
M	Month/Million
MBC	Mercedes-Benz Cars
MBV	Mercedes-Benz Vans

MPP	Monatsprogrammplanung (monthly programme planning)
NST	National sales type
OEM	Original equipment manufacturer
OP	Operational planning
PBK	Programme, Bedarfe, Kapazitäten (Programmes, demand, capacities)
PbP	Part by Part
SA	Sonderausstattung (Special equipment)
SC	Supply chain management sector (Department at Daimler AG)
SCM	Supply chain management
SCOR	Supply Chain Operations Reference (Model)
SKD	Semi-knocked-down
SP	Strategic planning
SUV	Sports Utility Vehicle
SWOT	Strengths, weaknesses, opportunities and threats
SIPOC	Supplier, input, process, output, customer
S&OP	Sales & Operations Planning
TBE	Teilebedarfsermittlung (Material forecast)
TKL	Typklasse (Class type)
TQM	Total Quality Management
OEM	Original Equipment Manufacturer
OICA	International Organisation of Motor Vehicle Manufacturers
VW	Volkswagen AG
WD	Working day(s)
WPP	Weltproduktionsprogramm (World production programme)
Y	Year

List of addenda

Chapter 1. Introduction to the study

Supply chain management (SCM) is an area of great interest for academics and professionals. The discipline has become a fundamental part of most businesses with a strong link to success and performance (Council of Supply Chain Management Professionals, 2017). Supply chains are under constant development as globalisation, the rise of new technologies and changing customer expectations influence the business environment (PricewaterhouseCoopers, 2013:3). A clearly defined business strategy provides guidance to business practices in such volatile times (Snowdon, 2008:3). In alignment with a company's strategy, processes form the backbone of business operations, which stresses the importance of process management (Hayler & Nichols, 2005:5). Successful sales and operations planning (S&OP), which strongly depends on the performance of supply chain processes, is a crucial component in SCM (Tinker, 2010:5; Ball, 2013:1; Logility, 2017a).

The first chapter of this thesis briefly introduces the topic of the study and provides background information and rationale. In addition, the problem statement and research questions of the study are listed and the chapter further illustrates the scope, limitations and assumptions made in the research process. A conceptual framework and reading guide complete the first chapter.

1.1. Background

Worldwide demand for passenger vehicles is steadily growing with a shift from traditional markets in Western Europe and North America to markets in developing countries in Eastern Europe, Asia, South America and Africa (Verband der Automobilindustrie, 2016:16-20). As a result thereof, revenue and profit of car manufacturers develop with an overall positive trend (McKinsey&Company, 2016:4). Emerging markets such as Brazil, Eastern Europe, South Africa and India are expected to show steady economic growth in the future (KPMG, 2016:7). At the same time, original equipment manufacturers (OEMs) develop and diversify their products to compete in diverse and demanding markets. This diversification relates to new business models such as car sharing as well as a more diverse offer of cars in their portfolio (McKinsey&Company, 2016:13). The automotive industry is dominated by big holdings and co-operations, one of which is Daimler Aktiengesellschaft (AG) (OICA, 2017).

Known for their passenger vehicles, the German company Daimler AG consists of five business units: Mercedes-Benz Cars, Mercedes-Benz Vans, Daimler Trucks, Daimler Buses and Daimler Financial Services Daimler AG (2017a). Figure 1.1 illustrates the divisions of the company.

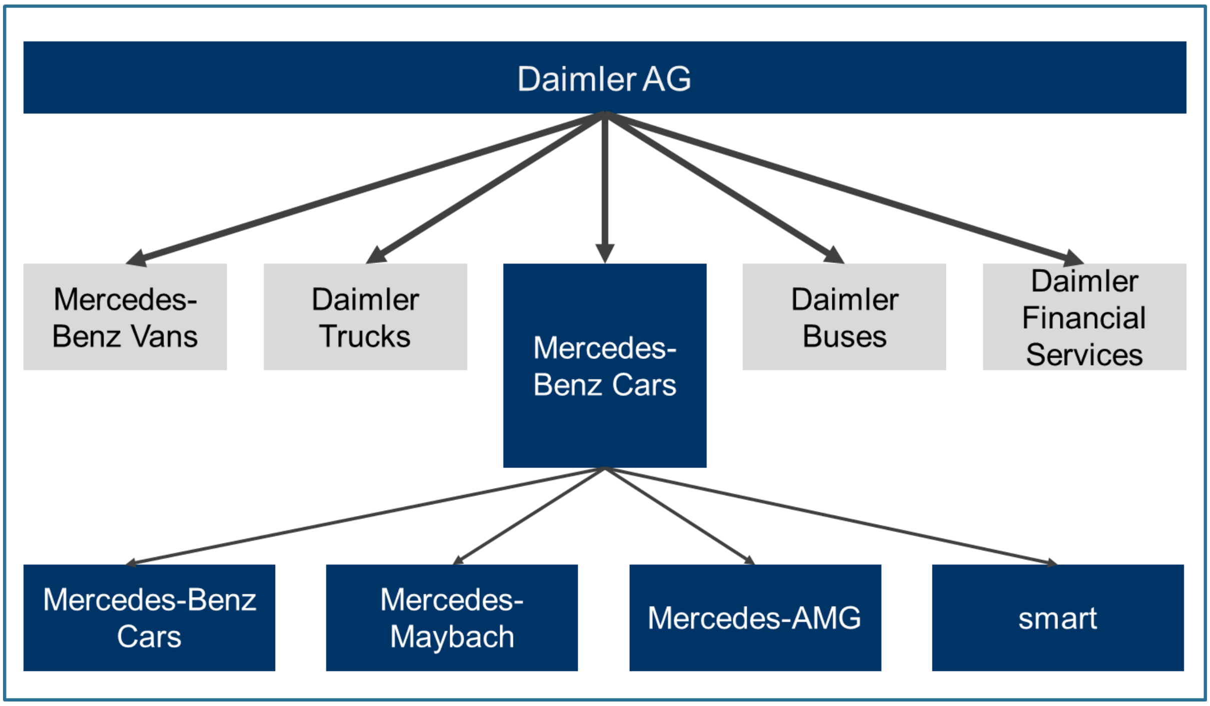


Figure 1.1: The divisions of Daimler AG with a focus on Mercedes-Benz passenger cars

Adapted from Daimler AG (2017a)

The business unit in charge of passenger vehicles, Mercedes-Benz Cars (MBC) is further divided into the classic Mercedes-Benz cars, the luxury segment, Mercedes-Maybach, the sports division, Mercedes-AMG, and the urban car segment, smart (Daimler AG, 2017a). The OEM needs to be innovative and flexible in order to gain access to new markets in this highly competitive environment. The planning of a worldwide production programme for passenger vehicles assists the OEM in satisfying demand in a competitive way.

A thriving production programme depends on successful collaboration of many players in a company's business environment (Porter, 1986:21). To facilitate this, S&OP is aimed at harmonising the cross-functional co-operation of role players through a uniform planning strategy and targets (Supply Chain Visions, 2013:171). Within a company, two of the key players for demand and capacity planning are the departments in charge of sales and SCM. The sales department aims at fully exploiting the market potential, while simultaneously maximising profit (Chopra & Meindl, 2007:191; Hüttner & Song, 2007:4). It is a challenge for SCM to facilitate the planned sales numbers through demand and capacity management, both on an internal level and in co-operation with suppliers. A combination of import strategies enhance the possibility to penetrate potential markets but also lead to more complex planning processes and supply chain configurations (PricewaterhouseCoopers, 2013:20).

Depending on market size, development state of the country and several other factors, an OEM can decide between three strategies. It is possible to import fully assembled vehicles as completely-built-up (CBU) vehicles, develop an assembly plant in the foreign country, or to assemble completely-knocked-down (CKD) vehicles, which are prepared and packed in the country of origin, but final assembly takes place in the foreign country of destination. There are different variations of CKD-vehicles, with different degrees of assembly before import (Pfohl, 2010:350; Koether, 2014:99). In order to regulate supply of foreign vehicles, it is common practice that countries levy import duties. These markets are less accessible for foreign vehicles, unless the OEM produces or assembles the vehicles locally (Klug, 2010:328; Koether, 2014:99).

Daimler AG operates several production and assembly facilities for passenger vehicles, which can be classified as CBU- and CKD-vehicle plants. Besides the plants in Germany, where Daimler AG originated, CBU-vehicle plants are also located in the United States of America (Tuscaloosa), South Africa (East London), Hungary (Kecskemet) and China (Beijing). In addition to these, CKD-vehicle plants are located in Brazil (Iracemápolis), India (Pune), Thailand (Bangkok), Vietnam (Ho Chi Minh), Malaysia (Pekan) and Indonesia (Jakarta) (Daimler AG, 2017b). Figure 1.2 illustrates the locations of all MBC plants for passenger vehicles.

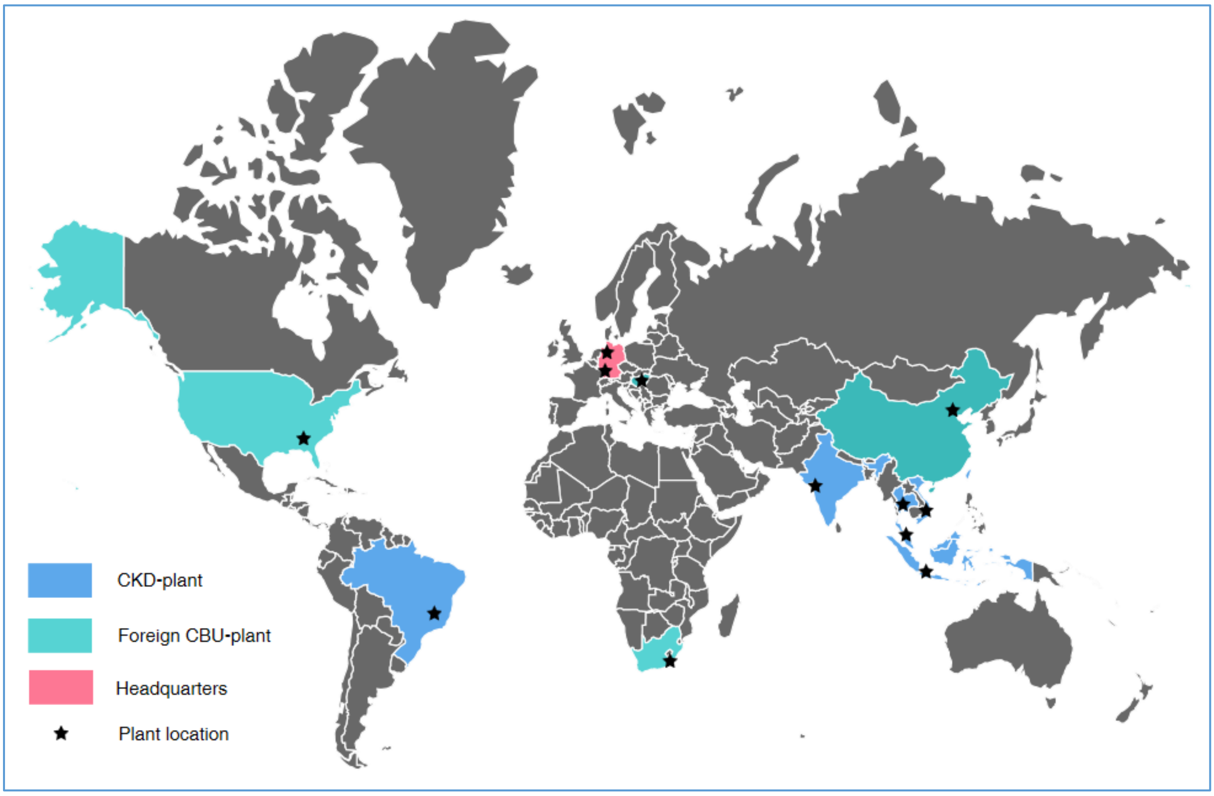


Figure 1.2: Plant locations MBC
Adapted from Daimler AG (2017b)

CKD-vehicle plants serve as an entry strategy into a new market with high market entry restrictions and demand not significant enough to build a CBU-vehicle plant (Klug, 2010:328; Koether, 2014:99). Due to the current high standards in infrastructure, it is possible to procure vehicle parts from a vast number of suppliers from almost all over the world to several production facilities. As a result, well-performing processes are required to manage demand and production volumes. A synchronised and effective demand and capacity planning system for all plants and processes has the potential to increase supply chain planning throughout the whole network of Daimler AG.

This study focuses on an evaluation of specific demand and capacity planning processes for CKD-vehicles at MBC. Improved demand and capacity processes can potentially assist in increasing supply chain performance. The overall purpose of this research is to evaluate and identify potential improvements for the selected demand and capacity planning processes for CKD-vehicles at MBC. Additionally, a qualitative evaluation of process performance metrics provides potential improvements in performance measurement to measure the processes in place. The significance of this study will be discussed further in Section 1.2.

1.2. Significance of research

The significance of process and performance improvement for CKD-vehicle planning is twofold. A competitive CKD-vehicle business offers development opportunities to MBC. In addition, an improvement of business practices potentially strengthens MBC internally.

The production of CKD-vehicles increases constantly despite rather small numbers relative to the total vehicle production output (Fahrzeug-Programm-Online, 2017). In addition to the volume increases in existing plants, Daimler AG also plans to open a new CKD-facility in Russia in 2019 (Daimler AG, 2017c). An increase in vehicle production output subsequently increases the significance of improved planning processes. Both external and internal factors contribute to the significance of the topic and the researcher’s motivation to conduct research in this field.

Globally, CKD-vehicles gain increasing attention due to recent political developments. While CKD-vehicle production as an import strategy is mostly relevant to developing countries, for example countries in Asia, current political development may lead to possible changes in import regulations in the Western world. Individual countries indicate a possible return to protectionism after a period of developing international trade. These countries often leave or threaten to leave trade unions and politicians openly state the possibility of introducing import taxes on finished goods. It is often too costly and time-consuming to open a production plant in such countries (Dudenhöffer, 2017; General Secretariat of the Council, 2017). As a result, the use of CKD-vehicles would still allow market access with lower investment costs. With possible volume increases in the future, an efficient demand and capacity planning process becomes more important.

Moreover, CKD-vehicle importation is a potential opportunity for MBC to gain access to African markets. Increasing development but relatively low demand and strict import rules currently characterise the market situation in many African countries (PricewaterhouseCoopers, 2014a; KPMG, 2016:37). In general, there seems to be sufficient existing research focusing on SCM in the automotive industry. On the contrary, process performance management, S&OP, as well as the field of CKD-vehicles in particular, offer plenty of opportunities for research. These opportunities serve as a motivation and further stress the significance of the topic for Daimler AG.

Considering internal factors, improved demand and capacity planning processes can potentially yield higher quality data output. MBC requests the necessary capacities based on a qualitatively higher foundation. As a result, the allocation of supplier capacities becomes more accurate. In addition, certain aspects of demand and capacity planning have to be processed manually due to the different handling of CKD-vehicle plants. Improved processes in turn allow the allocation of resources to other areas.

Increasing numbers of CKD-vehicles emphasise the fact that it is unavoidable to assess demand and capacity planning processes currently in practice. Even with current production output, an improved process for demand and capacity planning will allow for improved performance of the supply chain. Not only MBC, but also suppliers of the OEM benefit from standardisation and improved accuracy. A supplier's planning strongly relies on the quality of capacities reserved through MBC. Improved order quantities therefore affect the performance of all parties involved in the supply chain.

In summary, improving process performance for CKD-vehicle planning potentially strengthens the market performance of MBC, allowing for further growth through the CKD-vehicle business. Internally, subsequent processes can potentially benefit from improvements resulting from this study, leading to further performance improvements. Currently, demand and capacity planning for CKD-vehicles at MBC faces several challenges. In Section 1.3, the problem statement of the study is further elucidated.

1.3. Problem statement

The problem statement identifies the gap of knowledge with the intention of emphasising why the study is significant and beneficial to all stakeholders (Coley & Scheinberg, 2008:40). The three most important planning processes relevant to this study are those for production volumes, for special equipment (SA), as well as for ordering and shipping. There is currently little awareness at MBC of a standardised planning process for these three aspects. Most activities of these processes take place in departments specifically designed for CKD-vehicle planning. Certain activities, such as bottleneck management or supplier management, however, take place in a consolidated manner for CBU- and CKD-vehicles. These departments lack basic understanding of the preceding processes and the origin of information (SC/KP, 2017a).

Generally, MBC handles the two strategies for CKD- and CBU-vehicles differently in terms of demand and capacity planning. To an extent, the two strategies require different processes, which justifies the existing differences. The reason why CKD-vehicles, which only account for a small percentage of the total production output of MBC, require specific handling procedures is not always clear. The different handling procedures potentially require additional work and different resources, for example for order management of CKD-vehicles (SC/WTO2, 2017a). The department for demand and capacity planning has identified the need to better understand and potentially align the processes for demand and capacity planning for CKD- and CBU-vehicles, which can be seen as the main motivation for this study (SC/KP, 2017a).

With regard to planning of ordering and shipping, all CKD-vehicle plants in the world apply different procedures for order management. Only once the real number and specification of orders are known, the individual CKD-vehicle plants submit their planning information to the centralised SCM department that is in charge of demand and capacity planning. The ordering process takes place manually and each CKD-vehicle plant follows different procedures and processes, which negatively affects process performance (SC/WTO2, 2017a).

In order for MBC to track and improve performance, performance measurement is necessary (Ball, 2015b:1). There is, however, uncertainty about performance measurement of processes currently in place. A performance measurement system is in place but employees are mostly unaware of it. In addition, the effectiveness of metrics and targets in place is questionable. Similar to the processes, performance measurement differs from CKD-vehicles to CBU-vehicles.

Three reasons are identified as the root causes of the problems described. Firstly, the CKD-vehicle business is often belittled due to small production output. Besides the company's perception of CKD-vehicles, the relatively low contribution to business revenue in relation to the total production figures, is a main cause of this problem. CKD-vehicles account for approximately 2% of MBC's total production volume per year. CKD-vehicle production output has, however, tripled over the past 10 years (Fahrzeug-Programm-Online, 2017). Due to the comparatively low production output, the departments in charge neglected the development and maintenance of planning processes. Secondly, in addition to the small production output, the product diversity usually is limited to only certain car models and SA packages available in each market. Lastly, the matter is aggravated by the fact that CKD-vehicle plants, often owned by local subsidiaries in the country of production, follow different approaches for demand and order management (SC/KP, 2017a).

The current situation leads to a number of complications. In an ideal production environment without any unforeseen complications, the quality of demand and capacity planning for production volumes and especially for SA parts already varies to an unknown extent. With a forecast of differences in quality, of parts or assembled vehicles, the foundation for any further actions is already unstable. The automotive industry is extremely volatile with many players of different tiers involved in production. Capacity constraints and bottlenecks can occur on a daily basis. Bottleneck management of MBC as a whole currently needs to rely on uncertain and possibly incorrect planning due to the CKD-component included.

The current model for bottleneck management does not allow restrictions on SA for CKD-vehicles, mostly due to the unclear procedures and inaccuracy (SC/KP, 2017a). This leads to CKD-vehicle plants receiving all ordered parts in case of a bottleneck if the part is built in both CKD- and CBU-vehicles. Local content parts excluded, the majority of parts come from common suppliers for CKD- and CBU-vehicle production. In case of a shortfall, the lack of demand and capacity planning for CKD-vehicles potentially leads to a production stop in the CBU-vehicle plant. Sales restrictions are often put in place to prevent complications leading to a production stoppage. This means that customers cannot choose specific SA unless they are willing to postpone their purchase by a few weeks or even months. For some customers, an extended waiting period is an unacceptable obstacle, often leading to loss of sales (MS/SOP, 2017).

The evaluation of relevant processes in order to improve demand and capacity planning for CKD-vehicle plants is necessary to avoid further deterioration of the situation. The lack of process performance management inhibits the application of performance results for process improvement. Monitoring of process performance and improvement of existing processes is not continuously taken care of. As a result, employees as well as management are unaware of potential problem areas. Even if there is existing awareness of inefficiencies, lack of proof in the form of performance evaluations complicates improvements. Figure 1.3 illustrates the problem identification as described by Coley & Scheinberg (2008:41-45), focussing on the problem, its cause and its impact.

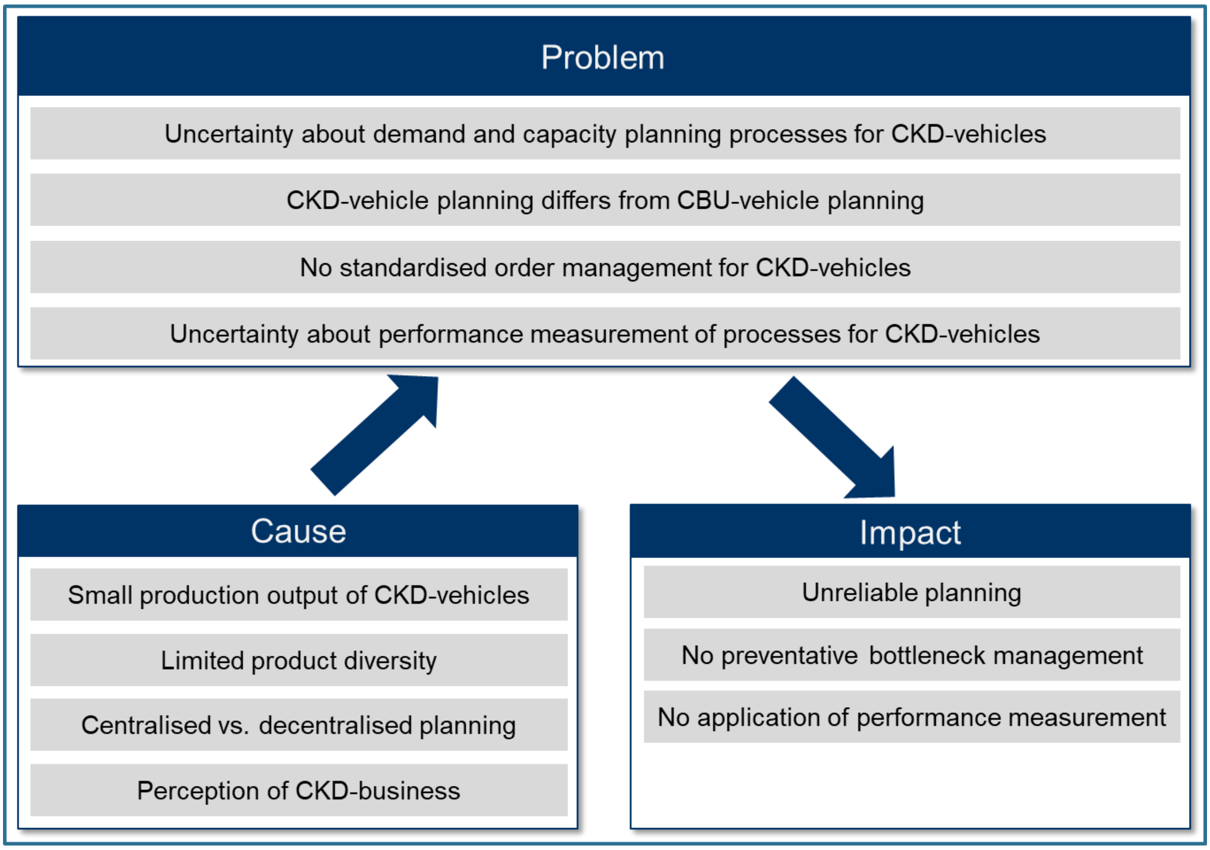


Figure 1.3: The problem statement

While the described problem is specific to MBC, factors such as uncertainty about processes, unreliable forecasting and inefficient performance measurement are issues known in literature. As part of this research, several databases, both publicly available and private to Daimler AG, have been searched to ensure that such a study has not been conducted yet. Public databases include SunScholar, ProQuest and EBSCOHost. Furthermore, Daimler AG maintains an internal database for research reports and theses, namely DaimlerDocks. No study with the same content has been identified in these searches. Generally, literature suggests improvements to problems such as mentioned above. The literature review in Chapter 2 will introduce theories that can be applied to solve the problem statement.

The problem itself is linked to other internal factors, all potentially affecting the overall performance of the supply chain. The goal of this study is to find solutions to the problems stated in order to reduce the impact on business performance. The research questions introduced in Section 1.4 guide the problem solving process.

1.4. Research questions

This study aims to answer several research questions. In order to ensure attainable results, the research questions narrow down the scope of the topic. All research questions will be answered within the context of Daimler AG's business unit MBC. These questions assist in solving the overarching problem and are defined as follows:

1) What are the current processes for CKD-vehicle demand and capacity planning?
2) What are positive aspects about the processes currently in place in accordance with business practices and existing theories?
3) What complications occur as a result of the current processes in accordance with business practices and existing theories?
4) What are possible improvements to increase the performance of these processes in accordance with business practices and existing theories?
5) What are appropriate metrics to measure the performance of these processes?

The study aims to answer the research questions within the context of MBC. The study is not representative of all companies in the automotive industry. An evaluation of planning processes for demand and production capacities for CKD-vehicles for MBC will be derived from the results of the research conducted. In Section 1.5, each research question will be further discusses in connection with its relevant objections.

1.5. Research aim and objectives

This section introduces objectives to guide the research process. Objectives define useful, feasible, unambiguous and informative milestones and goals to guide the research process and answer the research questions (Mills, Durepos & Wiebe, 2010). A number of objectives have been defined to guide the answering of the research questions. The objectives are in close alignment with the research questions listed in Section 1.4. The following 13 objectives further guided the research study:

- The identification of current processes for CKD-vehicle demand and capacity planning.
- The identification of current processes for CBU-vehicle demand and capacity planning.
- The identification of existing theories regarding demand and capacity planning.
- The identification of positive aspects of CKD-vehicle demand and capacity planning.
- The identification of complications of CKD-vehicle demand and capacity planning.
- The development of improvements for processes for CKD-vehicle demand and capacity planning.

- The identification of current performance metrics in place for CKD-vehicle planning.
- The identification of current performance metrics in place for CBU-vehicle planning.
- The identification of positive aspects of performance metrics in place for CKD-vehicle planning.
- The identification of negative aspects of performance metrics in place for CKD-vehicle planning.
- The development of improvements for performance metrics for CKD-vehicle planning.

The objectives define milestones of the research process that need to be achieved in order to answer the research questions and achieve the overarching aim of the study. Each research question is linked to one or more objectives and an objective can be linked to more than one research question, as illustrated in Figure 1.4. The overall focus of the study is on the processes for demand and capacity planning. The last three objectives solely focussing on performance metrics describe a qualitative approach to identifying possible metrics to measure process performance.

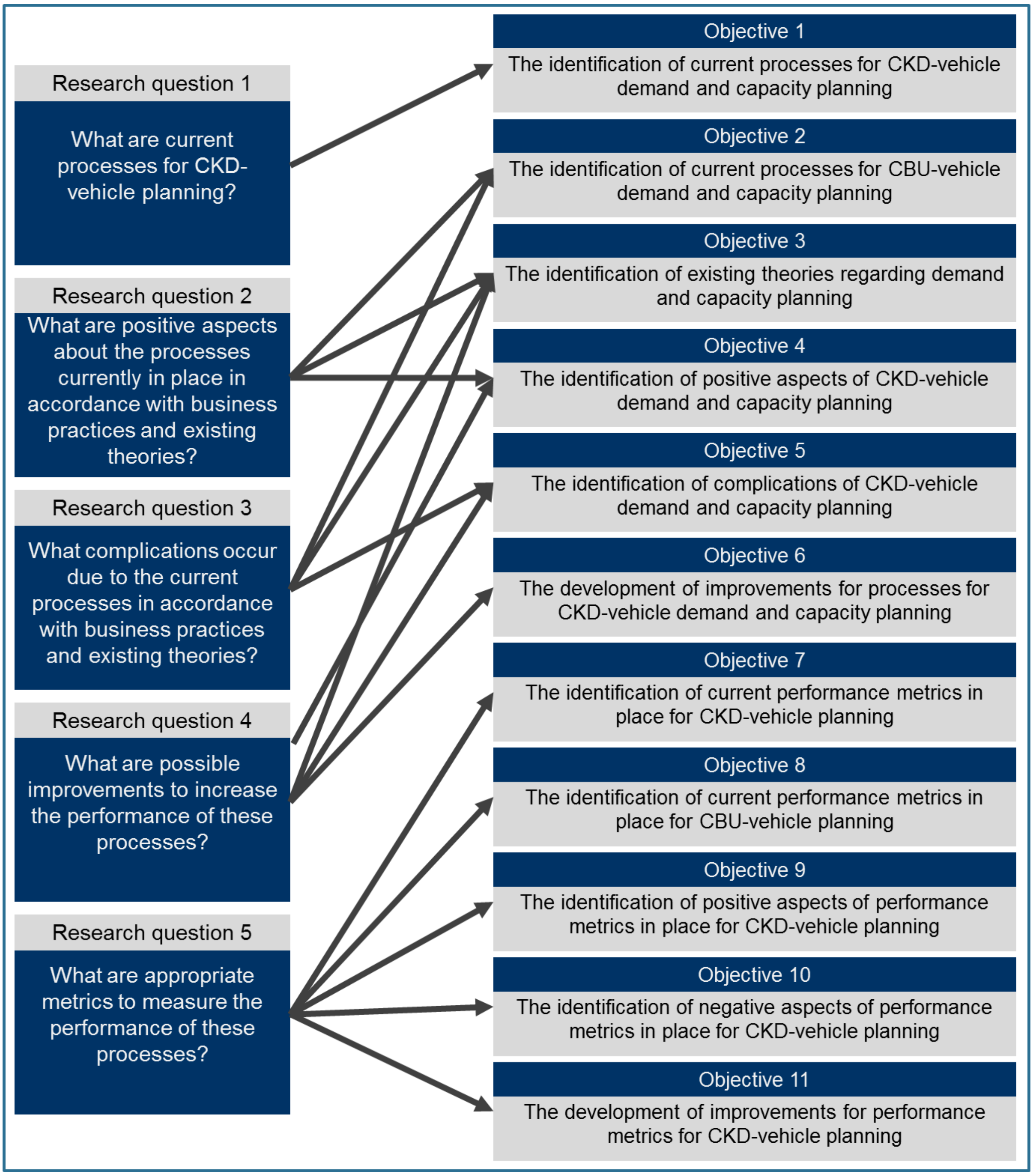


Figure 1.4: Research questions and objectives

The first research question aims at documenting the current processes for CKD-vehicle planning. In order to answer this question, it is necessary to identify the current processes for demand and capacity planning, including departments and activities involved.

The second research question focuses on the positive aspects of CKD-vehicle planning based on existing business practices and existing theory. The objectives that need to be achieved in order to answer this question include the identification of current processes for CBU-vehicle demand and capacity planning, the identification of existing theories regarding demand and capacity planning, and the identification of positive characteristics of the currently existing processes for CKD-vehicle planning.

Contrary to the second research question, the third research question aims at identifying complications occurring in the processes currently in place. In alignment with the second research question, this question is linked to the identification of processes for CBU-vehicle demand planning and existing theories. In addition, the identification of complications plays a crucial role in answering this research question.

The fourth research question concludes the research on processes by suggesting possible improvements for CKD-vehicle planning processes. The answer to this question is based on the objectives that identify existing theories regarding demand and capacity planning. Based on existing theories and under consideration of the previously identified positive and negative aspects, the development of improvements for CKD-vehicle demand and capacity planning takes place.

The fifth research question analyses the aspect of performance metrics by identifying suitable performance metrics to measure process performance. Objectives required to answer this questions are the identification of current performance metrics for CKD- and CBU vehicle planning and the identification of positive and negative characteristics of the metrics. In conclusion, the last objective focuses on the development of improvements for performance metrics for CKD-vehicle planning processes.

As an initial step, the evaluation of processes and performance metrics aims at improving the performance of the CKD-vehicle business. Subsequent processes such as bottleneck management and supplier management can benefit from these process improvements, allowing further performance increases. Such subsequent processes are, however, out of scope for this study. Section 1.6 further discusses the scope and limitations of the study

1.6. Demarcation of the study

A clear demarcation of the study assists in understanding the results of this research. This section discusses the scope and limitations under which research was conducted.

The study is company-specific. Research was conducted in co-operation with the MBC division of Daimler AG in Böblingen, Germany. The *Supply chain management* sector (*SC*) of MBC identified the need for research regarding CKD-vehicle planning due to the impact of these processes on their operations. The department in charge of demand and capacity planning showed especially great interest in this study.

Due to this great interest, the scope of the study focuses on demand and capacity planning. The term includes customer demand planning in relation with sales and marketing, supplier demand planning for parts and components as well as production, packing and assembly capacities of Daimler AG. Capacity planning entails the planning of vehicle production volumes. The term does not consider the actual production and assembly planning. Due to the complexity of supplier demand planning, the study's was not on this aspect, resulting in a focus on production volume planning, SA-planning as well as ordering and shipping planning.

The three processes of production volume planning, SA-planning and planning of ordering and shipping developed as the most significant processes for *SC*. The CKD-vehicle business comprises a number of other planning processes, such as strategic planning, that are not part of this study for reasons of complexity. The activities, input and output of these processes are limited to information relevant to *SC* and components with less relevance are reduced or omitted.

Furthermore, the study looks at supply chain and process performance from MBC's point of view. Despite the complex supply chain of MBC, the study is limited to information relating to MBC and the logistics service providers (3PLs) in charge of packing and shipping. The local organisations in CKD-vehicle markets count as subsidiaries of MBC.

In terms of limiting factors to the study, time and access to information played a significant role. The co-operation with and exposure to Daimler AG was limited to six months. As a result, the scope of the study is limited to the evaluation of processes and performance metrics and a suggestion of possible improvements. Insufficient time did not allow implementation and testing of improvements as a part of the study.

Lastly, despite the co-operation with MBC, data access was limited due to confidentiality reasons. MBC treats performance management with high levels of confidentiality, resulting in limitations with regard to the assessment of performance metrics. Therefore, the scope largely focuses on process evaluation with an indication of performance management. Section 1.7 further addresses the topic of confidentiality and research ethics.

1.7. Confidentiality and research ethics

Research was done in the context of demand and capacity management at the MBC division of Daimler AG. Daimler AG requires a confidentiality agreement for sensitive information. Therefore, a copy without any sensitive information and figures will be submitted to the university. The thesis submitted is desensitised with fictitious figures without any impact on the quality of the research results. This is necessary for the university to publish the results of the research. An original copy with all sensitive information and original data will be provided to Daimler AG, upon request only. The original data is in control of Daimler AG and will not be published unless Daimler AG decides to do so or agrees to a publication in written form.

For referencing purposes, the study refers to the Daimler AG abbreviation rather than to the name of the participant or author of a document. The research requires contact and interaction with human participants in the form of focus groups, interviews, conversations and observations. The research does, however, not require personally sensitive data about the individual participants. Their knowledge and expertise with regard to their profession is what this research aims at. Respondents participated on a voluntary basis and could withdraw from the study at any time without any reason or justification. This thesis does not reference individual employees. Section 1.8 provides further information on data collection by introducing the conceptual framework of the study.

1.8. Conceptual framework

The conceptual framework summarises the activities of research and serves as a schedule for the research process. The conceptual framework for this study is divided into two parts: The alternated framework developed by the American Production and Inventory Control Society Supply Chain Council (APICS SCC) and an application to the different tasks of this study (APICS, 2017). Moreover, the section of the framework which is applied to this study is inspired by the approach developed by Bolstorff & Rosenbaum (2011), using the Supply Chain Operations Reference (SCOR) model for process improvements in SCM. Figure 1.5 illustrates the conceptual framework.

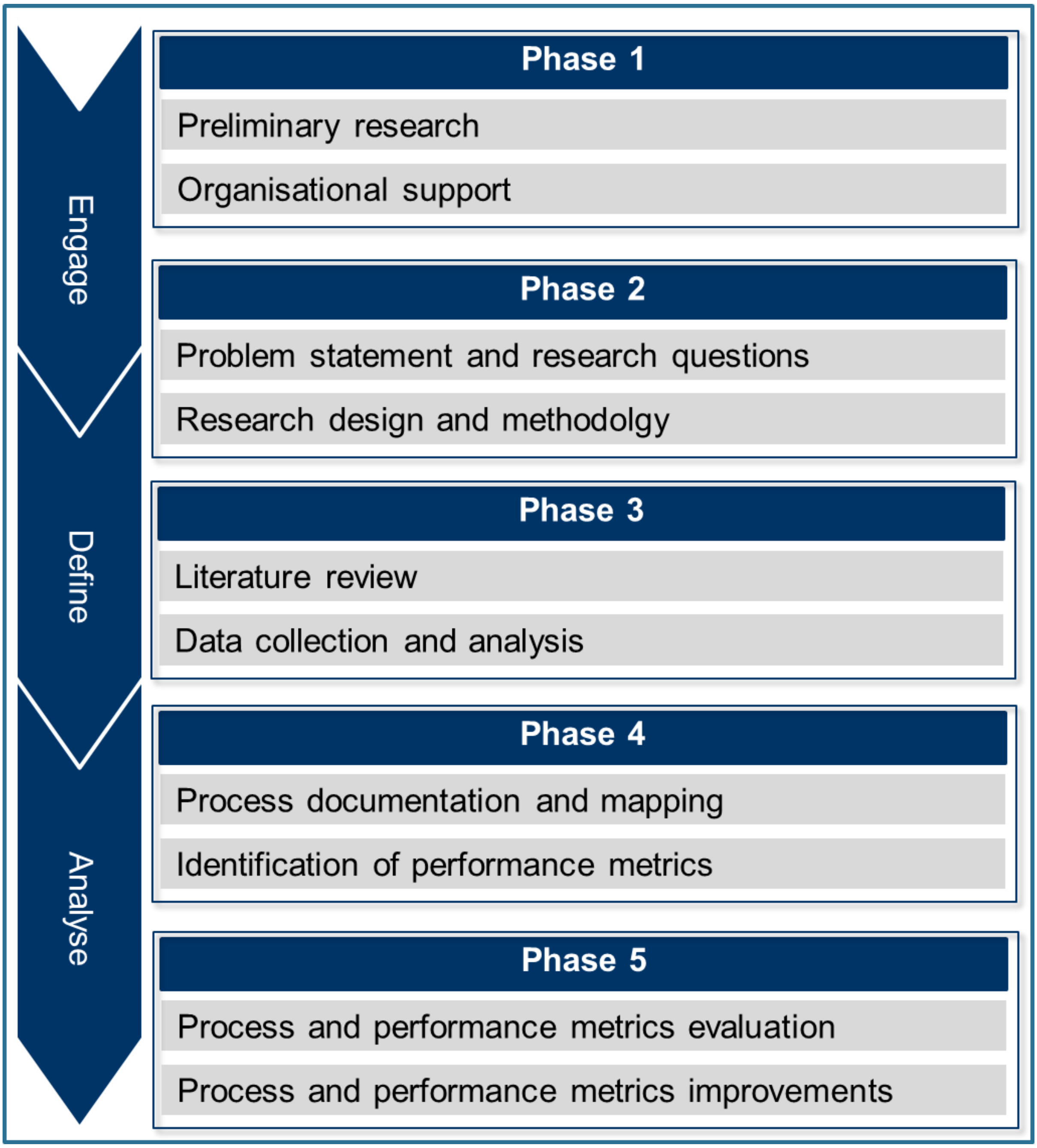


Figure 1.5: Conceptual framework

The flow diagram on the left side of Figure 1.5 states the outcomes of each phase of the research process. On the right side, the different phases are allocated to key deliverables of the research process of this study.

The first phase describes the initial engagement of the researcher with the topic. Preliminary research ensures that the researcher gains an overview of the field of research in order to be able to select and define a topic. Since this study focuses on a case linked to a single company, the first phase also describes organisational support. Both administration and acceptance play an important role. Questions regarding the function of employees within the company as well as which employees in charge of supervision were clarified.

Phase two further defines the premises and circumstances of the study. The scope of the study, problem statement, research questions and objectives identify the boundaries and purpose of the study. Furthermore, research design and methodology are defined in this step.

The third phase contains the analysis part of the study. This phase describes the desk and field research component, including the literature review, primary and secondary data collection and data analysis. This phase lays the foundation for the following fourth phase.

Phase four focuses on process documentation and mapping based on the information gathered in the previous phase. Further, this phase consists of the identification of performance metrics currently in use.

Concluding the study, phase five consists of evaluation of the processes and metrics previously identified. Based on the evaluation as well as existing theories and business practices, the research identifies possible improvements for planning processes and metrics to measure the performance of these processes.

The conceptual framework provides a broad overview of the schedule that was followed in the study. The framework also structures the approach to the research process. The structure of this thesis is in partial alignment with the conceptual framework. The structure of the thesis will be explained further in Section 1.9.

1.9. Chapter overview

This reading guide provides an overview of the thesis. It is structured by chapters with a brief description of the content of each chapter. Figure 1.6 functions as a guideline for orientation throughout the thesis.

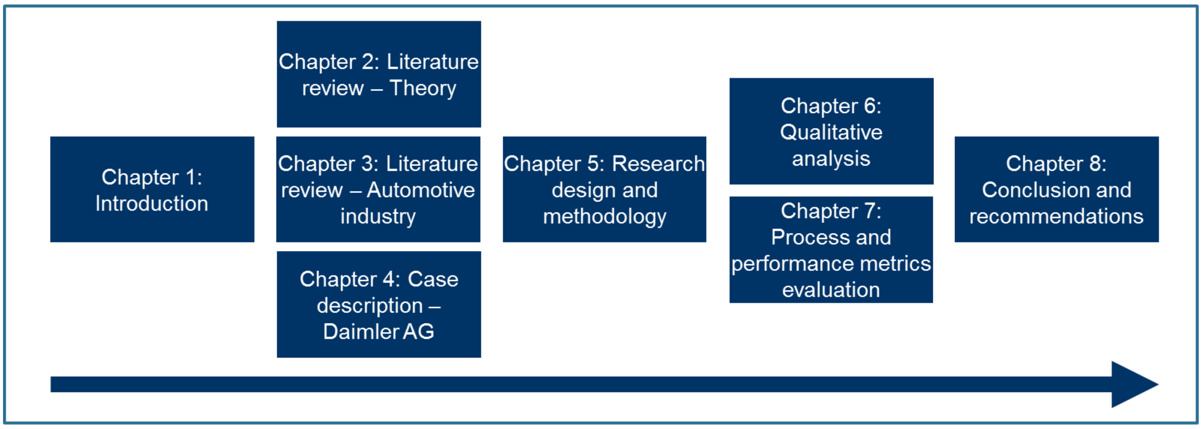


Figure 1.6: Reading guide

Chapter 1: Introduction

The first chapter introduces the theoretical and applied background of the study. This chapter also outlines the structure of the study, describes the study's purpose and breaks it down into a problem statement and further research questions. Additionally, the significance and aim of research is discussed. A brief overview of the conceptual framework gives the reader an idea of the technicalities of the study.

Chapter 2: Literature review – Theory

The first part of the literature review begins with an overview of SCM, process management and supply chain performance. In order to identify a gap in existing knowledge, this chapter also focuses on S&OP and business strategy.

Chapter 3: Literature review – Automotive industry

The second part of the literature review provides background information on the global car industry, beginning with an introduction of purchasing and delivery forms. The main components are the introduction of competitors in the automotive industry, as well as an overview of internal and external influences on the industry.

Chapter 4: Case description – Daimler AG

This chapter introduces Daimler AG in general and, more specifically, MBC. The chapter further describes the current situation, including demand and capacity planning for CKD- and CBU-vehicles.

Chapter 5: Research design and methodology

The fifth chapter outlines the research design and methodology used in the study. Information about data collection, data analysis and presentation of results are provided.

Chapter 6: Qualitative analysis

In the sixth chapter, results obtained from collected data are presented. The analysis takes place in a qualitative manner. Results are also described and interpreted in preparation for Chapter 7.

Chapter 7: Process and performance evaluation

An assessment of current processes defines their structure. Additionally, the evaluation indicates positive and negative characteristics of the processes, resulting in potential areas of improvement. In terms of performance metrics, this chapter recommends potential metrics to measure the improvements.

Chapter 8: Conclusion and recommendations for further research

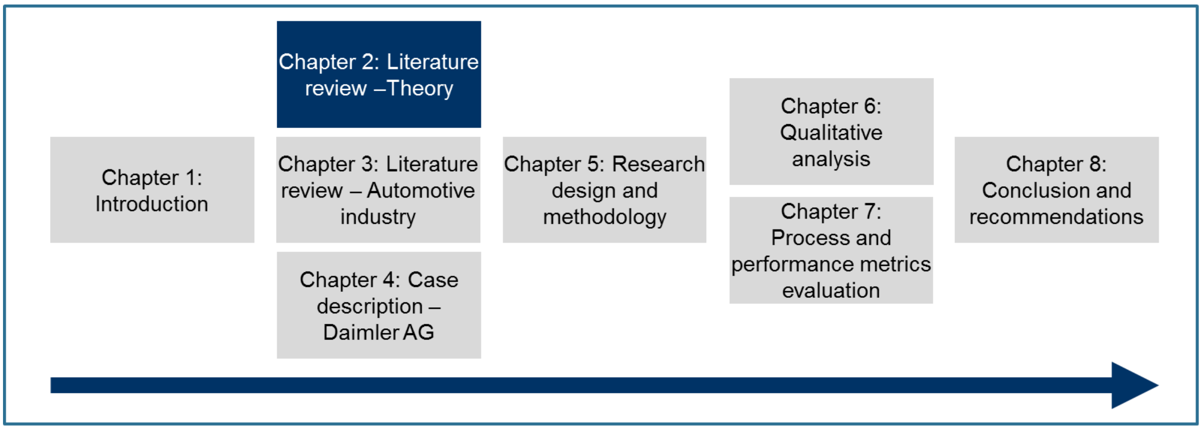
This chapter includes a summary of the results of the study, recommendations for the future and indications for further research in the same area.

Chapter 2. Literature Review – Theory

"It sounds plausible enough tonight, but wait until tomorrow.

Wait for the common sense of the morning."

(Herbert George Wells)



2.1. Introduction

Theoretical background information regarding supply chain processes, supply chain performance and sales and operations planning (S&OP) provides an overview of the topic and related fields. Academic journals, books, reports and renowned websites offer a variety of qualitative background information. This literature review points out concepts and theories in the research area which serve as a foundation of knowledge and emphasise the significance of the study. The broad structure of the literature review is illustrated in Figure 2.1.

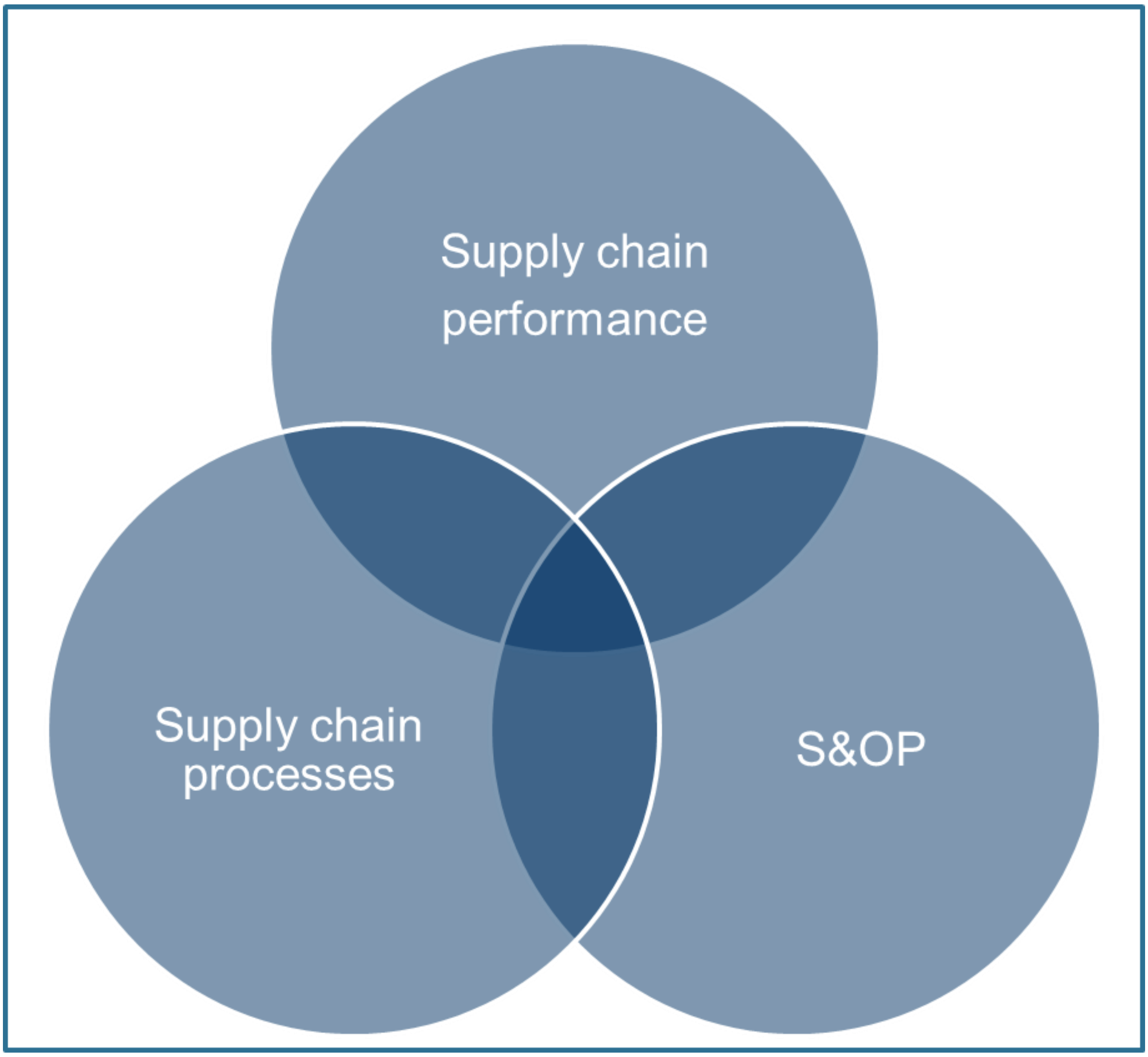


Figure 2.1: Topics covered in the literature review

The three main fields of research relevant to the study all have independent theories and concepts related to them, but also overlap to an extent. The literature review is structured in a way that all sectors are analysed individually, before focusing on the combined theories and factors relevant to all fields of study in a conclusion. The inner section Figure 2.1, where the three circles overlap, refers to the conclusion and summary of the theoretical literature review which will lay a basis of understanding for practical application discussed in the following sections.

2.2. Logistics and supply chain management (SCM)

In the automotive industry as well as in many other advanced manufacturing industries, production facilities and different suppliers are spread all over the globe. Due to decreased labour costs and increasing demand, production and assembly facilities are moved or expanded to emerging countries. Porter (1986:19) explains the term *globalisation* through his theory of competitive advantage. An industry can be defined as global when activities are integrated worldwide in order to achieve a competitive advantage. Effective SCM is necessary in order to coordinate all organisations involved and achieve optimal performance. This section defines logistics and supply chains in order to explain SCM and common practices in the field.

2.2.1. Logistics management

Academic literature, thought-leaders and leading councils provide a variety of definitions for the term *logistics management*. These definitions are characterised by different perspectives, different focus areas and different logistics standards due to the continuous development of the industry.

This study follows the definition of logistics management as composed by the Council of Supply Chain Management Professionals (CSCMP). The Council of Supply Chain Management Professionals (2016) defines logistics management as follows:

Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers' requirements. Logistics management activities typically include inbound and outbound transportation management, fleet management, warehousing, materials handling, order fulfilment, logistics network design, inventory management, supply/demand planning, and management of third party logistics services providers. To varying degrees, the logistics function also includes sourcing and procurement, production planning and scheduling, packaging and assembly, and customer service. It is involved in all levels of planning and execution-strategic, operational, and tactical. Logistics management is an integrating function which coordinates and optimizes all logistics activities, as well as integrates logistics activities *with other functions, including marketing, sales, manufacturing, finance, and information technology.*

The CSCMP's definition focuses on management and integration as the organising aspect of transport and supply management on a strategic and operational level. After a precise definition of logistics management, Section 2.2.2 looks into suitable definitions for the term *supply chain management*.

2.2.2. Supply chain management

The Council of Supply Chain Management Professionals (2016) defines SCM as follows:

Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies.

Burt, Dobler & Starling (2003:3) define SCM as a communication system which links the flow of information and goods between all interacting companies to ensure high quality and to reduce inefficiencies. Both definitions include two important elements; firstly, a link between several companies and secondly, the flow of information and goods. While the Council of Supply Chain Management Professionals (2016) uses a neutral approach, Burt *et al.* (2003:3) include a valuing aspect in their definition which is the effective and efficient design of a supply chain. Tellarino, Pellandini, Battezzati, Fascina & Ferrozzi (2007:173) similarly describe SCM as the coordination of services and products from the acquisition of supplies to the sale of the product to the final consumer. The definition distinguishes between downstream activities, which describe the flow of goods, and upstream activities, which describe the flow of information. Figure 2.2 illustrates the flow of upstream and downstream activities.

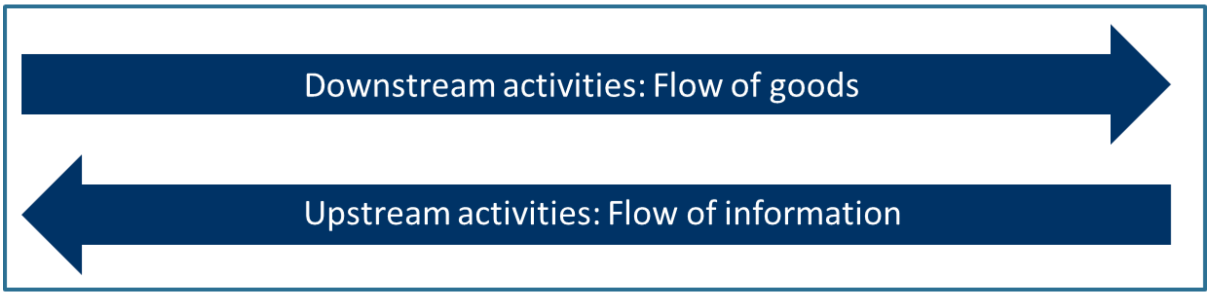


Figure 2.2 Upstream and downstream activities

Simchi-Levi, Kaminsky & Simchi-Levi (2004:2) follow a cost-oriented approach. Their definition of SCM entails approaches that integrate supply chain partners to produce the necessary quantity at the planned time, in the correct order, to the desired location with the aim of minimising costs while achieving service standards. A reduction of inefficiencies reduces costs and increases profitability. The definitions put forth by Burt *et al.* (2003:3) as well as Simchi-Levi *et al.* (2004:2) therefore correspond to each other, despite the different focus points. Maintaining an efficiently operating supply network requires more attention than the management of one individual company. The minimisation of costs across a complete supply network is a necessity in SCM. *Global optimisation* refers to developing the best strategy for the entire network (Simchi-Levi *et al.*, 2004:2-3).

Before a supply network can operate successfully, suppliers and ideally clients, need to be incorporated into the network. The process of supply chain integration entails the co-operation and interaction across firms in a network in order to link suppliers and consumers into an incorporated supply network (Huang, Yen & Liu, 2014:65). Once integrated, a large number of organisations interacting with each other requires dedicated management, especially when linked together in operations and flow of information. Horn *et al.* (2014:39) describe a shift of tasks in supply management and purchasing from buying from the supplier with the best price to building a relationship with the most sustainable supplier. The long-term aim is to develop a value-creating relationship to enhance success for the whole supply chain.

The business environment has progressed from individual companies competing against each other, to whole supply chains acting as a competitive unit in the market (Hernández-Espallardo, Rodríguez-Orejuela & Sánchez-Pérez, 2010:101). Jain, Nagar & Srivastava (2006:400) stress that in a supply network, it is not sustainable if one company's benefit is based on the loss of another organisation within the network. For a short period, one organisation sacrificing in order to enhance the performance of others, might work. However, in the long run, the disadvantaged company will harm the overall performance of the network, rearrangements will need to be considered or else the company will be likely to end the co-operation.

This concept stresses the importance of SCM and its growing complexity. With increasing integration, cross-company information exchange gains significance and advanced systems are necessary to manage the information flow. For example, Radio Frequency Identification (RFID) uses radio waves to transmit information such as delivery date, storage location or pickup date stored on a microchip (Violino, 2005:1). Enterprise Resource Planning (ERP) systems administer the data of a company or even offer a common data base for suppliers, manufacturers and warehouses, if linked to each other (Microsoft, 2016). Electronic Data Interchange (EDI) transmits information from company to company within a network in a consistent format, focusing on business data only (Supply Chain Visions, 2013:70).

2.3. Organisational structures in logistics

The integration of logistics into the organisational structure of companies has developed quite extensively over time. According to Bowersox, Closs & Cooper (2007:524), the incorporation of logistics as a function of companies started in the 1950s, when logistics gained importance. Over time, different strategies of integration emerged, resulting in a *centralised* or *decentralised* organisation of logistics. A centralised approach incorporates logistics as an independent department, while a decentralised approach facilitates individual logistical tasks in several existing departments (Pfohl & Gareis, 2005:238). Figure 2.3 provides an example of a decentralised organisational structure, while Figure 2.4 illustrates a centralised organisational structure. Both figures focus on entities that are related to logistics only, while other functions are omitted for reasons of clarity.

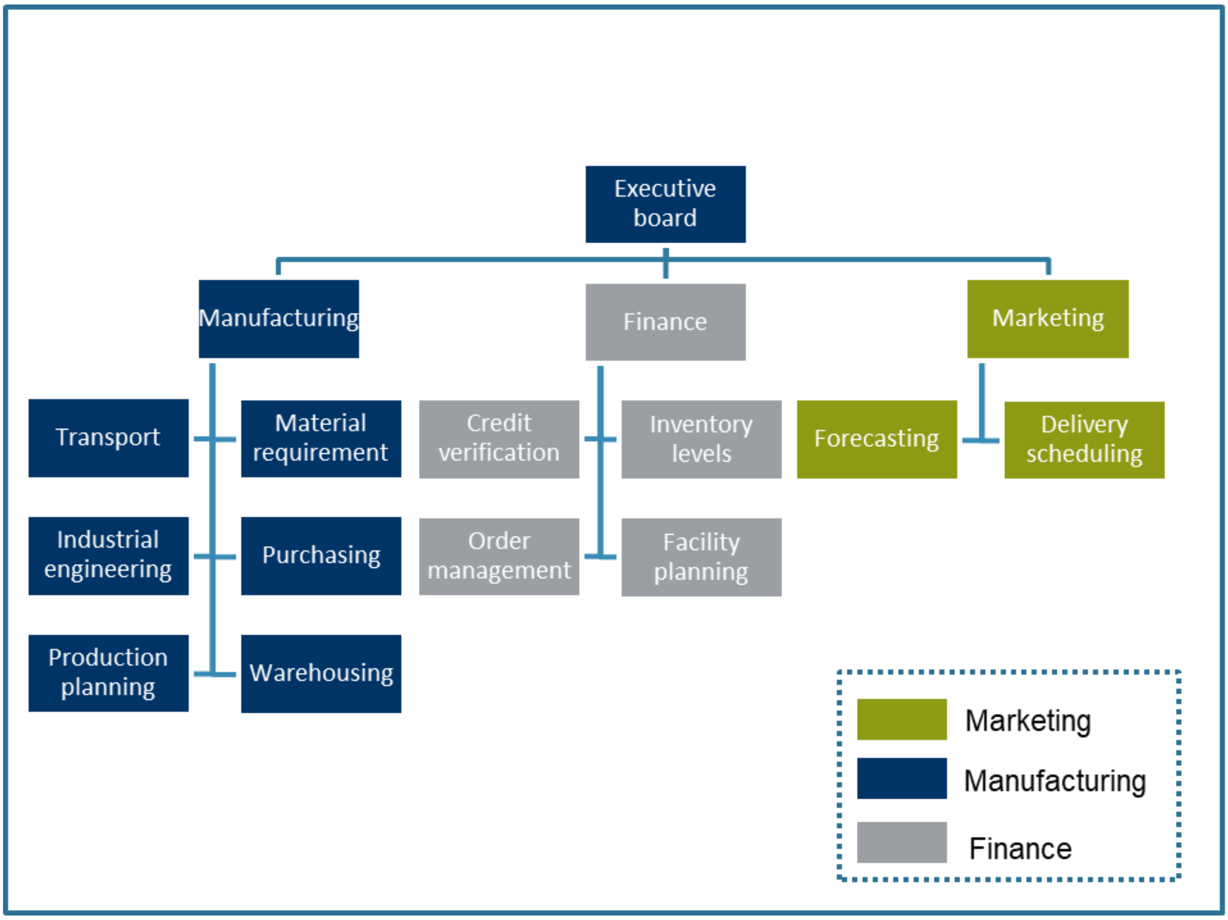


Figure 2.3: Decentralised organisational structure for logistics responsibilities

Adapted from Bowersox et al., (2007:524)

In a decentralised organisational structure, the executive board oversees the department of manufacturing, finance and marketing as shown in Figure 2.3. Manufacturing involves teams in charge of transport, industrial engineering, production planning, material requirement, purchasing and warehousing. The finance department facilitates credit verification, order management, inventory levels and facility planning. The marketing department manages forecasting and delivery scheduling (Bowersox *et al.*, 2007:524-525).

With the increasing importance of logistics and SCM, a separate entity specifically designed for logistics, as is the case in a centralised organisation, enhances the efficiency and performance of a business (Pfohl, 2010:240). Contrary to a decentralised organisational structure, Figure 2.4 illustrates the structure of a centralised logistics department.

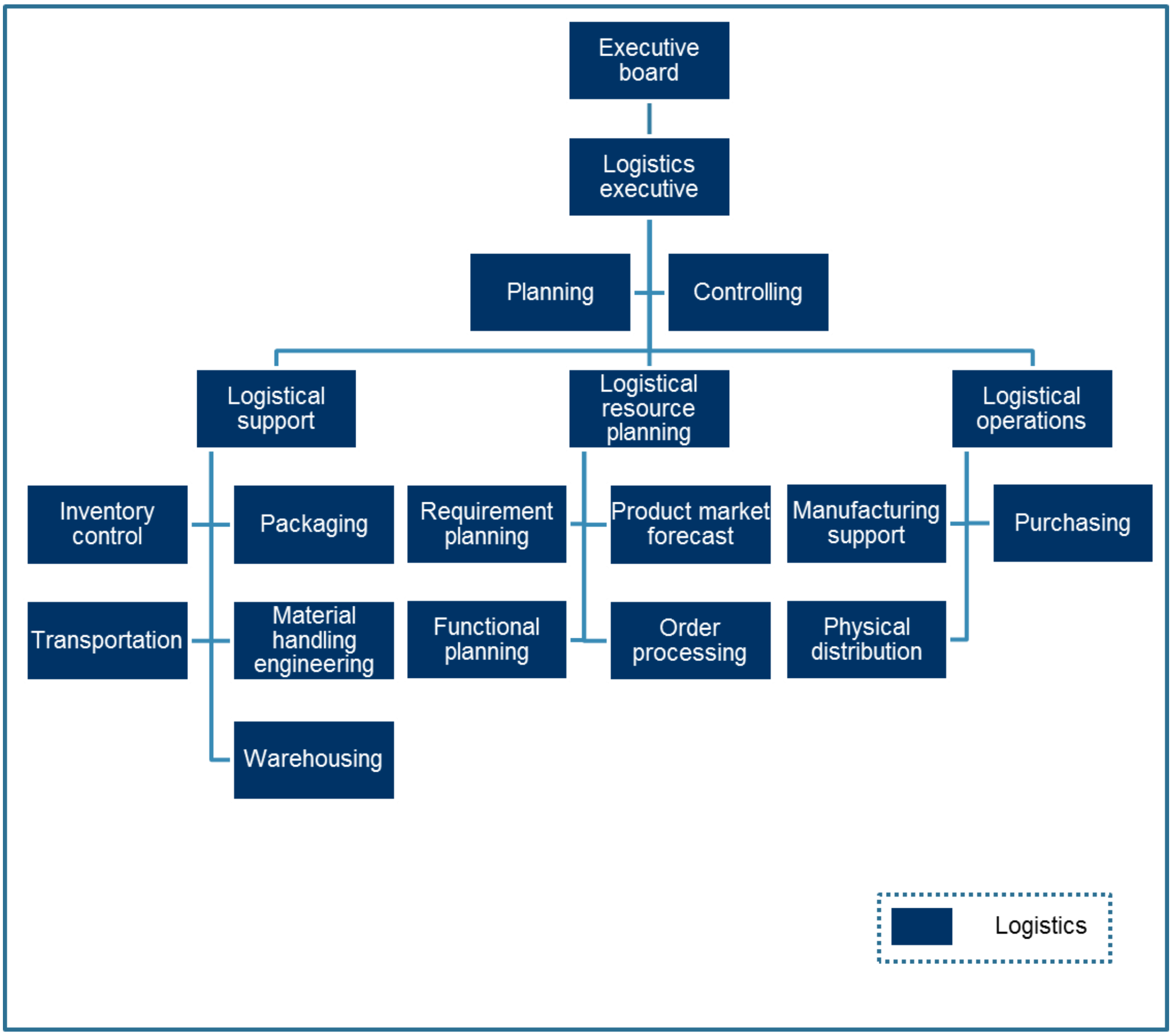


Figure 2.4: Centralised organisational structure with a focus on logistics

Adapted from Bowersox et al. (2007:527)

In a centralised organisational structure, a company establishes a particular division in charge of logistics and SCM. A logistics executive reports directly to the executive board or is a member thereof. *Planning* and *Controlling* oversee the entities of *Logistical support*, *Logistical resource planning* and *Cogistical operations*. *Planning* focuses on strategic planning of all other logistical teams, while *controlling* manages performance. *Logistics support* manages day-to-day business which comprises *inventory control*, *transportation*, *packaging*, *material* *handling engineering* and *warehousing*. *Logistics resource planning* manages *Requirement planning*, *Functional planning*, *Product market forecast* and *Order processing*. Lastly, *Logistics operations* covers *Manufacturing support*, *Physical distribution* and *Purchasing* (Bowersox *et al.*, 2007).

Based on assumptions made by Felsner (1980), Pfohl (2010:242-245) further develops the concept of divisional organisation structures. Divisional companies differ depending on their level of decentralisation. A company can either manage logistics centralised, completely decentralised or in a combination of the two. In a combined approach, a company manages a centralised logistics department in co-operation with logistics departments in each division (Pfohl, 2010:243). While a decentralised logistics management department benefits from market proximity and the ability to individually adapt to specific circumstances, a centralised logistics department profits from economies of scale for administrative costs and order quantities (Pfohl & Gareis, 2005:244).

Despite logistics being more efficient as a separate entity, co-operation with other departments benefits the overall performance of a company. Internal collaboration is therefore essential. In order to plan demand and capacities, successful SCM requires the involvement of internal departments such as marketing and finance as well as external parties such as suppliers or logistics service providers (3PL). The concept of S&OP describes a joint approach of demand and capacity planning as introduced in Section 2.4.

2.4. Sales and operations planning (S&OP)

The term *sales and operations planning* describes a strategic planning process which involves common planning activities from several entities within a company such as sales, marketing, production and SCM. Together, these departments have an overarching aim to increase profitability of the business as a whole instead of pursuing individual benefits (Supply Chain Visions, 2013:171). The process of S&OP enables a company to predict and control business operations as a result of cross-functional involvement (Snowdon, 2008:5; McCollum, 2017:33). Typical steps of S&OP include sales revenue planning, demand planning, supply planning, profit based supply/demand balancing and a management review (Aberdeen Group, 2007:2). Figure 2.5 illustrates the steps of S&OP.

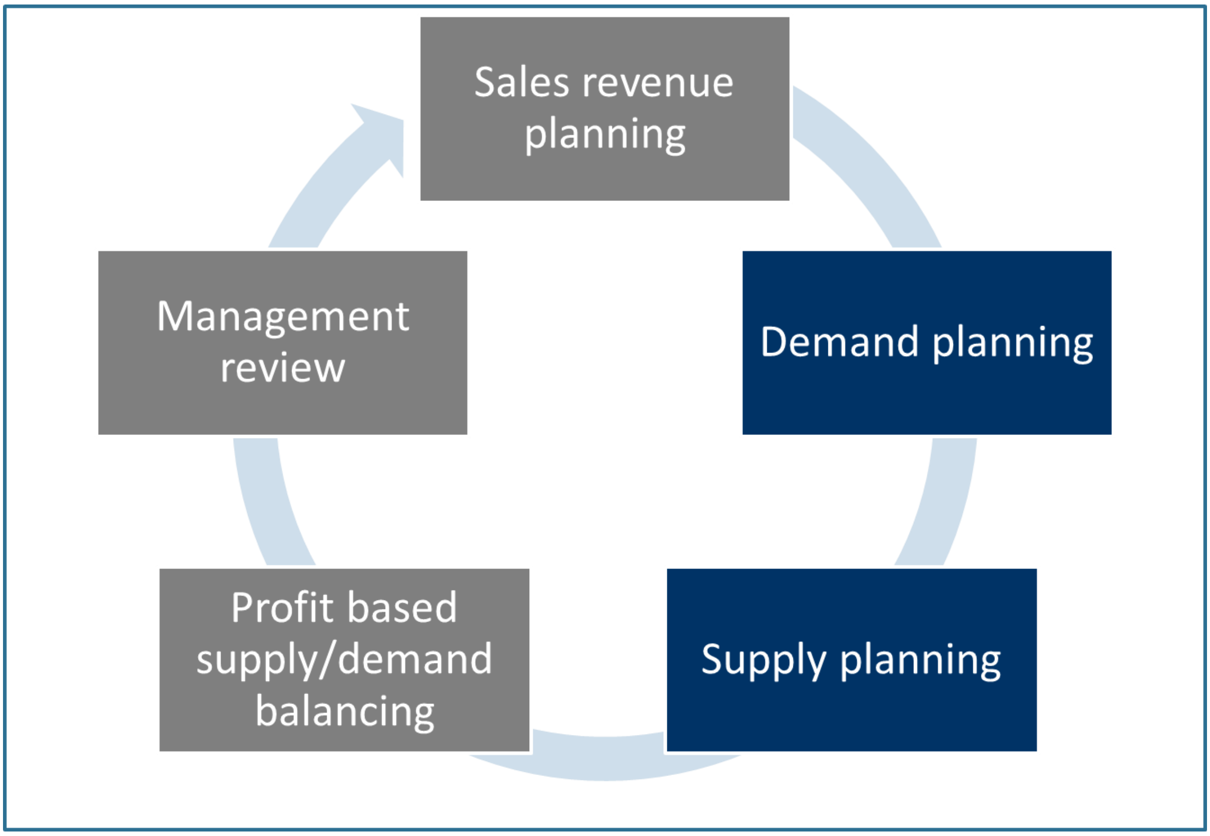


Figure 2.5: The individual steps of S&OP

Adapted from Aberdeen Group (2007:2)

A different department conducts each step with some steps taking place in a cross-functional manner. In Figure 2.5, steps of S&OP linked to SCM are highlights in blue while other steps in grey are owned by other departments. The process consists of the following activities:

- **Sales revenue planning:** This usually takes place in the marketing environment. A review of the product portfolio is the main component of this step. In a product review meeting, employees and managers decide about the lifecycle of products, in other words whether new products should be introduced, or existing products continued or discontinued (Aberdeen Group, 2007:2; Tinker, 2010:6; Logility, 2017a).
- **Demand planning:** Based on the previously conducted product review, demand planning takes place. The sales department develops a demand forecast, after which this forecast is aligned with the product portfolio (Aberdeen Group, 2007:2; Tinker, 2010:6; Logility, 2017a).
- **Supply planning:** With the results of the demand planning as a basis, supply planning calculates supply required to meet unconstrained demand. Usually, the operations department facilitates these activities (Aberdeen Group, 2007:2; Tinker, 2010:6; Logility, 2017a).

- **Profit based demand/supply balancing:** Based on the results from the product, demand and supply planning, the finance department reviews the plans to verify alignment with their financial goals (Aberdeen Group, 2007; Logility, 2017a).
- **Management review:** Once the finance department agrees to all planning output and plans, top management's approval is required to pursue S&OP. The approval of top management marks the concluding step of S&OP. As S&OP describes a continuous process, that should ideally take place on a monthly basis, the process continues from the beginning (Aberdeen Group, 2007; Tinker, 2010:6; Logility, 2017a).

The steps in Figure 2.5 describe the structure of S&OP. In order to successfully implement S&OP, additional efforts need to take place. Besides process- and organisation-related improvements and tools, a company's culture and climate needs to be open for S&OP by introducing a goal-orientated vision (Tuomikangas & Kaipia, 2014:257). Both employees and executives need to understand the link between planning processes and business vision. Often, the lack of understanding of the new planning processes amongst executives and employees results in poor implementation of S&OP (Matthews & Dixon, 2016:3). Furthermore, the ownership of the S&OP process needs to be clearly identified based on capabilities to manage the process (Ball, 2015a:10). According to Ball (2015a:14), S&OP should be owned at executive level or at least benefit from executive sponsorship. Matthews & Dixon (2016:4) insist that executives need to own the process to reach full potential of S&OP.

According to Ball (2015a:3), a large number of companies do not reach their full potential when it comes to matching demand and supply. Especially for companies with a comprehensive product portfolio, it is essential to segment demand forecasting, at least for the key products and customers (YoKell, 2014; Ball, 2015a:7). Ball (2015a:4) further stresses the importance of involving sales, marketing as well as financial planning into the S&OP process, especially for managing constraints, as these departments can share valuable insights.

In addition to cross-functional co-operation, there are other requirements necessary to succeed in S&OP. McCollum (2017:33) describes S&OP as a general cultural transformation. Employees, management and overall company culture need to accept and incorporate the changes in their daily business operations. Conflicting interests between departments jeopardise the success of S&OP. There is no place for individual or team career advancement in a cross-functional co-operation. Instead, the overarching business strategy needs to guide operations (APICS, 2017b:7). Such cross-functional co-operation includes the use of the same data sources across the company and complete willingness to share data across functions (APICS, 2017b:7; McCollum, 2017:33). Cross-functional strategy and goals as well as availability of data enable a business to better respond to unplanned developments with regard to demand and capacity planning, leading to a proactive demand and capacity management rather than “firefighting” in a reactive manner (Ball, 2015a:10).

Tinker (2010:5) adds that implementing and improving S&OP is a continuous process which requires improvements in many other business-supporting areas. Oliver Wight (2017) and Aberdeen Group (2007) developed S&OP further into Integrated Business Planning (IBP), calling it a best-practice model. The crucial factor here is a monthly review of planning activities to align a business’ strategy with operational activities to achieve continuous improvement (Purton, 2008:11; Oliver Wight, 2017). Furthermore, the monthly review of product management, demand and supply enables the company to reconcile the gap between business strategy and operations (Purton, 2008:11).

In addition to key components such as demand and supply, supporting factors are crucial for an effective S&OP. Technology is an exemplary area that affects the success of demand and supply planning (Dogan, 2017:42; Logility, 2017b:2). Many companies depend on spreadsheets and manual data input which is error-prone and time-consuming (Lash, 2017; Logility, 2017a). Other potential problem areas include incorrect usage of software or faulty software configuration (Matthews & Dixon, 2016). Logility (2017b:7) recommends the implementation of a clear technology roadmap that indicates future development for computer systems and technology in general.

Successful S&OP enables business to increase supply chain performance significantly. Ball (2013) describes S&OP as a non-negotiable for superior supply chain performance. Best-in-class businesses that have implemented and practice S&OP achieved to reduce supply chain operating costs by almost half and manage demand volatility more effectively (Ball, 2013:2). Another study has identified that S&OP has the potential to increase forecast accuracy by 20%, to improve working capital by 15% and to grow revenue by 5% (Logility, 2017a).

While technology plays a crucial role, the backbone of S&OP, however, is process and performance management. Performance measurement, through means such as metrics, allows for an evaluation of performance. Clearly defined processes further structure planning activities (Tinker, 2010:5; Logility, 2017a). Section 2.5 introduces process management and Section 2.6 focuses on performance management.

2.5. Process management in supply chains

A *process* is defined as a unique series of time-based actions or activities planned to achieve a specific end result (Hayler & Nichols, 2005:5; Supply Chain Visions, 2013:153). *Process improvement* further describes activities or designs implemented to improve a specific aspect, such as quality or costs (Supply Chain Visions, 2013:153). The implementation and management of processes entails plenty of variations and challenges. While this section introduces different process management models, one particular model might not be a perfect fit for every company. Potential differences in an industry or even between departments of a company require different types of process models (van der Aalst, 2012:563; vom Brocke, Schmiedel, Recker, Trkman, Mertens & Viaene, 2014a:534). Process management is a continuous improvement process that should be institutionalised in order to avoid focus on one department (vom Brocke *et al*., 2014:534-535). For successful implementation, it is beneficial if the employees understand the need for improvement and the changes resulting thereof (vom Brocke *et al.*, 2014:535).

A variety of process management practices exists. For this study, the Supply Chain Operations Reference (SCOR) model and Six Sigma are of most significance. This section introduces the SCOR model and the philosophy of Six Sigma process management, while a summary of other relevant process management practices concludes this section about process management.

2.5.1. The Supply Chain Operations Reference (SCOR) model

The SCOR model describes six key process areas required to satisfy customer demand. The areas described are *Plan, Source, Make, Deliver, Return and Enable* (Supply Chain Council, 2012:i.2).

- **Plan**: Processes associated with this category entail requirements to operate the supply chain. Planning activities such as preparation and gathering of requirements and available resources and capabilities require the most attention (Supply Chain Council, 2012:2.0.1).
- **Source**: This category focuses on processes relevant to ordering, purchasing, scheduling and storage (Supply Chain Council, 2012:2.0.1).
- **Make**: The third category describes all processes relevant to the transformation of materials into goods, including assembly, maintenance and recycling (Supply Chain Council, 2012:2.0.1).
- **Deliver**: The deliver category summarises processes linked to customer orders, more specifically with their creation, maintenance and fulfilment (Supply Chain Council, 2012:2.0.1).

- **Return**: Return embodies all processes associated with reverse logistics, such as the decision to return, the disposition as well as the scheduling, shipment and receipt of the return (Supply Chain Council, 2012:2.0.1).
- **Enable**: This category combines all processes linked to management. This includes performance management, supply chain network management or risk management (Supply Chain Council, 2012:2.0.2).

While all supply chains are different, the Supply Chain Council (2012) aggregated the SCOR model to a level that allows identification with a variety of businesses involved in supply chain activities. Each company involved in the supply chain has its own key processes, which can all be summarised in the six key processes named above. Figure 2.6 illustrates the six processes in organisations in a supply chain and the integration between these.

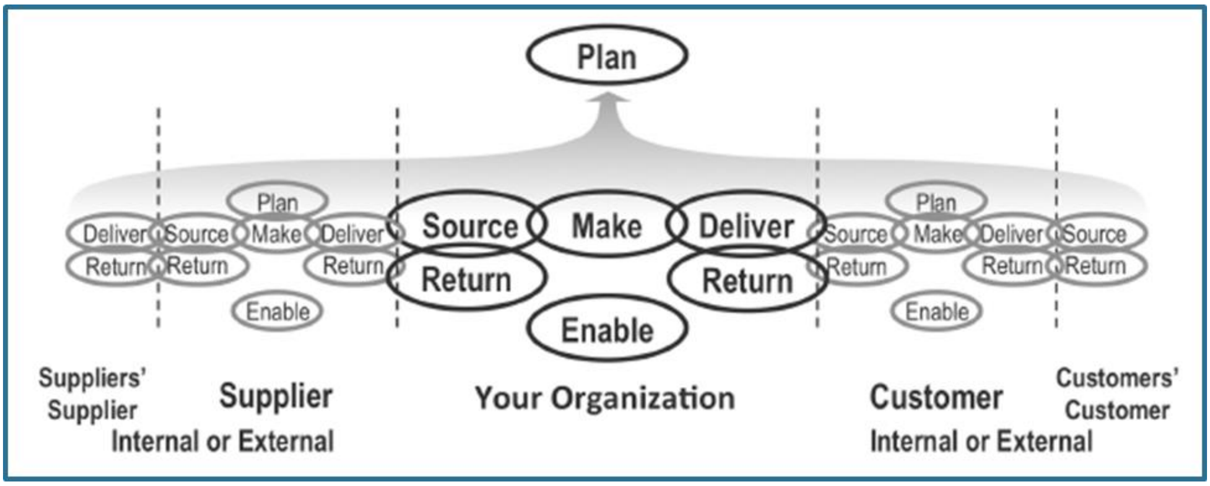


Figure 2.6: Supply chain processes in the SCOR model
Supply Chain Council (2012:i.2)

Each organisation in the supply chain has individual processes. The SCOR model contains processes for customer interaction, physical material flow, and market interactions. The model excludes sales and marketing, product development and research and development.

In order to be applicable to many industries, SCOR follows a general approach as opposed to an industry- or company-specific view. Therefore, SCOR is divided into different levels, three of which are covered by the SCOR model and one which is company-specific (Supply Chain Council, 2012:i.2)

As illustrated in Figure 2.7, the SCOR model covers the top three levels of processes. The first level, process types, describes the scope and content of a process. Examples for this level are the categories of plan, source, make, deliver, return and enable. The second level of the SCOR model describes the operations strategy of a process, forming the configuration of a supply chain. Examples for this level include make-to stock or build-to order as described in Section

3.3.3. Level three describes the individual process elements for each process step with a focus on processes, input and output, process performance, practices, technology capabilities, as well as skills and staff. Examples for process elements include the scheduling of deliveries or the shipping of orders (Supply Chain Council, 2012 i.3).

The SCOR model describes the fourth level of process models. However, it does not include this step in the SCOR model framework. At this level, the implementation of processes takes place. SCOR does not include the implementation of process models due to specific industry or company requirements. The SCOR model describes a hierarchical structure for its processes. A level one process consists of several level two and level three processes (Supply Chain Council, 2012:i.3). Figure 2.7 illustrates the hierarchy of the SCOR model.

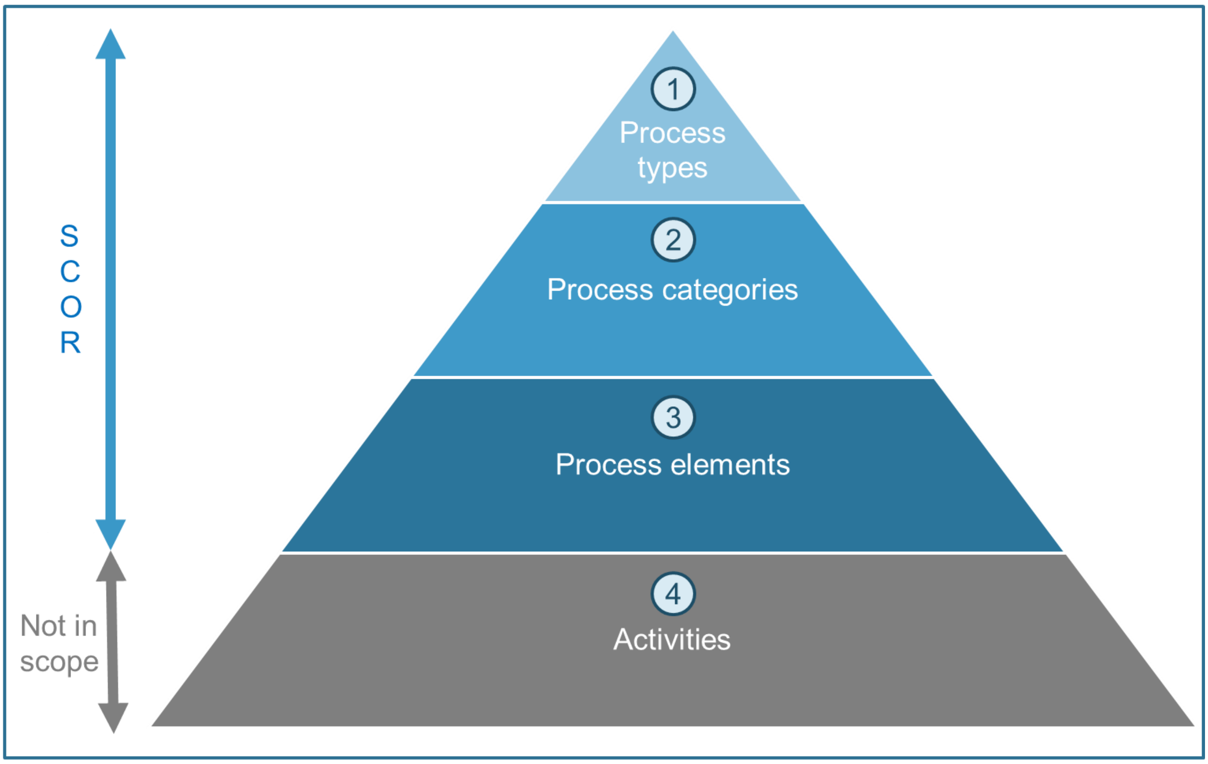


Figure 2.7: The hierarchy of the SCOR model

Adapted from Supply Chain Council (2012:i.3)

Besides the focus on processes, the Supply Chain Council acknowledges interdependencies with other entities of the business environment to stress that a process cannot function by itself. Therefore, the SCOR model is further divided into four categories:

- **Performance**: Offering standardised metrics to measure process performance and to develop strategic goals (Supply Chain Council, 2012:i.4).
- **Processes**: Offering standard descriptions of management processes (Supply Chain Council, 2012:i.5).

- **Practices**: Offering management practices to improve process performance (Supply Chain Council, 2012:i.6).
- **People**: Offering standard definitions for required skills for supply chain processes (Supply Chain Council, 2012:i.7).

In addition to the categorisation and process examples, APICS (2017a) provides a roadmap for process implementation. The implementation is divided into five different phases, namely the phases of *Engage, Define, Analyse, Plan and Launch*. The conceptual framework as introduced in Section 1.8 follows the same approach. Figure 2.8 illustrates the implementation process of the SCOR roadmap.

Figure 2.8: SCOR implementation roadmap

Adapted from APICS (2017a)

The roadmap is divided into five stages. Each phase describes a number of activities:

- **Engage***:* The phase of engagement describes the first involvement of the SCOR project with the respective organisation. Roles within the project are allocated and process ownership is identified (Bolstorff & Rosenbaum, 2011).
- **Define**: The second stage focuses on the definition of the project scope. The scope includes a schedule composed of objectives and milestones, a budget as well as measurements of success (Bolstorff & Rosenbaum, 2011).
- **Analyse**: The third phase consists of analytical activities. It entails the development of metrics, the identification of a performance gap and complications in the existing processes as well as the definition of performance targets (Bolstorff & Rosenbaum, 2011).
- **Plan**: The fourth phase applies the results of the previous phase in order to improve existing processes. The design of new suitable metrics in alignment with newly developed or adjusted processes takes place (Bolstorff & Rosenbaum, 2011).
- **Launch**: The final phase describes the implementation of new processes and metrics. As part of the implementation, regular performance reviews are required to measure the efficiency of the changes implemented (Bolstorff & Rosenbaum, 2011).

The SCOR model implementation roadmap provides a broad guideline to implement processes and performance metrics from the SCOR model. The SCOR model is of great significance to this study as it is a universal and globally known model for process and performance management. Certain industries require a more specific and customised process model, where a generalised process reference model might be insufficient. In addition, process design and improvement require further guidelines to define level four processes. Section 2.5.2 introduces another process management approach, referred to as Six Sigma.

2.5.2. Six Sigma process management

Six Sigma process management is a methodological approach that follows the strategy of *DMAIC – Define, Measure, Analyse, Improve* and *Control* (Hayler & Nichols, 2005:4; Supply Chain Visions, 2013:64). By applying DMAIC, management aims at increasing business success by solving existing problems with a focus on customer satisfaction (Hayler & Nichols, 2005:4; Berardinelli, 2012). The five steps consist of the following activities:

- **Define**: The aim of the first phase is to identify and outline the problem area, the process owner, a project charter and appropriate communication of change management (Hayler & Nichols, 2005:41-51; Berardinelli, 2012; SixSigma.us, 2017a).
- **Measure**: The second phase identifies processes and measurement systems in order to further develop and validate these. Measurement systems include existing metrics as well as new metrics. Concluding, it is recommended to validate the collected information with a professional with experience in the field and familiarity with the activities (Hayler & Nichols, 2005:62-68; Berardinelli, 2012; SixSigma.us, 2017b).
- **Analyse**: The third phase aims at identifying major influences on the performance of a process in order to understand process relationships. Moreover, the development of performance standards and goals takes place (Hayler & Nichols, 2005: 72-77; Berardinelli, 2012; SixSigma.us, 2017c).
- **Improve**: In the fourth phase, the model suggests to detect and assess possible enhancements, including financial factors and process capabilities. The improvement includes the design and implementation of enhancements to improve performance and, as a result thereof, customer satisfaction (Hayler & Nichols, 2005:40; Berardinelli, 2012; SixSigma.us, 2017d).
- **Control**: The final phase develops long-term operating procedures, including ownership, reaction plans and continuous improvement measures. At this stage, responsibility is transferred to the process owner to manage daily operations (Berardinelli, 2012; SixSigma.us, 2017e).

The Define phase includes a useful tool for process mapping called the SIPOC framework. SIPOC is an acronym for *Supplier, Input, Process, Output* and *Customer*. The tool summarises involved actors, input and output as well as the required process steps to turn input into output

(Hayler & Nichols, 2005:50; Bhalla, 2010:31; Carey & Stroud, 2017). Figure 2.9 illustrates the SIPOC framework.

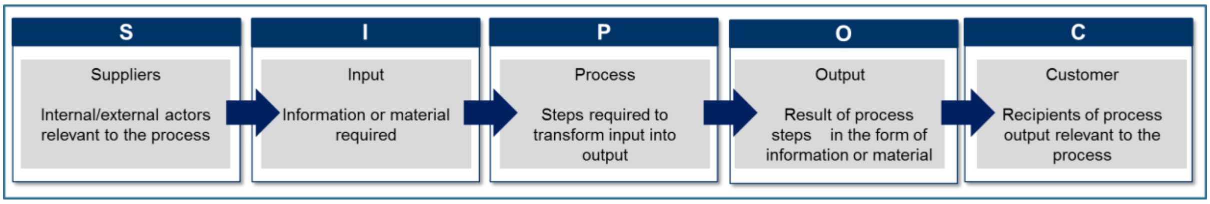


Figure 2.9: Outline of the SIPOC framework

Adapted from Hayler & Nichols (2005:50)

In Figure 2.9*, Suppliers* describes internal as well as external actors relevant to the process or involved in process activities. Raw materials or information required in the process are summarised under the aspect of *Input*. *Process* refers to the activities required to transform input into output in a step-by-step manner. *Output* defines the results of individual process steps as well as the final result, either in the form of material or information. *Customers* refers to the recipients of output created through the process (Hayler & Nichols, 2005:50; Bhalla, 2010:31; Carey & Stroud, 2017).

Carey & Stroud (2017) recommend that the SIPOC framework should be applied after data collection. Once interviews have taken place, the SIPOC framework summarises process components, allowing for an assessment of existing information and identification of missing information. Besides its function as a data-collection plan, the SIPOC framework identifies the essence of a process (Bhalla, 2010). Once processes become more detailed and complex, the SIPOC framework becomes difficult in display in the framework (Hayler & Nichols, 2005:50). It is, however, a good way to collate information on a process in order to start process mapping.

Similar to the SCOR model, Six Sigma is widely known and MBC follows this approach for process management. Besides the SCOR model and Six Sigma, there is a variety of different approaches to process management. Section 2.5.3 briefly introduces other notable process management practices.

2.5.3. Other process management practices

Similar to Six Sigma, *Total Quality Management* (TQM) orientates a company's success at the level of customer satisfaction (American Society for Quality, 2017a). Communication with stakeholders plays an important role as stimulation for continuous improvement (Supply Chain Visions, 2013:198). Zu, Robbins & Fredendall (2010:87) state that Six Sigma can be viewed as a development of TQM. Further principles of TQM involve total employment involvement, system integration, continual improvement and communications (American Society for Quality, 2017b).

While TQM employs means of continuous change, *Business Process Reengineering* (BPR) promotes drastic changes. BPR describes a fundamental redesign of processes, aiming at significant performance improvements by focusing on outcomes (Hammer, 1990; Supply Chain Visions, 2013:164). According to Hammer (1990), a drastic redesign of processes avoids that businesses simply update outdated processes with recent technology and ignore other problems. The method is, however, criticised for high failure rates, mostly due to organisations not being able to adapt to the changes (Cao, Clarke & Lehaney, 2001:332).

The models SCOR, Six Sigma, TQM and BPR represent some of the major approaches to process management in the field of SCM. Process management is strongly linked to performance management. Section 2.6 introduces the concept of supply chain performance.

2.6. Supply chain performance

According to PricewaterhouseCoopers (2013:8), companies with a focus on supply chain performance increase their operational and financial results. Companies that acknowledge supply chain as a strategic asset generally perform stronger than companies that see supply chain as a necessary means to manage supply and inventory. Levers that improve supply chain performance and, as a result, increase value, are maximising delivery performance, minimising supply chain costs and maximising volume flexibility as well as responsiveness (PricewaterhouseCoopers, 2013:10-11). Additionally, Ball (2015a:2) stresses the importance of S&OP to enhance a company's business performance. Further, Deloitte (2017:6) identified supply chain strategy, integrated technology, end-to-end processes as well as organisational alignment as crucial factors to improve supply chain performance.

In his value chain framework, Porter (1986) states that the field of SCM falls under support activities with responsibilities throughout the value-creation process. Supply chain performance therefore has a major impact on primary activities, especially inbound logistics, operations and outbound logistics. Figure 2.10 illustrates the value chain stipulated by Porter (1986:21), where the relevant categories for supply chain performance are highlighted in blue.

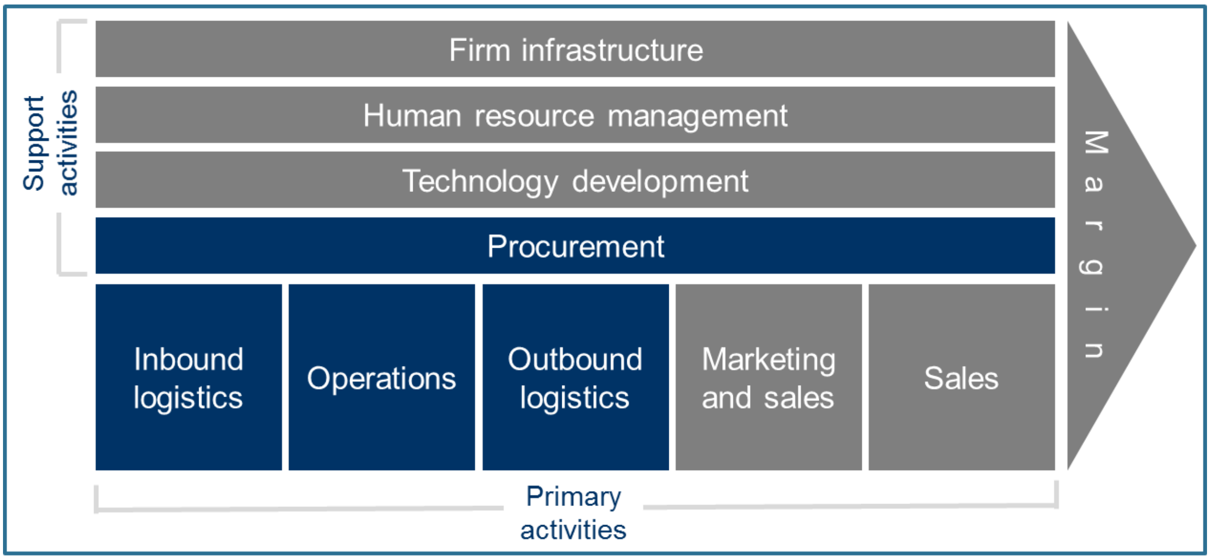


Figure 2.10: The value chain

Adapted from Porter (1986:21)

In the end, the performance of primary and support activities together defines the profit margin of a company. More recent development indicates that the supply chain gained importance and developed from being a supporting activity to forming the backbone of business as companies and especially supply chains globalise (Barloworld Logistics, 2015:6). Consequently, management and measurement of supply chain activities should also become a focus for original equipment manufacturers (OEMs) and suppliers. This section introduces the significance of strategy, vision and mission to performance. Further, the section describes performance measurement approaches, concluding with a description of supply chain maturity.

2.6.1. Strategy, vision and mission

A company's *strategy* steers the business operations towards a long-term goal, providing a roadmap for the future. In an ideal business environment, management orientates common business processes such as demand and supply planning to align with the company's strategy. When making short-term decisions, the strategy provides guidance to align these decisions with long-term planning (Snowdon, 2008:3-4). Chopra & Meindl (2007:22) highlight the importance of a corporate strategy based on a selection of customer needs, with the aim of satisfying these needs in a specific manner. In order to steer business operations in line with the strategy, management further splits the strategy into functional sections according to the divisions of a company (Snowdon, 2008:4). As an example, supply chain strategy focuses on inventory, operations facilities or information flow. The value chain, as described in Section 2.6, emphasises the importance of an alignment of the strategies of individual functions as well as with the corporate strategy (Chopra & Meindl, 2007:24). In order to make the strategy tangible and understandable for employees of all departments and positions, an integration with milestones as well as a clear vision and mission statement is recommended (Snowdon, 2008:4).

The *mission* statement defines the purpose of a business. Similar to the strategy, a company should have an overarching mission. In addition, each department should have a mission linked to the function of the department, in order to guide daily business operations. Further, the mission statement defines boundaries and indicates aspirations of a business (Christopher, 2011:288). The vision is linked to the aspiration of a mission. The *vision* statement defines the aspirations by specifying a goal, giving an indication of the position a company wants to achieve. A strong link between vision and customer satisfaction is common (Christopher, 2011:288; Supply Chain Visions, 2013:211). A clear vision statement allows employees to understand what type of business the company aspires to become. Ideally, employees of all levels can identify with the vision to create a means of enablement and motivation (Snowdon, 2008:4). Figure 2.11 illustrates the interaction of strategy, mission and vision.

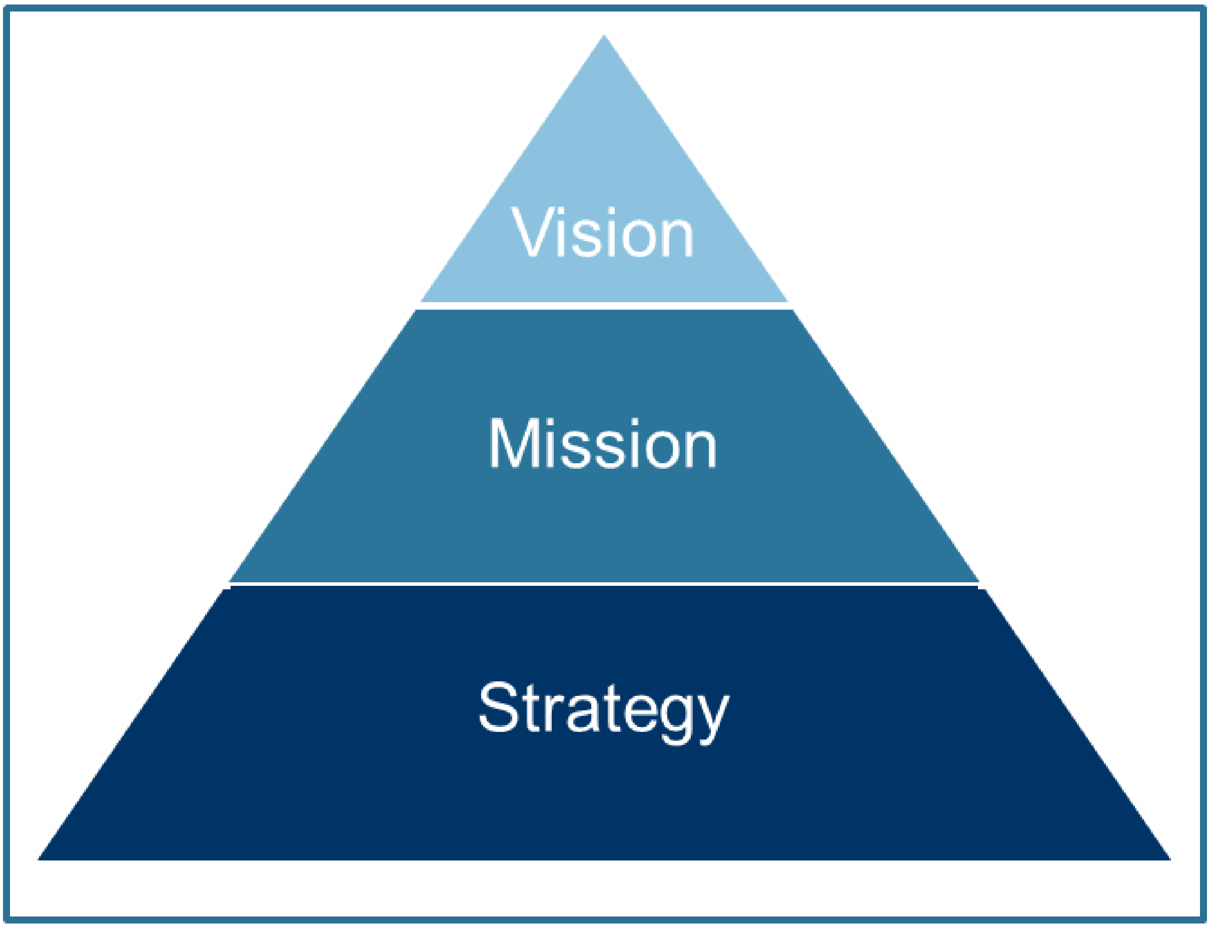


Figure 2.11 Strategy, mission and vision

Snowdon (2008:3) stresses the importance of a precise and tailor-made strategy, mission and vision to distinguish a business from competitors. The supply chain strategy should, however, have a clear strategic orientation. A strategy can, however, only be successfully executed if supporting processes are in place (Chopra & Meindl, 2007:25). The SCOR model, as introduced in Section 2.5.1, divides the strategic orientation of supply chains into the categories of reliability, responsiveness, agility and costs (Supply Chain Visions, 2013:i.4). Similar to the SCOR model, Higgins & Hack (2004:5) explain that together with values, vision and mission form the basis for performance measurements, discussed in Section 2.6.2 in terms of metrics.

2.6.2. Performance measurement and metrics

Performance needs to be measured in order to be managed and improved (Logility, 2017b). With regard to processes, measuring efficiency indicates potential improvements (Balanced Scorecard Institute, 1998). *Metrics* and *measures* are required for a company to execute performance management. Metrics are specific areas of measurement which are quantifiable, and a measure is a number to a specific metric (Supply Chain Visions, 2013:125).

The type and number of metrics is an important management decision. *Key performance indicators* (KPIs) describe an approach that focuses on metrics of strategic importance to the company or the respective department (Christopher, 2011:239). The number of metrics often differs depending on the industry, company or department. As a guideline, each entity should have approximately seven KPIs in order to avoid information overload and negligence of the important issues (Davis & Novack, 2012:15).

In their white paper, Higgins & Hack (2004:24-25) divide indicators into different categories in order to have a balanced performance measurement. The white paper stresses the importance of an even mix of financial and non-financial indicators. In terms of time, performance indicators should consist of leading and lagging indicators in order to monitor short- and long-term development. When developing metrics, standard definitions such as those provided in the SCOR model, which Section 2.5.1 introduces for performance management, serve as a useful orientation. Further, a corporate, standardised integration of KPIs enhances the effectiveness of the metrics. It is important that employees and management understand the metrics, to be aware of the impact of their work (Davis & Novack, 2012:15).

Specifically for managing supply chain performance, the SCOR model provides a variety of metrics, focusing on reliability, responsiveness, agility, costs and asset management efficiency (Supply Chain Council, 2012:i.4). Table 2-1 summarises the criteria SCOR defines for performance measurement in SCM.

Table 2-1: SCOR performance measurement criteria

Adapted from Supply Chain Council (2012:i.4)

Attribute	Definition	Example metric
Reliability	The ability to perform a task as expected	Perfect order fulfilment
Responsiveness	The speed at which tasks are performed	Order fulfilment cycle time
Agility	The ability to respond to external influences	Flexibility Adaptability
Costs	The cost of operating supply chain processes	Total cost to serve Cost of goods sold
Asset management efficiency	The ability to efficiently use assets	Inventory days of supply Capacity utilisation

The attribute of reliability focuses on the outcome of processes, measuring the predictability of the outcome. Metrics to measure performance for these criteria include on-time delivery or perfect order fulfilment. The criterion of responsiveness measures the speed at which process tasks are performed. An example is a metric that measures order fulfilment cycle time. The next performance criterion describes agility, which is described as the ability to respond to external influences such as market changes or competitive advantages. Exemplifying metrics are flexibility and adaptability. While the attributes of reliability, responsiveness and agility describe customer-oriented criteria, cost and asset management efficiency focus on internal performance criteria (Supply Chain Council, 2012:i.4).

In alignment with the SCOR model metrics, Aberdeen Group summarised the metrics related to S&OP used by successful companies (Ball, 2015b:2). The report takes into account S&OP process performance in addition to the internal and customer focus. Table 2-2 introduces these metrics.

Table 2-2: S&OP metrics

Adapted from Ball (2015b:2)

Attribute	Definition	Example metric
Demand/supply match	The ability to accurately forecast demand	Forecasting accuracy
Supply performance	The ability to accurately plan production	Percentage of planned production
Customer satisfaction	The times required from order to delivery	End-to-end order-to-delivery lead times
S&OP process management	Plan of record of process improvement	Number of assumptions/decisions

To measure internal performance, Ball (2015b:2) introduced forecasting accuracy as well as supply performance. The ability to accurately forecast demand describes the act of matching demand and supply. The accuracy of a forecast can either be measured for a stock-keeping-unit or the metric can be aggregated to the level of a product family (Ball, 2015a). Similar to the metric of forecasting accuracy, APICS (2017b:16) suggests forecasting bias or error as a suitable metric to measure S&OP performance.

As a measurement for supply performance, Ball (2015b:2) defines the ability to accurately plan production. A potential metric is the percentage of planned production. Lead time plays a significant role for customer satisfaction from a supply chain perspective. Lead time is defined as the time periods required from order to delivery. The metric of end-to-end order-to-delivery lead time measures customer performance Ball (2015b:2). Different from the SCOR model, Ball (2015b:5) highlights the importance of measuring process management with a focus on implementation rather than cost. S&OP process management, in the form of the plan of record of process improvement, can be measured through the metric of the number of assumptions or decisions made with regard to process changes and implementation (Ball, 2015b:4).

The implementation of metrics does, however, not guarantee performance improvement. Cecere (2016a:180-182) identified continuity of leadership, a holistic view, an alignment in reporting relationships and technology as crucial success factors. In general, a company with a steady management, and as a result thereof, continuous leadership style, is more likely to improve performance at a faster pace (Cecere, 2016a). Management's understanding of supply chain performance as a connected system further facilitates performance improvement (Cecere, 2016a). When it comes to reporting to management, it is beneficial for the performance of a company when all metrics are reported to the same manager. This should be done at departmental level as well as at corporate level (Cecere, 2016a). Lastly, Cecere (2016a:182) identifies the importance of technology as a distinguishing factor. Companies that employ technology to make use of data in supply chain planning are more likely to improve as opposed to companies that depend on Microsoft Excel (Cecere, 2016a). Other models also acknowledge interdependencies between individual aspects of the business environment. Section 2.6.3 introduces one of these models, namely the 7-S Model.

2.6.3. The 7-S Model

McKinsey designed a complex model for performance evaluation in 1982, called the 7-S Model (Peters & Waterman, 1982:9). The model considers seven factors relevant to business success. These seven factors consist of three "hard" factors, namely *Strategy*, *Structure* and *Systems*, as well as four "soft" factors, namely *Style, Staff, Skills* and *Shared values* (Peters & Waterman, 1982:9). The design of the model is illustrated in Figure 2.12.

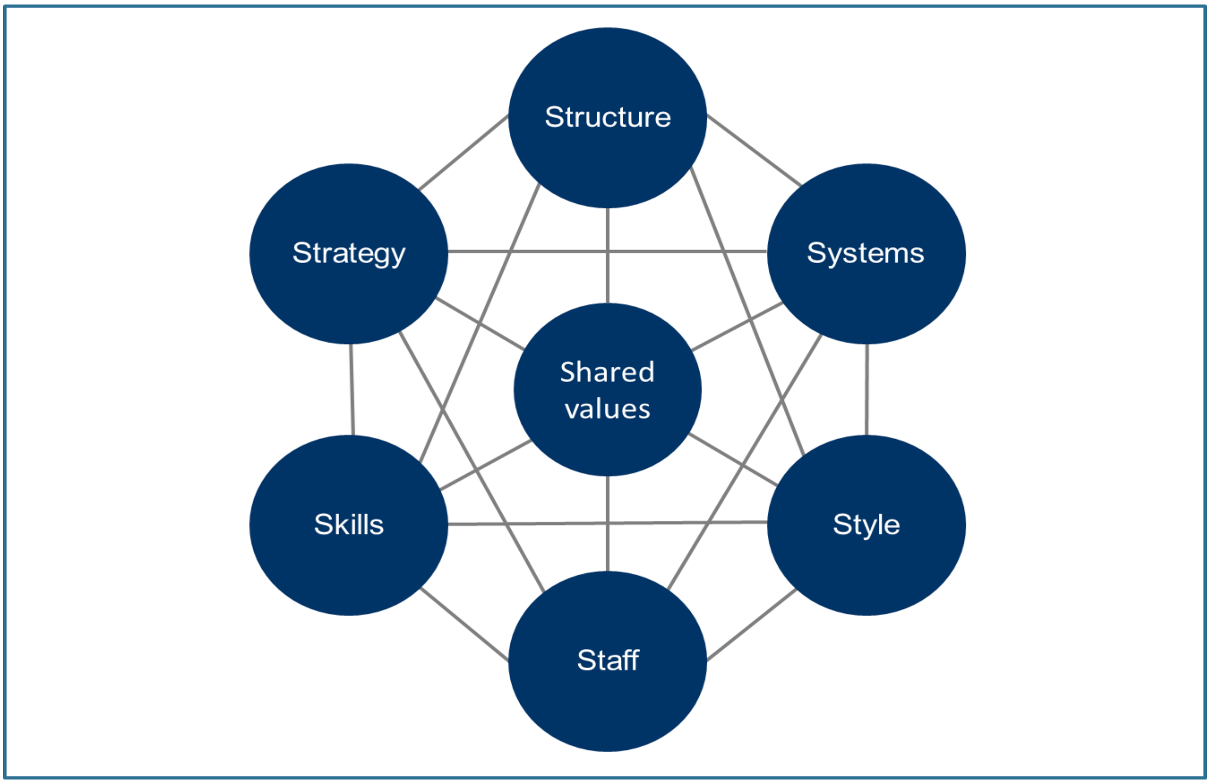


Figure 2.12: The 7-S framework

Adapted from Peters & Waterman (1982:10)

The division between hard and soft factors stresses the different natures of the factors. Hard factors summarise the organisational aspects of the model. The three hard factors are:

- **Strategy**: Strategy describes the overall tactical plan of a company or individual entities within a company. Often, the combination of a company's structure and strategy poses a threat to the performance of an organisation.
- **Structure**: The factor of Structure refers to the hierarchical organisation of a company. The functional division in departments, team size and reporting structures fall under this aspect. In many instances, the structure of a company is impractical and not goal-orientated.
- **Systems**: Rather than actual computer systems, this factor describes processes in place, such as S&OP, demand planning or order management. The focus is on the way in which work is done (Bryan, 2008).

As opposed to hard factors, soft factors refer to the social aspect of the model, which can be especially hard to change (Peters, 2011:7). The four soft factors are:

- **Style**: The term Style refers to company culture, including attitudes of employees and leadership styles. While style is an important factor, specifically in terms of change management, it is especially hard to transform.

- **Staff**: The model includes talent management under the term of Staff. Amongst other factors, staff refers to training, development or turnover. Diversity of employees in terms of gender, cultural background or professional field also contribute to this factor.
- **Skills**: The factor of Skills includes both organisational as well as employee skills. In many instances, the skills of a company require further alignment with the other factors of the 7-S model to achieve better business performance.
- **Shared values**: This aspect of Shared values is located in the centre of the model to symbolise the common impact of all other factors. The term refers to the ultimate goal a company is trying to achieve, such as an increase in profit. Over time, other factors become relevant, such as social responsibility or diversity (Bryan, 2008).

All seven factors are equally important and required to be planned and fostered in order to maintain a successful business (Peters, 2011:7). Despite being developed over 30 years ago, the model is still highly relevant and in common use (Bryan, 2008; Peters, 2011:7). Examples given above stress the relevance in today's business environment. In addition to the previously introduced concepts relevant to performance management, a variety of other practices exists. Section 2.6.4 summarises further performance management practices.

2.6.4. Other performance management practices

Besides the previously introduced performance management practices, a variety of other tools and methods exist. This section summarises the practice of benchmarking, the balanced scorecard tool and the philosophy of lean management.

Benchmarking describes the activities of comparing practices, measurements or processes against high performers (Christopher, 2011:237; Supply Chain Visions, 2013:19; APQC, 2017). A comparison can either take place against competitors from the same industry, other industries, or internally against best-in-class business units (Bowersox *et al.*, 2007; Christopher, 2011:237; Supply Chain Visions, 2013:19; APQC, 2017). Benchmarking is a method of measuring and improving performance. However, the method does not define what to measure. Cecere (2015) suggests that benchmarking can be applied to supply chain planning. Christopher (2011:239) further implies that measurements can be KPIs taken from the SCOR model. A combination with the system of a balanced scorecard is also possible.

A *balanced scorecard* is a strategic management tool that provides a holistic view of the business by aligning operational activities with large-scale objectives such as strategy, vision and mission (Christopher, 2011:239; Supply Chain Visions, 2013:17; Balanced Scorecard Institute, 2017). The tool summarises financial and non-financial factors (Christopher, 2011:239). The aspect of combining financial and non-financial factors emerged from a focus on customer satisfaction (Higgins & Hack, 2004:6). Higgins & Hack (2004:24) further explain that a balanced scorecard aims at eliminating non-crucial information by focusing on a summary of factors. The content of the balanced scorecard can be in the form of KPIs (Christopher, 2011:239; Balanced Scorecard Institute, 2017).

The third performance management practice follows a different approach. *Lean management*, developed from Toyota's production philosophy, focuses on waste reduction of any kind and value creation to increase customer satisfaction (Klug, 2010:253; Supply Chain Visions, 2013:113). The main principles are, amongst others, standardisation, synchronisation and flow (Klug, 2010:256). In their definition, the Lean Enterprise Institute (2014) stresses that the involvement of all employees is required to design processes that improve performance.

Performance management practices are assisting tools to maintain a high level of supply chain performance. The holistic view of the models enables companies to facilitate means to improve maturity. Section 2.6.5 introduces the concept of supply chain maturity.

2.6.5. Supply chain maturity

Supply chain maturity is the equivalent of a lifecycle, identifying different stages depending on the advancement of a supply chain (Rüth, 2014). Different levels of automation and different tools characterise the technical component of supply chain maturity. Payne & Salley (2017:1) therefore define five stages of supply chain maturity, ranging from stage one to stage five.

Figure 2.13 illustrates the stages of supply chain maturity in relation to their target and focus. The target can either be revenue-orientated or aimed at cost-reduction. Regarding the focus, the model suggests a differentiation between an inside-out or outside-in approach. While the inside-out strategy focuses on the development of core competencies within the company, the outside-in approach moves towards customer orientation.

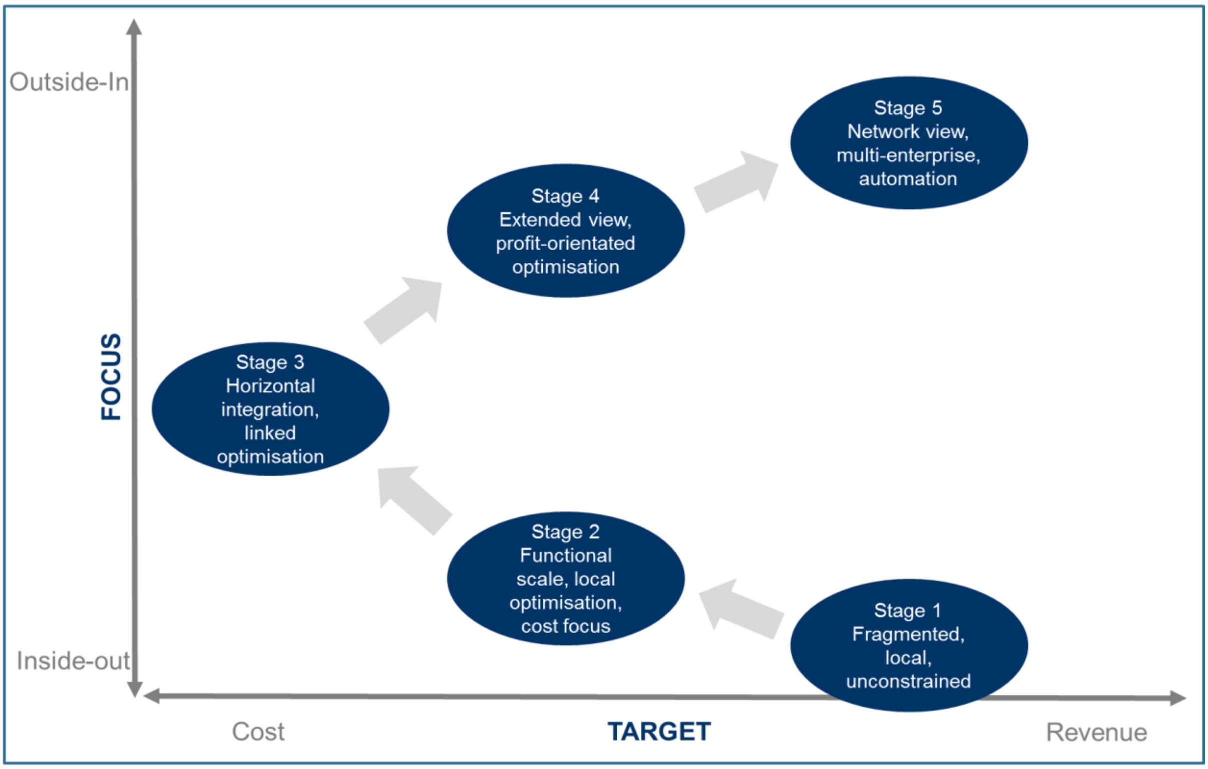


Figure 2.13: Supply chain maturity model

Adapted from Payne & Salley (2017:4)

In the first stage as shown in Figure 2.13, supply chain planning takes place in a fragmented, unstructured and unconstrained manner. Planning processes are based on Microsoft Excel or basic Enterprise Resource Planning (ERP) applications. A focus on the department rather than cross-functional collaborations result in many individual Excel sheets and independent planning activities and decisions. Another characteristic of this first stage is a reactive management approach rather than a preventive approach to SCM (Payne & Salley, 2017:5-6). Hüttner & Song (2007:6) describe supply chains at the first stage as static supply chains without formal standards, a high degree of manual practices and a focus on production for manufacturing companies. The focus on production is supported by the inside-out focus and a target to increase revenue rather than reducing costs (Payne & Salley, 2017:4). Supply chains with a low maturity level apply functional metrics that lack cross-functional orientation (Cecere, 2013).

In order to reach the second stage, a company is required to change from a departmental to a functional focus. Additionally, a standardisation of functional best practices merges isolated processes (Payne & Salley, 2017:6-7). Rüth (2014) adds that when proceeding to the next stage, the company attempts to integrate the different players involved in supply chain planning.

A functional scale, local optimisation and a focus on costs characterise the second stage (Payne & Salley, 2017:4). In this stage, companies realise the importance of cross-functional planning. Processes are rather orientated at their function than at the department in charge of the process, allowing for steady information flow between involved departments (Payne & Salley, 2017:7). At this stage, the supply chain reaches functional excellence with processes within functions, but still lacks cross-functional consistency (Hüttner & Song, 2007:7). The target shifts towards cost-reduction and the focus slowly moves towards customer-orientation (Payne & Salley, 2017:4).

A means to increase maturity is the implementation of cross-functional demand management for all products (Rüth, 2014). In order to support demand management, Payne & Salley (2017:7) recommend to choose a system provider that covers not just demand planning tools but also other aspects of S&OP. The cross-functional integration of systems and tools enhances the possibility to develop an end-to-end supply chain, including all contributing parties (Payne & Salley, 2017:7).

In the third stage, a supply chain reaches horizontal integration and aims at linked optimisation of processes (Payne & Salley, 2017:4). An uninterrupted connection between functions facilitates the contribution towards the company's strategy Payne & Salley (2017:7). Hüttner & Song (2007:7) also stress horizontal integration, further highlighting the availability of customer information throughout the company. The focus evenly balances inside-out and outside-in strategies, while the target clearly lies on cost reduction (Payne & Salley, 2017:7).

The development from the third to the fourth stage requires the system integration of suppliers and customers in planning processes. In addition, the outsourcing of non-core activities becomes a more common option (Rüth, 2014). As a result, tools and systems need to work for multi-enterprise supply chains (Payne & Salley, 2017:10). The implementation of cross-functional metrics is essential, potentially even covering several players in the supply chain (Cecere, 2013).

In the fourth stage, a business extends its view and reorientates its focus to profit optimisation (Payne & Salley, 2017:4). Outsourcing of non-core activities of supply chain planning enables a company to focus on core supply chain planning (Payne & Salley, 2017:11). The external collaboration enables a business to share information with suppliers and other supply chain partners such as 3PLs (Hüttner & Song, 2007:7). The last three stages are aimed at cost reduction, resulting in reduced supply chain costs when a company reaches level four. Therefore, SCM targets revenue improvements in the fourth stage. The focus on the customer supports the aim of revenue improvement (Payne & Salley, 2017:4).

While many companies aim at reaching the fourth stage, only few companies aspire to reach the fifth stage of supply chain maturity since the level of automation is too high (Payne & Salley, 2017). In order to proceed to the highest level of supply chain maturity, Payne & Salley (2017:12) recommend to further increase automation of planning processes and to make use of digitalisation.

Supply chains in the fifth stage are characterised by a network view, multi-enterprises and planning or executing convergence (Payne & Salley, 2017:4). Companies facilitate big data and machine learning to further automate planning processes (Payne & Salley, 2017:14). Features such as online real-time order configuration and status updates are possible in such an “on demand” supply chain (Hüttner & Song, 2007:7). With low costs, the target clearly lies on revenue management. Further, supply chains in this stage solely focus on the customer (Payne & Salley, 2017:4).

A variety of factors defines the maturity level of a supply chain, including strategic orientation, S&OP and the use of technology. All these aspects form part of this literature review. Section 2.7 summarises the findings of the literature review.

2.7. Concluding remarks

In conclusion, this chapter discusses logistics and SCM in general, with a more detailed elaboration of S&OP, process management in supply chains and supply chain performance. The chapter introduces process management practices and approaches to performance measurement to provide a foundation to answer the research questions of the study.

The organisational structure of logistics and supply chain functions plays a significant role with regard to supply chain processes and performance. A centralised logistics organisation enables a company to focus on logistical activities such as SCM. Furthermore, high hierarchies potentially reduce efficiency in terms of decision-making and process management as the majority of processes involve several departments and management levels.

Within a business, S&OP especially requires cross-functional organisation and management in order to be successful. Demand and capacity planning, the subject of this thesis, constitutes a part of S&OP. Further success factors for S&OP entail the segmentation of demand planning as well as frequent, ideally monthly, reviews of the individual planning processes involved.

When it comes to processes, there is no one-size-fits-all model suitable for all types of processes. The study focuses on process management according to the SCOR model and Six Sigma. Both approaches define guidelines for implementation which this study follows. The

Plan component of the SCOR model is the most relevant to this study. The model defines, however, processes at higher levels too general for this study. A component of Six Sigma is the SIPOC framework, a tool to summarise information relevant to a process.

In addition to the process aspect, SCOR defines metrics to measure process performance. In order for a business to approach performance management successfully, metrics should be balanced in terms of time and what they measure. Targets for metrics can be set by following either an internally or externally orientated benchmarking strategy. Additionally, all metrics should be aligned with an overarching strategy, vision and mission. The implementation of metrics alone does not guarantee an increase in supply chain performance. Other influencing factors are company staff and expertise, company structure, and technology. All these factors combined determine the maturity of the supply chain.

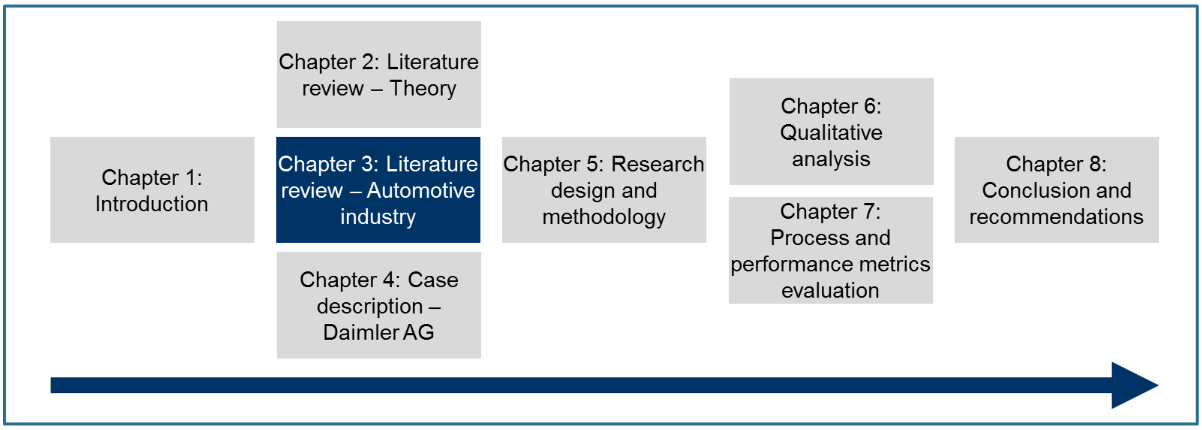
While this chapter focuses on the theoretical background of this study, Chapter 3 provides background information on the automotive industry and supply chain practices specific to the industry.

Chapter 3. Literature review – Automotive industry

"I believe in horses.

Automobiles are a passing phenomenon."

(Germany's Emperor Wilhelm II)



3.1. Introduction

This chapter of the literature review links the automotive industry to supply chain management (SCM) and provides qualitative, descriptive information about the industry relevant to the field of the study. The structured literature review identifies key information, developments and concepts relevant to SCM.

Besides the literature review as a base of knowledge, a meta-analysis provides insight into recent and future development of the automotive industry. A meta-analysis is the statistical analysis of results from a variety of individual studies (Glass, 1976:3). It is especially useful to consolidate the results of a large amount of literature. For this chapter, a simplified version of a meta-analysis shows which trends are currently prevalent in the automotive industry. Studies and reports of the past five years provide a basis for the analysis. The analysis investigates and evaluates the number of times authors mention predefined key words regarding trends in publications. Publications considered are annual reports from the three leading original equipment manufacturers (OEMs) in Germany as well as seven independent publications by consulting firms. The results are divided into internal and external influences. This chapter further addresses SCM specifications, purchasing and delivery forms common in the automotive industry as well as the main OEMs in the industry.

3.2. Supply chain management in the automotive industry

Particularly in car manufacturing, different approaches have been developed in production and SCM depending on the origin of the manufacturer. The importance of suppliers varies and has adapted as manufacturing has developed over time. Henry Ford introduced mass manufacturing in the early 1900s which was characterised by complete interchangeability of parts within different vehicles of the same model (Womack, Jones & Roos, 1990:27). Ford's approach of mass manufacturing included the production of all parts for the final car, including raw materials used to produce the parts. Vertical integration as seen with Henry Ford's approach to manufacturing was one of the major trends in the beginning of car manufacturing (Nevins, 1954:223). Suppliers operated as dependent departments within the company of the OEM and supplier management was not necessary. Internal communication with all involved parties having the same aims and intentions coordinated supply and manufacturing. The OEM could thus focus on the core activities of its business by outsourcing activities that were not part of the core business or that did not create value. However, as a result of outsourcing, purchasing and network management became new tasks with increasing importance. Instead of planning an activity or process internally, external suppliers and service providers were involved.

The significance of suppliers has grown over time with OEMs increasing outsourcing activities (Frigant, 2009:419). According to PricewaterhouseCoopers (2014b:9), suppliers in the automotive industry account for more than 60% of the value added to a finished product. It is therefore essential for OEMs and suppliers to invest in research and development to differentiate themselves from competing suppliers. Moreover, car manufacturers offer cars with increasing customisation, resulting in diversification of car models. Different variations can be combined with each other resulting in a vast number of different options for customers. For an average middle class car produced by a German manufacturer, a customer can choose from approximately 400 trillion different variations (PricewaterhouseCoopers, 2014b:14). Diversification, however, reduces the benefits of economies of scale and decreases forecast predictability across the supply chain. To counter this, additional technologies assist in managing orders and demand throughout the supply chain.

According to Zelbst, Green, Sower & Baker (2010:582), systems such as RFID and Enterprise Resource Planning (ERP) enable individual entities in a supply chain to continuously share information in real time in order to strategically and tactically profit from the sharing process. McCormack, Johnson & Walker (2003:83-84) determined that communication between suppliers and manufacturers via internet positively influences supply chain performance. Danese & Romano (2011:227) ascertain that successful supply chain integration includes not only suppliers, but also customers. Low inventory and planned ordering processes can be ensured through interaction between the OEM, suppliers, logistics service providers (3PLs) and customers. Customer integration facilitates and accelerates the ordering process. Therefore, the manufacturer needs well-integrated suppliers, 3PLs and ideally customers to fulfil orders in time without unnecessarily high inventory stock or delayed deliveries. An advanced level of supplier integration allows for more efficient order handling. A complete integration and significance of suppliers indicates a shift in powers in the industry.

Jürgens (2003:21-22) illustrates a transition in the European automotive industry from traditional hierarchically organised supply chains with an OEM in control of all suppliers, to a network where the OEM is seen as a brand creator. Suppliers develop and produce components and systems with high technical significance. The OEM is hardly involved in the process and only purchases a finished component for a vehicle. Therefore, the OEM loses power over suppliers and reduces technical knowledge of production expertise. There are different stages of SCM depending on the level of integration of the suppliers with the OEM. Bennett & Klug (2012:1284) define *logistics supplier integration* as corporate planning, operating and managing of all logistics processes from the beginning of the value-creating process to the final assembly. The more a supplier is integrated, the more successful it is to achieve common goals and to increase the productivity of the whole supply chain as one entity. The growing significance of suppliers further relates to an increasingly competitive business environment.

The increasingly competitive business environment in the automotive industry requires new measures to ensure competitive supply chains. Larsson (1999:50) elucidates that there is a transition from a traditional business concept where two companies have individual market transactions to a partnership with mutual trust and mutual financial gain for all parties participating in the transactions. A more recent study conducted by Fiala (2007:4) confirms the predicted shift in business relationships. According to Fiala (2007:4), all parties involved are linked to each other financially and by information and decision flows with each organisation having its own interest. In his definition, the author points out that every entity operates in its own preference which is likely to differ from the best solution for the whole supply network. A supply chain can be seen as an extended enterprise with common activities (Langley, Coyle, Gibson, Novack & Bardi, 2009:20). SCM is necessary to find a balance between every contributor’s own preference and the maximum benefit of the entire supply chain. Pooe (2012:10) takes the idea of collaboration even further by suggesting that a co-operation between suppliers, OEMs, unions and the government is necessary for an efficient industry.

Supply chains are not only limited to OEMs and suppliers of different levels. Strategic alliances between OEMs significantly increase the complexity of a network. According to KPMG (2014:29), strategic alliances are inevitable in order to survive in the automotive industry of the future. Strategic alliances or joint ventures allow multiple OEMs to source the same part or module from the same supplier. In advanced alliances, a joint production plant is even possible (Renault Nissan Mitsubishi, 2017a). The OEMs can have a common investment, common purchasing agreements and could even build the same car, just branded differently. Deloitte (2015:21) identified the growing complexity alliances with third parties and more complex business operations as key risk areas for suppliers. Current development shows that OEMs and suppliers are willing to take these risks.

In addition to these characteristics with regard to SCM, there are a several purchasing and delivery configurations common in the automotive industry. Section 3.3 introduces a number of configurations relevant to the industry.

3.3. Purchasing and delivery configurations

There is no generic approach to identifying the most suitable purchasing or delivery configurations in the automotive industry, mostly because manufacturers follow different strategies in terms of logistics, production and sales. This section introduces the production approaches of Build-to-Order (BTO) and Make-to-Stock (MTS), as well as export and assembly forms such as completely-knocked-down (CKD) and completely-built-up (CBU) vehicles. An introduction to the international commerce terms is also provided.

3.3.1. International commerce terms

Especially for international trade with regard to import and export, international commerce terms determine the responsibilities and activities to be paid for by the supplier and the purchasing company (David, 2013:180-181). The International Chamber of Commerce (ICC) developed a standardised set of rules for international trade, namely the International Commerce Terms (Incoterms), which are universally accepted for global trade. The latest update took place in 2010. The Incoterms define the point within a transaction where responsibilities, activities, insurance and risk are transferred from buyer to seller. Therefore, it is important that the point of delivery is clearly defined (International Chamber of Commerce, 2010).

The three most common Incoterms are *Ex Works*, *Free on Board* and *Cost, Insurance and Freight*. For Ex Works (EXW) delivery takes place at the seller's premises. Loading of goods and clearance for export are the buyer's responsibility. Free On Board (FOB) indicates that the buyer decided on a vessel and the seller delivers the goods on board of this vessel at a port decided on beforehand. The risk and responsibility passes from seller to buyer when the goods are on board of the vessel. Cost, Insurance and Freight (CIF) defines that point of delivery is on board of the vessel once the goods are loaded. Loss and damage on board are the buyer's risk. However, it is the seller's responsibility to contract for insurance with minimum cover (International Chamber of Commerce, 2010).

The sale of a vehicle for export includes several entities. The manufacturer and the sales company often differ for export sales. This also applies to CKD-vehicles. Section 3.3.2 introduces the import and assembly strategies of CKD- and CBU-vehicles.

3.3.2. Import and assembly strategies

The automotive industry is dependent on its export business. OEMs apply different strategies for export, ranging from importing complete cars manufactured in an autonomous plant in a foreign country, to serving the local and regional market with cars assembled in a foreign plant. Furthermore, different gradations exist in between. The type of import and assembly strategy depends on the company itself in combination with the foreign country's attractiveness for local production and imports regulations (Luethge & Byosiere, 2009:14; Barreto de Goes & da Rocha, 2015:226; El-Dorghamy, Allam, Al-Abyad & Gasnier, 2015:18).

The three most common forms of import are CBU-vehicles, semi-knocked-down (SKD) vehicles and CKD-vehicles (Banerjee & Mitra, 2008:3). For CBU-vehicles, the strategy entails the import of a car that is fully assembled and ready to drive. It is packed as a whole unit and shipped to the dealership (Barreto de Goes & da Rocha, 2015:226; El-Dorghamy *et al.*, 2015:18). For CKD-vehicles, the complete car is disassembled in kits for shipping and import. The kit can include the body shell of a car (Intarakumnerd & Fujita, 2008:40). Final assembly of individual kits takes place at a local manufacturing plant in order to sell the cars as a locally manufactured product in the market of destination (Barreto de Goes & da Rocha, 2015:226). SKD-vehicles form a middle ground from CKD-vehicles to full assembly. Often, the body shell of a car is already preassembled and shipped as a whole. Besides the imported kits, locally produced parts can be added into the assembly process, often on request by the government (Ishaq, 2003:233; Intarakumnerd & Fujita, 2008:40). Many local governments regulate the percentage of local components for SKD- and CKD-vehicle manufacturing to promote the local economy. These parts are called local content (KPMG, 2009:8; AIEC, 2016:32). Figure 3.1 summarises the different import strategies for CBU-, SKD- and CKD-vehicles.

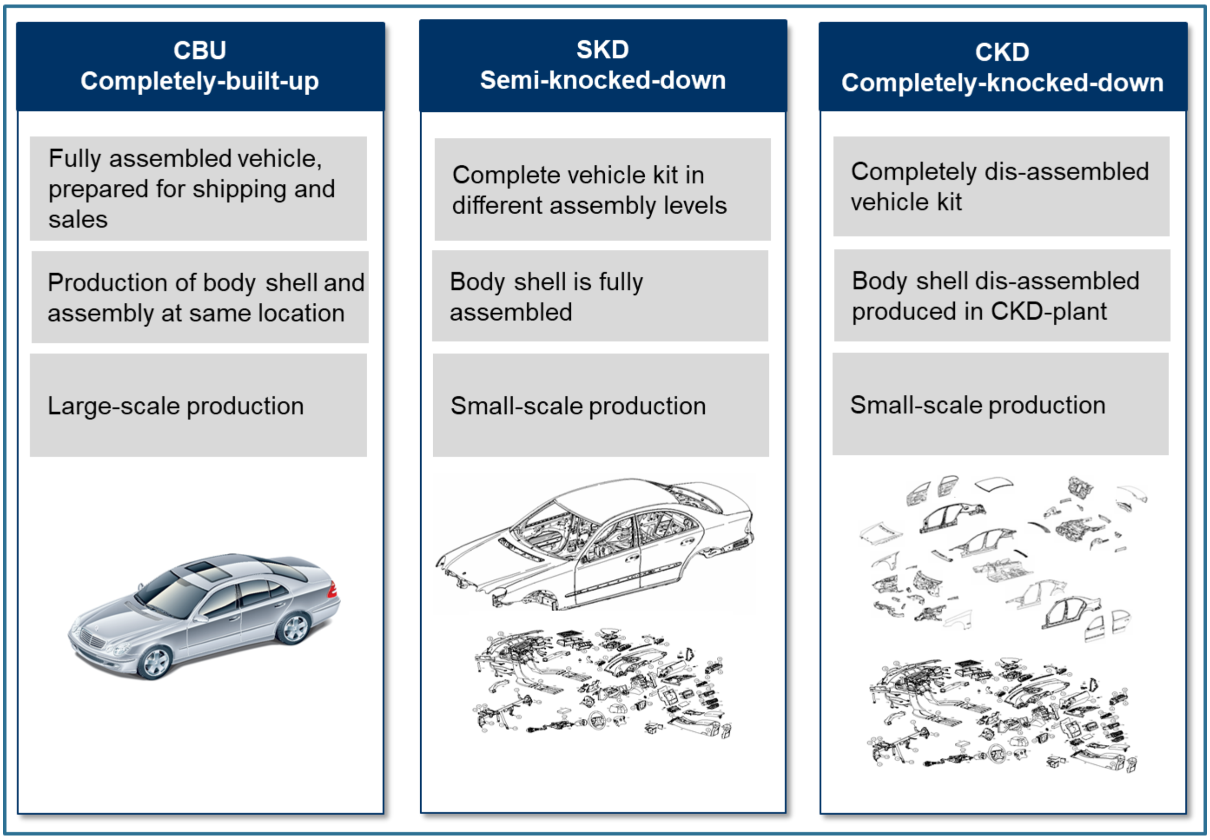


Figure 3.1: Comparison of import strategies

Adapted from SC/WTO2 (2017a:3-4)

Often, governments apply methods of protectionism in the form of import quotas and tariffs to reduce import and enhance local manufacturing (Luethge & Byosiere, 2009:114). Such governmental restrictions can go as far as completely banning CBU-vehicle imports (Husan, 1997:132). As a result, OEMs aim at reducing import obstacles by creating CKD-vehicle plants in order to remain competitive in the market without significantly reducing the profit margin. However, CKD-vehicle assembly often means low production figures with high product variety. The low production output results in increased costs per unit compared to manufacturing in a full assembly plant (AIEC, 2013:14). SKD- and CKD-vehicle plants can be seen as a step towards a full production plant. Once a plant has proven successful and production output has reached a certain volume, an expansion from SKD- or CKD-vehicle assembly to a full production plant is an option (Volkswagen AG, 2015:39). Alternatively, the local government allows international OEMs to continue imports in exchange for secured trade with the country of origin in co-operation with the foreign government (AIEC, 2013:37).

In conclusion, OEMs aim to balance between high import costs and increased production costs. The main reason for CKD- and SKD-vehicles are regulations by local governments. Additional relevant factors are the market size of the local market, possible trade zones with neighbouring countries which can be beneficial when producing locally, the attractiveness and capability to produce locally, as well as the potential to develop the plant further. A development of CKD- and SKD-vehicles to full assembly is possible if external factors allow it. Irrespective of the import strategy, forecasting of demand and orders is required. Section 3.3.3 illustrates the two principles of make-to-stock and build-to-order

3.3.3. Make-to-stock vs. build-to-order

Holweg & Pil (2004:81) identified two production strategies that strongly influence supply and production management. A manufacturer's goal can be to sell as many cars as possible, using incentives and stocks of finished goods as a means in order to benefit from economies of scale. Alternatively, a manufacturer aims to meet the customer's needs by selling the desired product at a higher price with lower production volumes. The strategies can even differ from model to model within the product range of a manufacturer. The first approach describes a *make-to-stock* (MTS) production process with cars being produced based on forecasting models, keeping items in stock for direct sales to the customer (Li, Zhang & Willamowska-Korsak, 2014:70). The second approach is a *build-to-order* (BTO) strategy, where the manufacturer produces a customised car based on a real customer order (Li *et al.*, 2014:69).

On the one hand, MTS, typical for mass manufacturing, benefits from high volumes through standardisation, which saves costs in terms of procurement and production. This results, however, in high storage costs and reductions in the sales price because the car is not exactly what the customer wanted to buy. On the other hand, BTO allows a customer to purchase the desired product in a configuration that suits the customer's needs best. Customised products reduce the inventory of finished goods. On the downside, supply management becomes more complex and delivery time potentially increases. In order to ensure acceptable delivery times, reliable partnerships with suppliers or inventory of parts is necessary (Holweg & Pil, 2004:2-5; Womack & Jones, 2005:162-164; Li *et al.*, 2014:70).

Producing cars based on a forecasting model leads to a vicious cycle (Holweg & Pil, 2004:15). As shown in Figure 3.2, producing vehicles to forecast leads to longer lead times for customised orders that encourages BTO-production. The customer assesses whether or not it is worth waiting for the desired car, usually for a higher cost, or buying a car slightly different from his dream car, for a lower price with immediate delivery. Discounts are used to incentivise customers, which further reduces profit margins and puts higher pressure on residual values. Therefore, the OEM produces more cars in order to achieve economies of scale. The increased production volumes are based on forecasts that closes the vicious cycle.

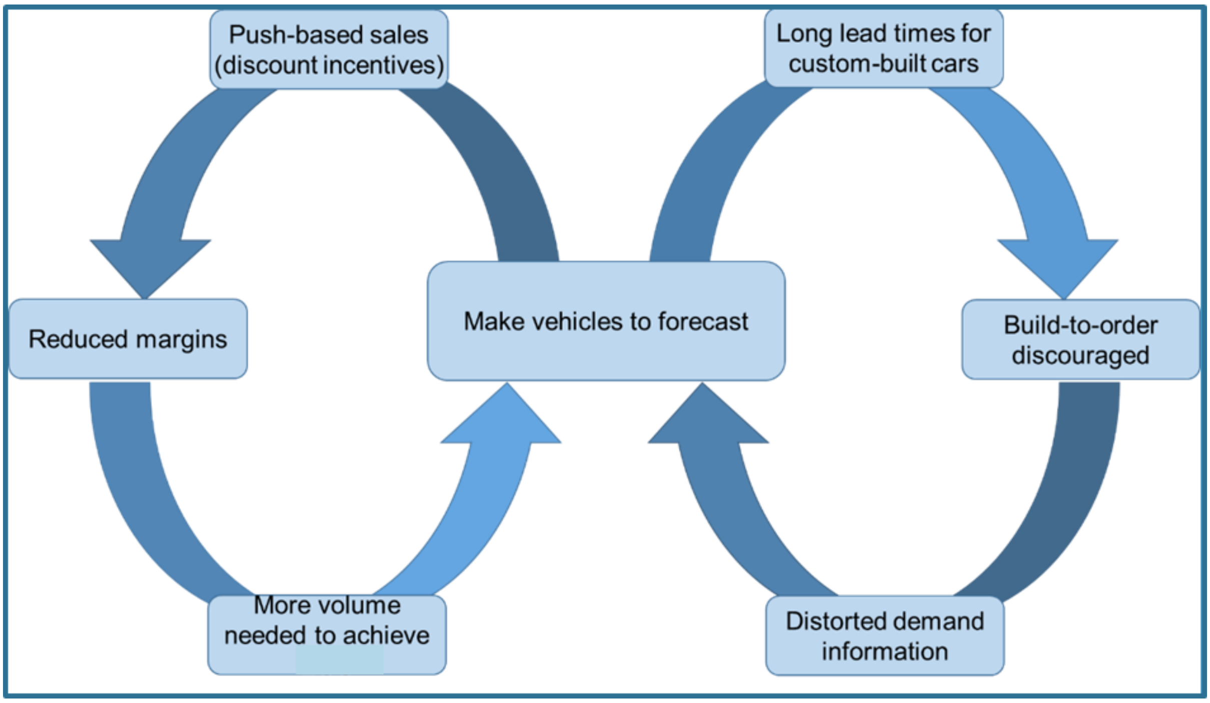


Figure 3.2: The vicious cycle of make-to-forecast

Adapted from Holweg & Pil (2004:15)

OEMs attempt to break the vicious cycle with modularisation and platform strategies by shifting research, development, supply and production from one individual model to a family of models, often across brands, or by shifting responsibility to the supplier. The platform is the technical foundation of a car which determines the foundation of a vehicle but does not influence the exterior car design itself. Platform strategies enable the OEM to roughly forecast demand without going into too much detail in terms of colour and equipment of a car which results in a gain of flexibility for OEMs and suppliers (Hüttenrauch & Baum, 2008:129-130; Deloitte, 2014a:15). Economies of scale can be achieved for generic parts. Both strategies can be seen as a continuation of Ford's approach of interchangeability of parts. It does, however, not completely solve the problem. Lead times for customised requests are still longer than expected delivery times of the customer. The strategies BTO and MTS lead to different supplier management and purchasing forms. BTO is a market-driven strategy, while MTS is forecast-driven. In many instances, import and assembly strategies strongly influence the balance between forecasted and real orders. Section 3.3.2 introduces the most common strategies in detail.

3.4. Organisations in the automotive industry

The automotive industry sold 88 million vehicles globally in 2016 (Parkin, Wilk, Hirsh & Singh, 2017:4). A handful of OEMs account for the largest share of produced vehicles. Figure 3.3

illustrates the top 15 OEMs in terms of production volume, where the volume is not only limited to light passenger vehicles, but takes into account all vehicles produced (OICA, 2017).

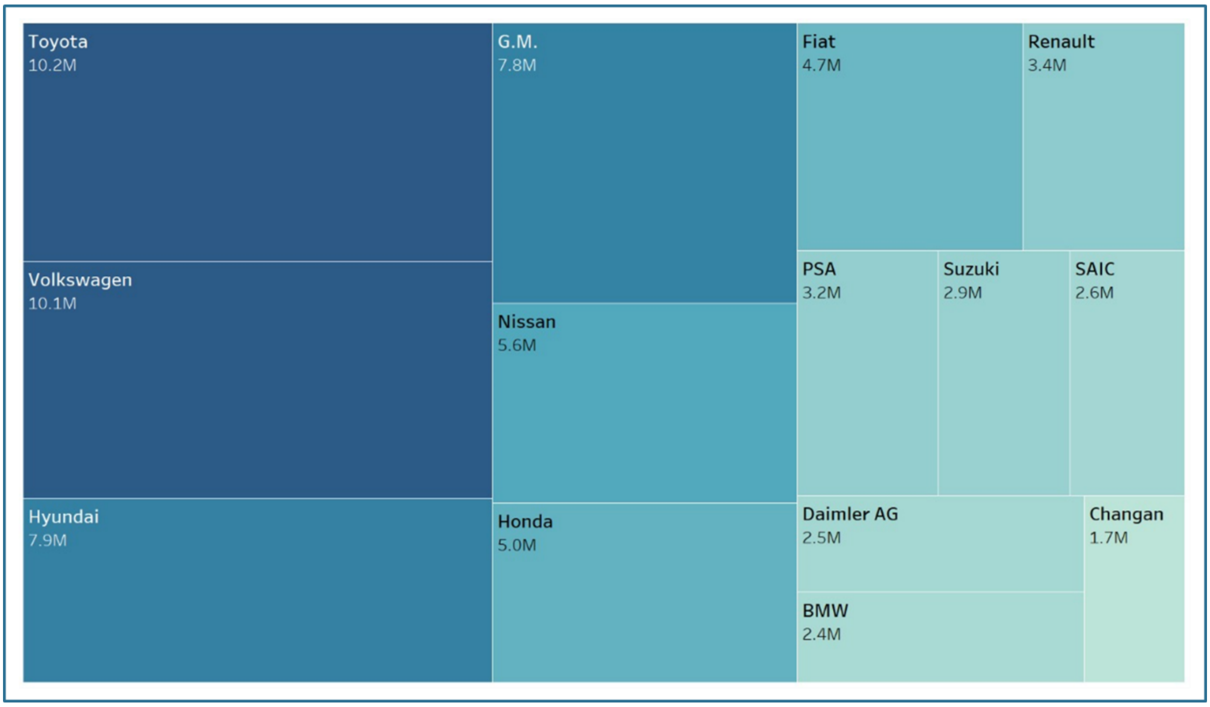


Figure 3.3: Top 15 OEMs based on vehicle production of 2016 (rounded in million)

Source: OICA (2017)

Toyota is the biggest car manufacturer with an annual production output of 10.2 million (OICA, 2017). With the head office in Japan, Toyota operates a total of 60 plants worldwide for the production of all automotive products and affiliated brands such as Lexus or Daihatsu (Toyota Motor Corporation, 2012a, 2017). Toyota is known for its innovative production system which integrated the just-in-time concept, an approach where parts are only delivered when needed, from the 1940s onwards (Toyota Motor Corporation, 2012b). Toyota's effort to produce sustainable vehicles is stressed by the fact that the OEM has already sold more than ten million hybrid vehicles since the production start in 1997 (Toyota Motor Corporation, 2017). Further, Toyota applies the strategy of CKD- and SKD-vehicle production to increase its presence in emerging markets (Toyota Motor Corporation, 2014).

The second OEM with a total annual production output of more than 10 million vehicles is Volkswagen Aktiengesellschaft (VW) with an annual production output of 10.1 (OICA, 2017). The group consists of 12 brands, including Audi, Seat, Skoda, Bentley, Porsche, Lamborghini and other light and heavy vehicle manufacturers. VW manages 120 production facilities in North- and South America, Europe, Africa and Asia (Volkswagen AG, 2017a). Some of these plants are CKD-vehicle plants, for example the assembly plant in Kenya which receives kits from the plant in South Africa (Williams, 2016). VW manages the group from the head office in Wolfsburg, Germany. The group is Europe's largest OEM (Volkswagen AG, 2017b).

Hyundai is the third largest OEM with a production output of 7.9 million vehicles per year (OICA, 2017). Besides the brand Hyundai, the South Korean manufacturer also comprises Kia Motors. The group manages production facilities in North- and South America, Asia and Europe (Hyundai Motor Company, 2017a). Hyundai is a relatively young OEM. The company was founded in 1967 but slowly developed to become one of the strongest automotive manufacturers in the world (Hyundai Motor Company, 2017b). Hyundai's international growth is facilitated by the assembly of specific models in CKD-vehicle plants, such as in Malaysia (Tan, 2005).

General Motors (G.M.), the fourth largest car manufacturer, accounts for an annual production output of 7.8 million vehicles (OICA, 2017). With its head office in Detroit in the United States, G.M. manages, amongst others, the brands Chevrolet, GMC and Cadillac (General Motors, 2017). G.M. still produces a large part of its vehicles in North America but also follows a strategy of market proximity to growing markets like China with new plants in this region (General Motors, 2017). In addition, G.M. also operates CKD-vehicle plants, for example in Colombia (Vargas, 2012). Recently, G.M. started to limit its business operations in specific areas through the sales of the brand Opel and through the discontinuation of production and sales of Chevrolet in South Africa (Johnson, 2017).

The Ford Motor Company (Ford) is the fifth largest OEM with an annual production output of 6.4 million vehicles (OICA, 2017). It was Henry Ford, the founder of Ford, who incorporated mass manufacturing in the form of a moving assembly line in 1913 (Ford Motor Company, 2017a). Today, Ford operates 34 assembly plants in North- and South America, Europe, Africa and Asia (Ford Motor Company, 2017b). Some of these plants are CKD-vehicle plants, such as the assembly plant in Russia (Vorotnikov, 2013).

Placed sixth, Honda accumulates a production output of 5 million vehicles per year (OICA, 2017). Besides the automotive production, Honda also accounts for notable production output in small aeroplanes and motorcycles. The company produces vehicles in 26 plants all over the world, including CKD-vehicle plants (Honda Malaysia, 2015). The majority of facilities are located in the founding country of Japan (Honda Motor Company, 2017).

The group Fiat Chrysler Automobiles accumulates an annual production output of 4.7 million vehicles (OICA, 2017). Besides the brands Fiat, Chrysler and others, the group manages Alfa Romeo, Jeep and Lancia. A total of 28 plants in North- and South America, Europe and Asia assemble the vehicles of all brands (Fiat Chrysler Automobiles, 2017). The OEM assembles CKD-vehicles locally in price-sensitive markets and customer groups depending on the brand and model, for example Fiat compact cars in India (Wright, 2013).

Groupe Renault reaches an annual production volume of 3.4 million vehicles (OICA, 2017). The French group incorporates, amongst others, the brands Dacia and Lada (Groupe Renault, 2017). In 1999, Renault formed an alliance with Nissan and Mitsubishi, making it the biggest alliance of OEMs with 122 manufacturing plants, including CKD-vehicle assembly facilities, and over 470000 employees worldwide (Grejalde, 2013; Renault Nissan Mitsubishi, 2017a; Renault Nissan Mitsubishi, 2017a). Daimler AG works in close co-operation with the alliance, currently building a joint production facility in Mexico (Nissan News, 2016).

Another French group, Groupe PSA, reached a total production output of 3.2 million in 2016 (OICA, 2017). Amongst others, brands in Groupe PSA are Peugeot and Citroen (Groupe PSA, 2017a). In 2017, Groupe PSA acquired Opel and Vauxhall from G.M. (Groupe PSA, 2017b). Similar to other OEMs, Groupe PSA operates a CKD-vehicle assembly plant in Russia, amongst other locations (Vorotnikov, 2013).

Suzuki is the 10th largest OEM with an annual production volume of 2.9 million vehicles (OICA, 2017). The Japanese manufacturer runs a total of 24 plants in Asia, North- and South America, Europe and Africa (Suzuki Motor Corporation, 2017a). CKD-vehicle plants are located in markets suchs as Malaysia (Mohamad, 2007). Similar to Honda, Suzuki is also known for its motorcycles (Suzuki Motor Corporation, 2017b).

With 2.6 million vehicles produced in 2016, SAIC is the biggest Chinese OEM (OICA, 2017; SAIC Motor, 2017a). SAIC produces an in-house luxury vehicle under the brand name Roewe as well as the basic line MG (SAIC Motor, 2017b). Furthermore, SAIC is affiliated with a number of other OEMs, including Volkswagen AG (SAIC Motor, 2017a). SAIC produces the majority of vehicles in China with only one CKD-vehicle assembly plant located in the United Kingdom (Adams, 2011).

Daimler AG is the 13th largest OEM with a production output of 2.5 million vehicles per annum (OICA, 2017). Mercedes-Benz is the main passenger vehicle brand of Daimler AG (Daimler AG, 2017d). Chapter 4 introduces Daimler AG in detail.

BMW Group is the third German OEM in the top 15 with an annual production volume of 2.4 million vehicles (OICA, 2017). Besides the brand BMW, the group also manages the brands Mini and Rolls Royce (BMW Group, 2016:4). BMW group operates 31 production and assembly plants all over the world, including CKD-vehicle plants in locations such as Russia (Vorotnikov, 2013; BMW Group, 2016:25).

Another Chinese manufacturer, Changan, is the 15th largest OEM with a production volume of 1.7 million vehicles per annum (OICA, 2017). Changan has the highest sales figures of domestic OEMs in China (Changan, 2017). Changan only recently entered the passenger vehicle market with the first vehicle launch in 2009. Before that, the company produced commercial vehicles only (Changan, 2017). The Chinese OEM produces most vehicles in China with CKD-vehicle assembly plants in Iran and Russia (Automotive News Europe, 2016).

The automotive industry is dominated by international companies mostly from Japan, Germany and the United States. While the origin of the manufacturer differs, most OEMs compete in similar markets under similar conditions. This trend also reflects in the location of CKD-vehicle assembly plants with a concentration on countries such as Russia, Malaysia or South America. Section 3.5 contains a summary of internal and external influences in the automotive industry.

3.5. Internal and external influences on the automotive industry

A meta-analysis, consisting of 10 publications, indicates which external influences and trends currently are significant to the automotive industry. This study analyses seven reports by independent organisations and three annual reports by German premium OEMs, divided in external development and trends within the automotive industry. Addendum A contains a summary of the results of the meta-analysis.

3.5.1. External influences on the automotive industry

Global trends have an impact on the automotive industry. This section summarises the most prevalent trends as mentioned in the analysed reports, namely globalisation and shift in markets, the rise of new technologies, digitalisation, sustainability, changing consumer expectations and preferences, demographic and urban development, big data, as well as geopolitical and economic instability.

- **Globalisation and shift in markets:** The automotive industry is currently suffering from a stagnation of sales in their biggest markets in North America and the United States. Emerging markets, however, increasingly develop growing economies, resulting in an increase in sales in these countries. Besides the main Asian markets of China and India, other nations such as Indonesia and Thailand increased their demand for car sales significantly in the last few years. Other emerging countries such as Russia or Brazil, which experienced steady growth in the last few years, currently indicate a reduced demand for passenger vehicles. On the African continent, countries such as Nigeria experience both economic growth and an increase in demand for passenger vehicles. In the future, the current markets are predicted to shift to less developed nations all over the globe, requiring more complex and efficient logistical and operational networks (KPMG, 2014:4-6, 2017:8-

9; PricewaterhouseCoopers, 2014:1; Deloitte, 2015:9; Audi AG, 2016:30; BMW Group, 2016:92-93; Daimler AG, 2016a:162; McKinsey&Company, 2016:3).

- **Rise of new technologies:** Continuous advancements in the technology sector positively influences innovations in the automotive industry. The cars of today have developed from a mainly mechanical means of transport to a provider of technological mobility and services (Deloitte, 2014b:3, 2015:9; KPMG, 2014:13; PricewaterhouseCoopers, 2014b:1; Audi AG, 2016:5; BMW Group, 2016: 94; Daimler AG, 2016a:26; McKinsey&Company, 2016:3).
- **Digitalisation:** Digital technologies have become an integral part of the consumer's everyday life. As a result, consumers expect their cars to live up to that standard (KPMG, 2014:14-16). Especially in the premium segment, passenger vehicles are equipped with complex entertainment and assistance systems. The value of all digital equipment of such a car is likely to surpass the value of the hard body and mechanics (PricewaterhouseCoopers, 2014b:1; Verband der Automobilindustrie, 2015:7; Audi AG, 2016:5; BMW Group, 2016:96; Daimler AG, 2016a:88; McKinsey&Company, 2016:3; KPMG, 2017:35).
- **Sustainability:** The term sustainability has become omnipresent in today's society. While the term covers social, environmental and financial aspects, the automotive industry stresses the environmental aspects. The production of a vehicle is extremely resource-intensive. On average, the production of an average passenger vehicle takes up 86% of all resources the vehicle uses in its complete lifecycle. In addition to the production, a car further uses resources and is high in emissions. Governmental restrictions in terms of fuel consumption and carbon dioxide emissions forcibly motivate OEMs and suppliers to improve their products. On top of that, there is societal pressure on OEMs to provide environmentally friendly options to environmentally conscious customers. While governmental regulations mostly aim at the reduction of emissions, manufacturers also look into ways of reducing resources by using recycled parts in new vehicles (KPMG, 2014:10; PricewaterhouseCoopers, 2014b:22-25; Daimler AG, 2016a:123-138; Deloitte, 2015:12; Audi AG, 2016:53; BMW Group, 2016:59-62; McKinsey&Company, 2016:3).
- **Changing consumer expectations and preferences:** Especially in urban areas, consumers do not necessarily own cars anymore. Car rental, including short-term rental, and shared mobility services are a common alternative to public transport. The preference of consumers has often shifted from cars large enough to carry a family to compact cars (KPMG, 2014:14-16). As a result, OEMs diversify their product range to attract both customers interested in compact cars and sports utility vehicles (SUVs). Moreover, customers expect a high level of safety and technical equipment when using a car. Mobile phone chargers, screens and parking assistants with cameras are common for vehicles in the premium segment, even for smaller compact cars. Due to one consumer often using

several cars, a consumer expects a car to be user-friendly with a similar arrangement of functions. Mobility services allow consumers to flexibly use cars that fit their current needs best. A business trip within the city requires a different type of transport mode than a family trip over the weekend. While car owners use the same car for all purposes, mobility service users can chose which car to use for each trip. This offers a platform for the diversified products of the OEMs. While the number of cars on the road are predicted to decrease, the miles travelled for each consumer are predicted to increase significantly. Overall, the importance of personal mobility has increased, while the importance of owning a car has decreased (PricewaterhouseCoopers, 2014b:1; Audi AG, 2016:5; McKinsey&Company, 2016:3; KPMG, 2017:25).

- **Demographic and urban development:** Urbanisation partly contributes to the development in the field of mobility and mobility services. The number of megacities increases steadily and average cities grow and develop suburbs that spread out further and increase the size of urban areas. Most cities are designed to accommodate fewer cars than people. The capacity of streets and parking spaces is limited, with private parking spaces becoming increasingly expensive. Public transport, where existent, is not an option for every need and consumer. While the population is aging in developed countries, developing countries have a fast growing, younger population with a strong acceptance of technology in their daily life. This resembles a growth in vehicle sales in relatively new markets such as China (KPMG, 2014:7, 2017:43; Audi AG, 2016:5; Daimler AG, 2016a:14).
- **Big data:** The field of big data also concerns the automotive industry. Consumer behaviour can benefit both the OEM and consumer. OEMs can learn from usage patterns and improve their products. For example, the technology in a car can be applied according to the patterns to offer additional services and comfort to the consumer. The big issue, however, is the aspect of data ownership and protection. While the majority of executives from the automotive industry believe that the OEM should be the owner of the data, most consumers think they should be the data owners. OEMs still stay relatively quiet regarding big data, while independent reports have picked up the significance of big data for the automotive industry (KPMG, 2014:19, 2017:37-41).
- **Geopolitical and economic instability:** The latest reports have picked up the issue of geopolitical and economic instability. Markets known to be stable over the past twenty years are threatening to become politically unstable. The political uncertainty in the United States and Europe influences purchasing behaviour and export opportunities for OEMs. Moreover, growing markets, which gained stability over the past few years, now move towards a trend of economic uncertainty. On the contrary, Asian markets, which have been risky and unstable in the past, developed into secure and stable markets for OEMs.

Besides the shift in market and purchasing behaviour, uncertainty about production facilities and regulations, which often depend on the government, contribute to a negative atmosphere (BMW Group, 2016:91; Daimler AG, 2016a:62; KPMG, 2017:42-46).

The reports analysed discussed above describe all external influences. Figure 3.4 shows the most prevalent influences discussed in the articles, together with the number of reports discussing the issues.

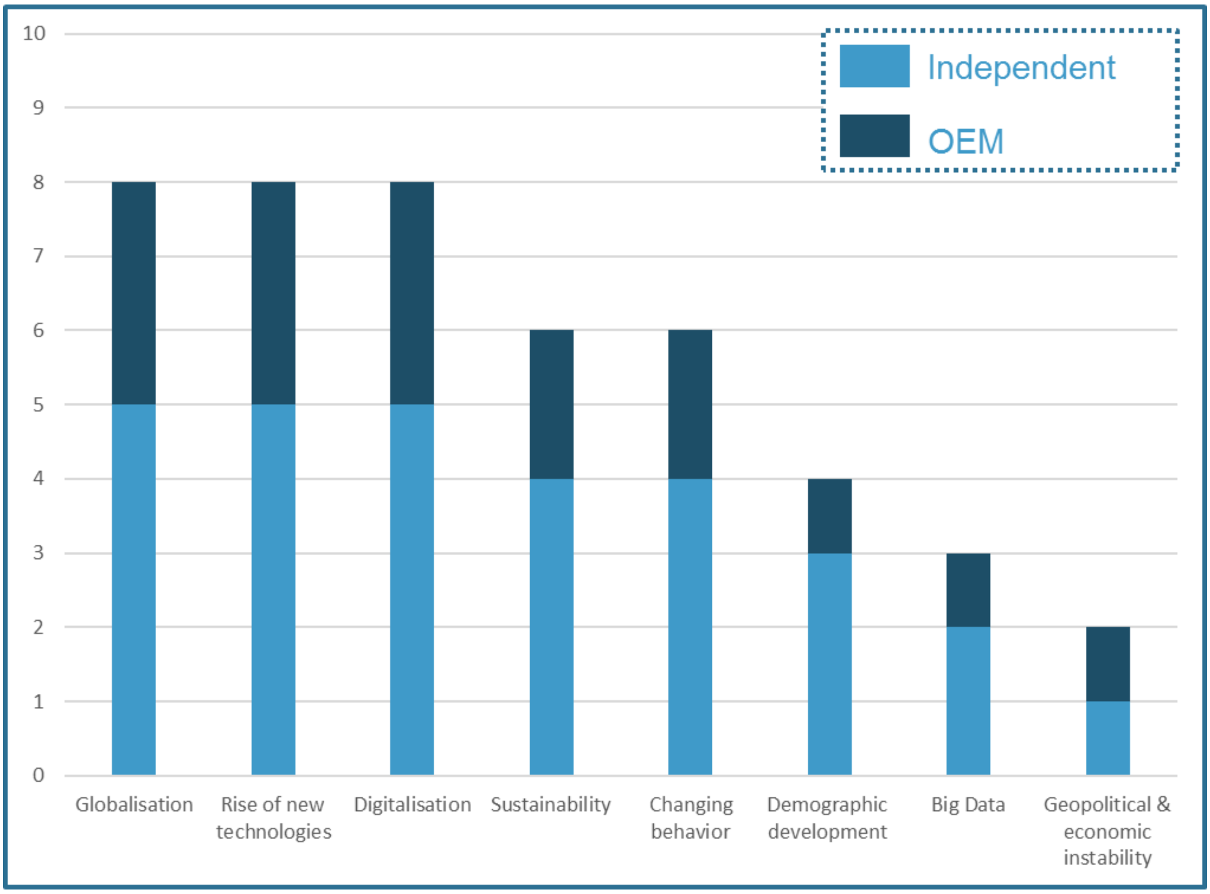


Figure 3.4: Results of the meta-analysis for external influences

(KPMG 2014, 2017; PricewaterhouseCoopers, 2014b; Deloitte, 2015; Verband der Automobilindustrie, 2015;Audi AG, 2016; BMW Group, 2016; Daimler AG, 2016a; McKinsey&Company, 2016)

Out of the 10 sources of literature, the three most prevalent topics are globalisation, rise of new technologies, and digitalisation. All three OEMs and five out of seven independent organisations discuss these issues. The aspect of geopolitical and economic instability is relatively new due to recent developments. Only one OEM and a recent study from 2016 analyse the potential impacts of the current political environment. The fact that it is limited to recent work indicates that it is a rather new issue. Many of these trends show links to each other with strong interdependencies. Moreover, these global developments lay the foundation for several trends in the automotive industry.

3.5.2. Trends in the automotive industry

The automotive industry reacts to global trends. External influences encourage the automotive industry to develop further or enforce reactions to certain events. The most prevalent trends found can be summarised as autonomous driving, new competitions and co-operations, electrification and alternative powertrains, connectivity, new business models and diversification, diverse mobility, platform strategy, standardisation and modularity, a shift in production to emerging markets, and the negative aspect of corruption and a loss of credibility. Each of these trends will be discussed below.

- **Autonomous driving:** Fully automated driving is possible thanks to today's standard of technology. However, the acceptance of consumers and ethical guidelines are not as advanced yet. Common features in cars that are currently available on the market include brake assistance, lane centering technology or adaptive cruise control. While most consumers gratefully accept such features, there is general scepticism towards fully automated driving. OEMs and technology companies have a more visionary point of view and further promote autonomous driving to create general acceptance. Besides the possibility of owning a car which drives autonomously, other prospects are autonomous mobility services such as a driverless ride services or car rental (Deloitte, 2014b:5; KPMG, 2014:7, 2017:8; Audi AG, 2016:51; BMW Group, 2016:17; Daimler AG, 2016a:13-16; McKinsey&Company, 2016:3).
- **New competitors and co-operations:** The hierarchies and orders of the automotive industry are changing, rendering them more diverse and complex (McKinsey&Company, 2016:5). Trends such as digitalisation or the rise of new technologies motivate new market entrants to target economically rewarding segments (BMW Group, 2016:94; McKinsey&Company, 2016:5; Verband der Automobilindustrie, 2015:7). Some of these new competitors originate from other industries, such as the computer industry, and therefore surpass the traditional OEMs with knowledge and experience in this field. In order to succeed, OEMs form partnerships and alliances with technology companies, often including start-ups. The opportunities arising from such partnerships often outnumber the risks and the danger of too little innovation to compete in the market (Deloitte, 2015:23; KPMG, 2017:28). Other forms of co-operations include strategic alliances with direct competitors, such as the alliance between Daimler AG and Renault-Nissan. The two OEMs plan to jointly run a production plant in Mexico (Daimler AG, 2016a:157). Additionally, co-operations between OEMs and suppliers allow the OEMs to outsource research and development of non-core parts (Daimler AG, 2016a:124).
- **Connectivity:** Digitalisation enables consumers to be connected anywhere and anytime. This includes the environment of a car. Most new vehicles have a mobile phone charger,

an entertainment system you can connect your phone to and some vehicles are connected to the consumer's smartphone and can be remotely controlled through an application on the phone (Daimler AG, 2016a:13). When renting a car, a customer's expectations include simple and universe connectivity to facilitate the journey. As a result, the level of connectivity also increases the profitability of a car with one connected car having up to ten times more revenue than a non-connected car. On a global scale, connectivity is more important to consumers from Asian markets as opposed to Europeans, most likely due to the age of consumers. OEMs are aware of the importance of connectivity to customers and constantly improve the integration of connectivity and presence through apps and mobile services (Audi AG, 2016:88; BMW Group, 2016:17; Daimler AG, 2016a:13; McKinsey&Company, 2016:4; KPMG, 2014:14-16).

- **New business models and diversification:** External influences motivate OEMs to diversify their product portfolio. Certain trends allow for more advanced technologies, while other trends force the OEM to distribute risk over several business units (Audi AG, 2016:123). OEMs have mobile applications for configuration of a car before sale, remote access to the own car and direct service contacts to the dealership. Mobility services such as car2go are subsidiaries of the OEM. On a different level, OEMs expand their product portfolio as can be seen in Section 4.4.2 (KPMG, 2014:7; Deloitte, 2015:18; Audi AG, 2016:123; Daimler AG, 2016a:32-35; Verband der Automobilindustrie, 2016:7).
- **Diverse mobility:** In today's world, there are many alternatives to owning a car. These alternatives include public transport, ridesharing services, renting from both a private individual or a rental service as well as ride-hauling services or electronic bicycles. Especially in urban areas, consumers can choose from many options and choose the most suitable offer depending on their needs (Deloitte, 2014b:16; KPMG, 2014:7, 2017:8; Daimler AG, 2016a:32-35; Verband der Automobilindustrie, 2016:7).
- **Electrification and alternative powertrains:** Consumers are aware of battery-driven vehicles and other alternative powertrains. However, most vehicles sold globally still have fuel-based engines. Other alternative powertrains, such as hybrid cars and fuel cell cars . are not as popular yet, but offer great potential. Battery-driven cars rely on infrastructure due to a limited battery lifespan. The infrastructure for charging stations is however insufficient (KPMG, 2017:8). Thus, OEMs are investing in infrastructure to promote battery-driven cars. An advancement in electrification is of great interest to OEMs to reduce the carbon dioxide emissions of their fleet. While the absolute targets differ from OEM to OEM, the strategic aspect of adding electric vehicles to their product portfolios remains similar. For example Daimler AG has the brands smart and EQ, while Audi introduced the e-tron model and BMW has the i model. Besides the sustainable image, many governments offer financial motivations to both OEMs and customers to reduce their carbon footprint by

driving with an electric vehicle (Audi AG, 2016:45-48; BMW Group, 2016:61; Daimler AG, 2016a:20-25;Verband der Automobilindustrie, 2016:7).

- **Platform strategy, standardisation and modularity:** With growing production output and increasingly diverse product portfolios, cost-efficient sourcing becomes essential. Therefore, OEMs follow a platform strategy with several models requiring the same equipment and parts. This type of vertical integration goes hand in hand with co-operations with suppliers in terms of research and development. For OEMs, it is a priority to reduce risk. Operating less production steps and outsourcing increasingly complex production processes to suppliers are two ways to mitigate risk (Audi AG, 2016:111; BMW Group, 2016:95; Daimler AG, 2016a:85; KPMG, 2017:9). Different approaches depending on the OEM can be observed. For example, Daimler AG formed a strategic alliance with Renault-Nissan, and Audi is part of the VW group and shares suppliers as well as parts with models from VW and Porsche (Audi AG, 2016:111; Daimler AG, 2016a:85).
- **Shift in production to emerging markets:** OEMs and suppliers follow the shift in demand with an adjustment of their production network. Many OEMs already have plants in markets such as China or Brazil and other increasingly favourable regions are Mexico and Russia (PricewaterhouseCoopers, 2014b:2; KPMG, 2017:9). The global production network of German OEMs has already shifted to emerging markets and this trend is predicted to continue (Audi AG, 2016:113; BMW Group, 2016:24; Daimler AG, 2016a:68).
- **Corruption and loss of credibility:** Recent developments in the automotive industry took an unpleasant turn concerning credibility and corruption. Accusations against several OEMs, including OEMs in the premium segment, concerning the actual consumption of diesel engines and the emission of these engines turned out to be partly true. Other OEMs are still under investigation (Deloitte, 2015:9; Audi AG, 2016:88; Daimler AG, 2016a:266; Verband der Automobilindustrie, 2016:6). As a result, many consumers are uncertain about the credibility of OEMs. It is necessary that the OEMs convince potential consumers of the benefits of the vehicle in terms of credibility and safety instead of distracting a consumer with interesting but not essential equipment packages.

The reports analysed above describe internal trends common in the automotive industry. Figure 3.5 illustrates the most prevalent trends discussed in the articles, together with the number of reports discussing the issues.

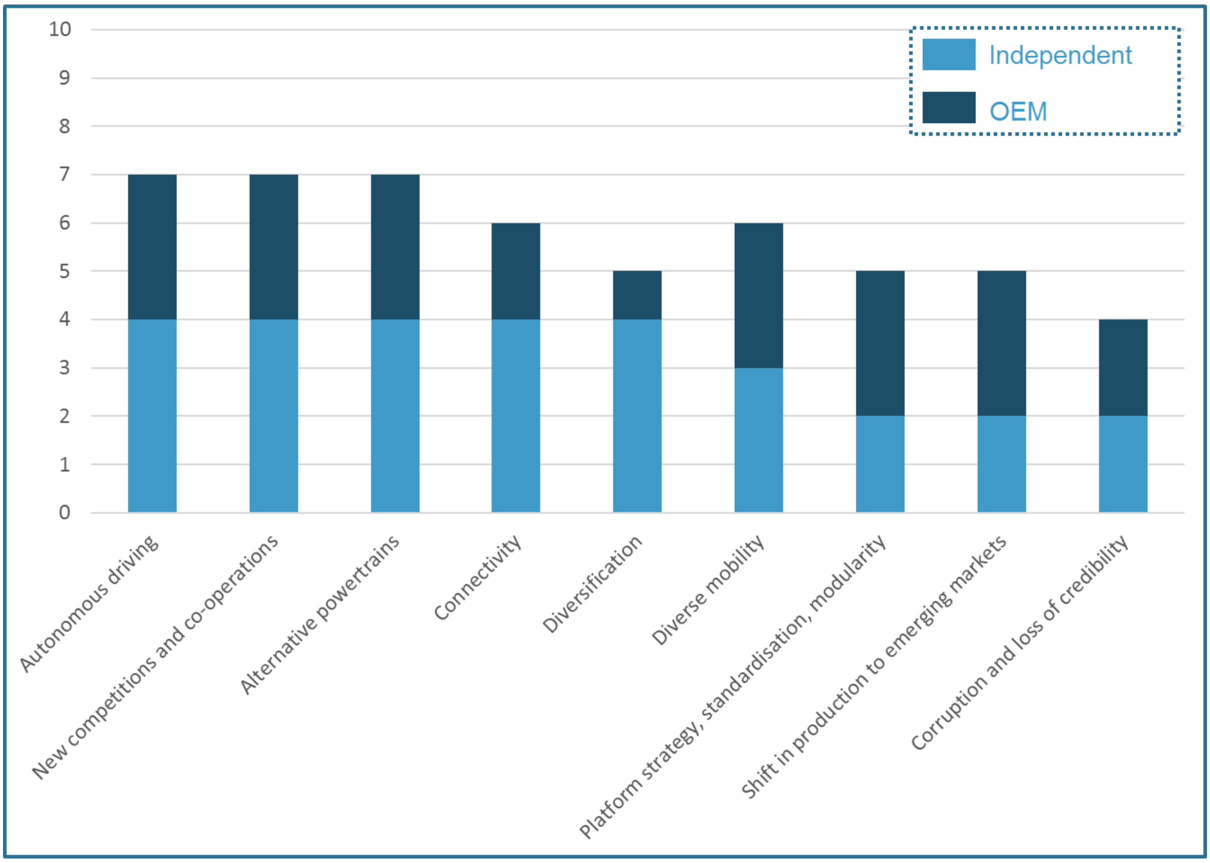


Figure 3.5: Results of the meta-analysis for internal developments

(KPMG 2014, 2017; PricewaterhouseCoopers, 2014b; Deloitte, 2015; Verband der Automobilindustrie, 2015;Audi AG, 2016; BMW Group, 2016; Daimler AG, 2016a; McKinsey&Company, 2016)

The three most prevalent trends are autonomous driving, new competitors and co-operations as well as an alternative powertrain, followed by connectivity and diverse mobility. New technologies strongly influence the trends, thanks to the possibilities made available. The intensification of platform strategies, standardisation and modularity, as well as the shift in production to emerging markets are topics relevant to OEMs and are discussed in their annual reports. Independent organisations seem to be aware of these trends but currently focus on other trends that are of direct relevance to the consumer.

3.6. Concluding remarks

As a starting point, specifics and development regarding SCM in the automotive industry are discussed in this chapter. Based on that, specific purchasing and delivery configurations are discussed. Further, this chapter provides information on the automotive industry by introducing the main OEMs and by analysing developments and trends in the industry.

In alignment with the initial literature review in Chapter 2, this chapter emphasises the importance of co-operation, integration of parties involved in the supply chain, as well as the implementation of suitable technologies. The implementation of technologies potentially strengthens the supply chain by enabling communication and information transfer between parties involved. The accessibility of information is of great relevance for the OEMs in order to integrate suppliers, 3PLs and even customers into the supply chain. In the current business environment, co-operation between OEMs, suppliers and 3PLs is essential to compete and to further increase performance. Other means of increasing competitiveness include a broad variety of import strategies. A variety of import strategies allow access to restricted markets, for example through the implementation of CKD-vehicle assembly plants instead of importing CBU-vehicles. The relevance of appropriate import strategies has especially increased in times of globalisation. Furthermore, an overview of the most common Incoterms is provided.

The automotive industry is shaped by external influences such as globalisation. Other influencing factors are the rise of new technologies, digitalisation and the importance of sustainability. Further, internal developments shape the future of the automotive industry. Crucial trends are autonomous driving, electrification of vehicles resulting in increasing product diversity, increasing platforms, a production and demand shift to emerging markets as well as co-operations between suppliers and alliances with other OEMs.

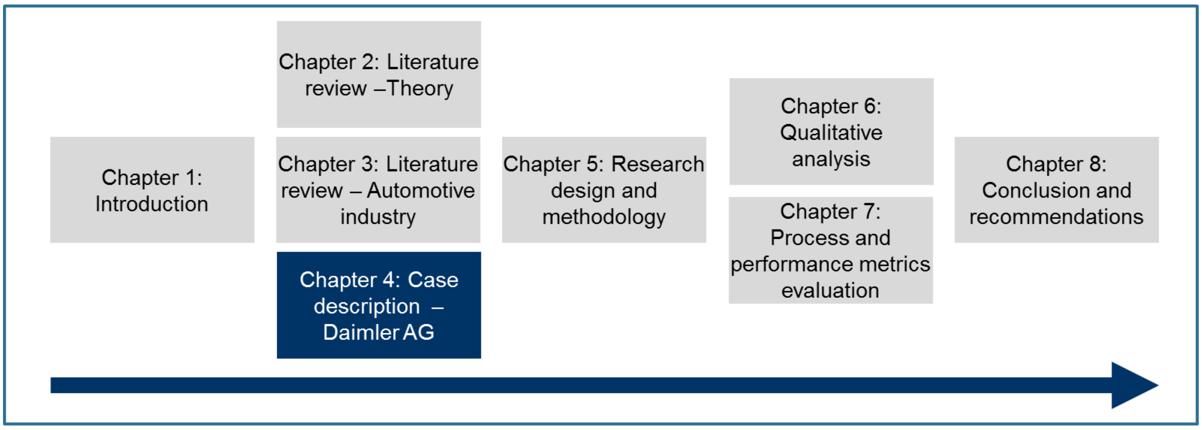
The number of big OEMs in the industry is very limited which further increases competition. One of the OEMs introduced is Daimler AG, the OEM which is the subject of this study. Chapter 4 introduces Daimler AG further, focussing on the passenger division Mercedes-Benz Cars (MBC) and the CKD-vehicle business practices.

Chapter 4. Case description – Daimler AG

“Mercedes-Benz

The best or nothing.”

(Daimler AG)



4.1. Introduction

This chapter introduces the company Daimler AG with a focus on the business unit Mercedes-Benz Cars (MBC) as this organisation represents the subject of this research study. A general overview and a section about the development of the organisation introduce the company. Further, this chapter investigates business and supply chain strategy in order to initiate the topic of demand and capacity planning. Part of this section is a description of the status quo of demand and capacity planning and import strategies, including completely-knocked-down (CKD) vehicles.

4.2. Development

The history of Daimler AG represents significant milestones in the development of the automotive sector. In turn, development of Daimler AG was influenced by other historic developments. Figure 4.1 illustrates the timeline of significant events in the company history of Daimler AG.

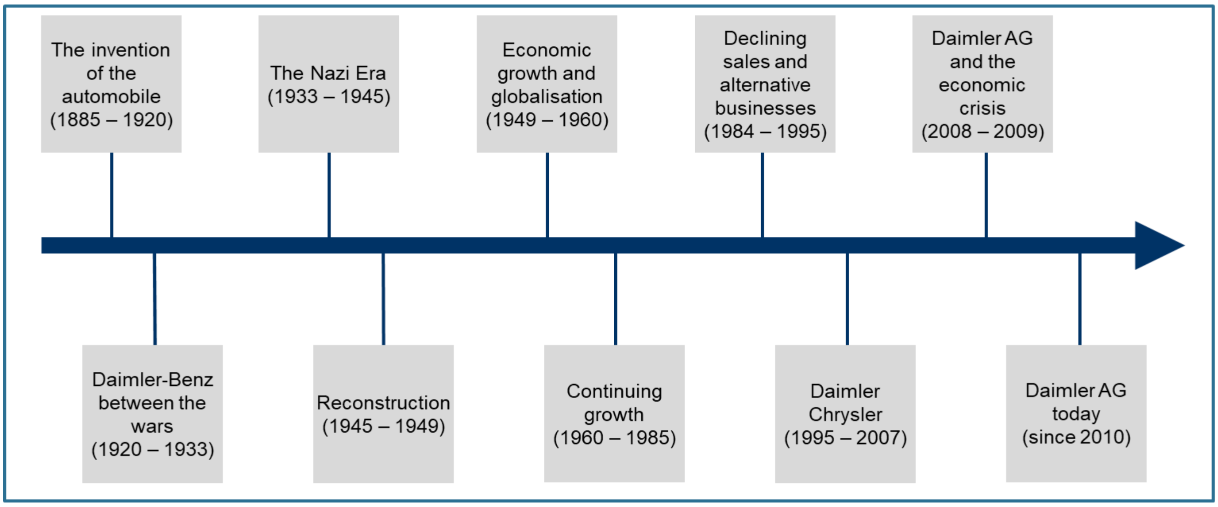


Figure 4.1: History of Daimler AG

(Daimler AG, 2017o)

Carl Benz, Gottlieb Daimler and Wilhelm Maybach independently invented engines and prototypes for cars from 1879 onwards. Carl Benz applied for a patent for the first gas-powered passenger vehicle in 1886 (Daimler AG, 2017e). After the patent application, it took a while until the car was driven. Only two years later in 1888, Carl's wife Bertha took the car for the first long-distance (180km) drive in the history of the automobile. Around the same time, Daimler and Maybach tested their car, which they named the *riding car*, for the first time in 1885. After a few test drives, it was not until 1894 that the commercial success of vehicles truly started with the *Benz velo* (Daimler AG, 2017f).

Based on the success of the Benz velo, Daimler's company, Daimler Motoren Gesellschaft (DMG), realised the entertainment value of cars. In 1901, DMG introduced the first racing car named Mercedes, and started to expand their business by producing racing cars. During World War I, a shift away from entertainment and passenger transport towards trucks, marks the beginning of involvement with heavy vehicles. After the war, many foreign markets in proximity were inaccessible. At first, both Daimler and Benz diversified their product range, producing other machines such as bicycles and typewriters. Low demand led to the realisation that economies of scale are necessary to maintain business. As a result, Daimler and Benz merged in 1926. In addition to the merger, the company developed new business principles. The most significant principles are a limited product range and a flexible production system, which helped to overcome the world economic crisis of 1929 (Daimler AG, 2017g).

After the economic crisis, the Nazi Era marks a dark history of Daimler AG since the company had strong ties with the Nazi regime. However, production flourished again from 1937 onwards. A shift from producing passenger vehicles to armaments such as trucks and aircraft engines resulted in extensive growth. Daimler-Benz's labour force was limited and could not keep pace with growing production. As a result, the company introduced forced labour. At the end of the war, prisoners, concentration detainees and forced civilians from Germany and other conquered countries made up half of the labour force. In 1942, passenger vehicle production came to a complete standstill due to high demand in armament production and repair (Daimler AG, 2017h).

With the end of the war in 1945, Daimler-Benz faced many difficulties. Demand for armaments broke off. The no longer existing Nazi regime had no successor to manage outstanding payments, and in addition to reduced demand and financial issues, all production sites were damaged or destroyed. Daimler-Benz returned to business by repairing US military vehicles during the time of the occupation. Once the plants' functionality was fully reinstated, the co-operation developed truck production as a main leg of the business. Daimler-Benz returned to profitable operations in 1948.

From 1949 onwards, Daimler-Benz continued to develop positively. The economic miracle increased demand for commercial vehicles. Once trade restrictions from World War II were removed, global exports significantly increased demand. A new division, producing buses and coaches, supplied Germany's need for vehicles for public transportation. In terms of passenger vehicles, Daimler-Benz returned to producing race cars, but also diversified towards luxurious, up-market passenger vehicles. In the 1950s, demand exceeded production capacities. On a national level, Daimler-Benz acquired other vehicle producers. Internationally, the company invested in new plants, in South America, Iran and South Africa amongst others. These plants followed the principles of CKD-vehicle assembly. With a growing production network, logistics gained importance (Daimler AG, 2017i). Despite fluctuation in market demand, growth continued to increase from 1960 to 1985. Daimler-Benz was a global leader in truck and bus production. In the field of passenger vehicles, the company excelled in the premium segment. Further product diversification for passenger vehicles reached new markets (Daimler AG, 2017i).

After a long period of growth, the period from 1984 to 1995 marked an era of declining growth and alternative business models. The second oil crisis hit Daimler-Benz in the late 1970's. In addition, newly developed, mostly Asian competitors became a threat to the company's profitability. The sales of commercial vehicles dropped, leading to financial loss in the business sector. As a result, Daimler-Benz re-adopted the strategy of diversification by exploring new potential business models. The company acquired and founded divisions specialising in aviation, electronics and services. This development also marks the beginning of the age of co-operation between businesses, as we know it today. The strategy of diversification, however, turned out to be without success for most business ventures (Daimler AG, 2017j).

Daimler AG's decision to terminate co-operations in other business fields in 1995, initiated a return to strengthening its core business. In 1998, Daimler AG merged with Chrysler, forming DaimlerChrysler AG. The merger was intended to safeguard the company's global competitiveness in a sustainable manner. Acquisitions in the truck and bus divisions extended the network for commercial vehicles. The merger with Chrysler however did not yield the expected benefits. As a result, the company renamed itself Daimler AG in 2007. Two years later, Daimler AG relinquished all shares in Chrysler, marking the end of a 12-year long partnership (Daimler AG, 2017k).

During the global economic crisis in 2008 to 2009, Daimler AG followed a different approach of acquiring new sources of financial capital from Saudi Arabia. This new capital is the foundation for significant investments in research and development. Daimler AG revived the pioneering spirit from its early beginnings, by moving into the direction of alternative drive technologies for both passenger and commercial vehicles. The second pillar to overcome the crisis was gaining better accessibility to new foreign markets. Daimler AG opened a plant in China in co-operation with a local subsidiary and plans evolved to expand the European production network (Daimler AG, 2017l).

The strategic approach during the crisis paid off. Since 2010, Daimler AG managed continuous growth in all business sectors (Daimler AG, 2017m). In terms of business structure, MBC founded a new division for production and procurement to manage the growing significance of purchasing and supplier management. In 2010, Daimler AG aligned itself with Renault-Nissan. This co-operation includes passenger vehicles and vans (Daimler AG, 2016a:157). New co-operations for trucks and vans assist Daimler AG in pursuing strategies for internationalisation. In order to continue to grow, Daimler AG formulated a long-term strategy, named *Mercedes-Benz 2020*. As original equipment manufacturer (OEM), the goal is to become the number one car manufacturer in the premium segment by 2020 (Daimler AG, 2017n). Part of the strategy is a product diversification in the car segment to access niche markets.

Throughout its history, Daimler AG maintained steady growth. Even during periods of economic crisis, Daimler AG managed to explore alternative routes to remain in business. This reflects the pioneering spirit of the original founders. In times of internationalisation and global growth, Daimler AG started to expand their business operations to foreign countries. In the beginning, production took place in the manner of CKD. In 1952, Daimler AG assembled the first car abroad in the CKD-vehicle plant in Argentina. In the 1950s and 1960s, the OEM added many new assembly plants to the production network. Most plants, however, only assembled cars for Daimler AG for a limited period of time. Figure 4.2 illustrates all CKD-vehicle plants and significant milestones in the history of CKD.

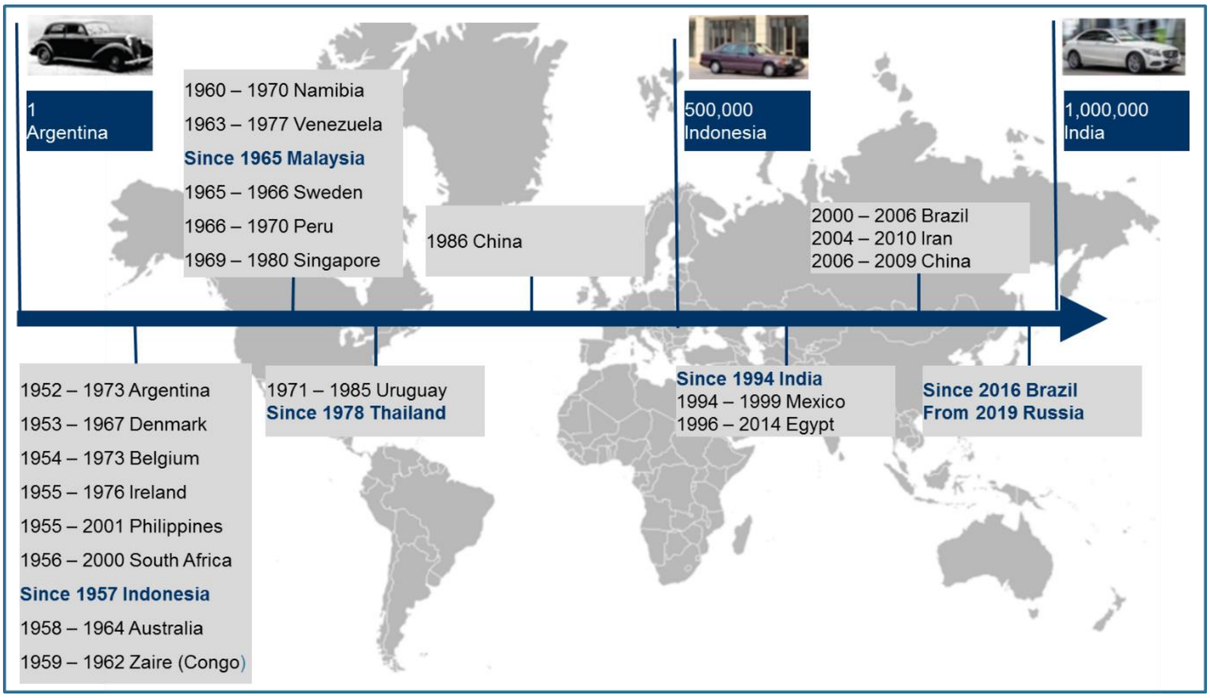


Figure 4.2: The development of CKD-vehicle plants

Adapted from Daimler AG (2016b)

Currently, MBC operates five CKD-vehicle plants in Indonesia, Malaysia, Thailand, India and Brazil. The OEM plans a sixth plant in Russia to start assembly in 2019 (Daimler AG, 2017b). Certain plants, such as South Africa and China, intensified their depth of assembly from CKD-vehicles to completely-built-up (CBU) vehicles. Other assembly plants discontinued their operations. In the 1950s and 1960s, a large number of plants led to a relatively low output of completed cars. By then, the number of CKD-vehicle plants decreased, but total output, however, increased. A trend from many plants with low production output to fewer plants with higher production output emerged (Daimler AG, 2016b).

The production figures of MBC developed with an overall positive trend. Figure 4.3 shows the annual production output for CBU-vehicles and CKD-vehicles from 2009 until 2026. Strategic planning (SP) and operational planning (OP) yield the forecasted units from the year 2018 to 2026. In total, production output has increased over time. In 2009, CBU- and CKD-vehicle's annual production programme combined reached the one million mark despite the global economic crisis. In 2017, eight years later, MBC produced two million cars per year. The forecast for 2021 onwards predicts production outputs close to three million units per year (Fahrzeug-Programm-Online, 2017).

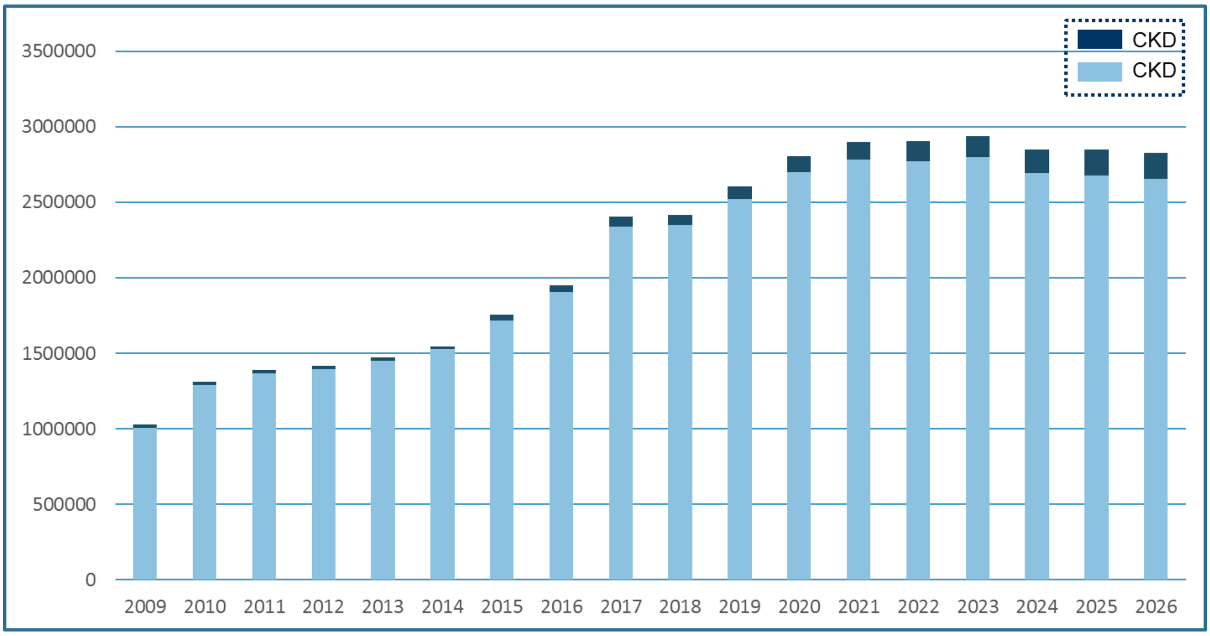


Figure 4.3: Development of vehicle units produced by MBC

(Fahrzeug-Programm-Online, 2017)

When looking at CBU- and CKD-vehicles individually, CBU-vehicles account for the majority of passenger vehicles produced as shown in Figure 4.3. It is, however, noticeable that CKD-units first decrease and then increase disproportionately. This is in line with the total production output for CKD-vehicles. From 2009 until 2012, CKD-vehicle production declined with a low of 1.32% of total production output in 2014. From 2015 onwards, CKD-units increases, as well as total output. On the other hand, CKD-unit output, increased disproportionally to CBU-unit output with 2.15% during the same period. The following years are expected to continue the trend of growth, from 2.65% in 2017 to 6.05% in 2026 (Fahrzeug-Programm-Online, 2017). Table 4-1 summarises the percentage of CKD-units from total output per year.

Table 4-1: CKD-vehicle output

(Fahrzeug-Programm-Online, 2017)

Year	2009	2012	2014	2015	2017	2018	2019	2021	2025	2026
CKD % of total	2.13	1.5	1.32	2.15	2.65	2.89	3.01	4.14	6.00	6.05

The expanding production of CKD-units is a sign that the CKD-vehicle business is gaining significance. This statement is supported by the fact that the ratio of CKD-units to CBU-units is predicted to also increase in the future. MBC's strategy of growth utilises the potential of CKD-vehicle assembly to gain further access to foreign markets and expand business operations there (Daimler AG, 2016b). The benefits of CKD-vehicles, as described in Section 3.3.2, allow MBC to expand business operations despite complicating political and economic situations. From the early days, the founders of Daimler AG excelled through a pioneering spirit combined with the ability to adapt to new circumstances, allowing the company to flourish. Until today, investments in technology and a positioning in the upper premium market forms the basis for Daimler AG's strategy of growth. A goal-oriented supply chain, aligned with the strategy of the company, is the backbone of this plan.

4.3. Key figures

Daimler AG is a multinational holding company divided into five business units: MBC, Daimler Trucks, MBV and Daimler Buses. MBC is a globally known brand. Over 8500 sales outlets are located across the globe, production facilities currently exist in 19 countries. The network expands continuously with new outlets for all business units (Daimler AG, 2016a:92). Figure 4.4 compares different key measurements and summarises selected figures for each business division. The business divisions include passenger vehicles, trucks, vans, buses and the Daimler Financial Services (DFS). The key figures *return on sales* and *unit sales* does not apply to DFS as this is a unit offering services.

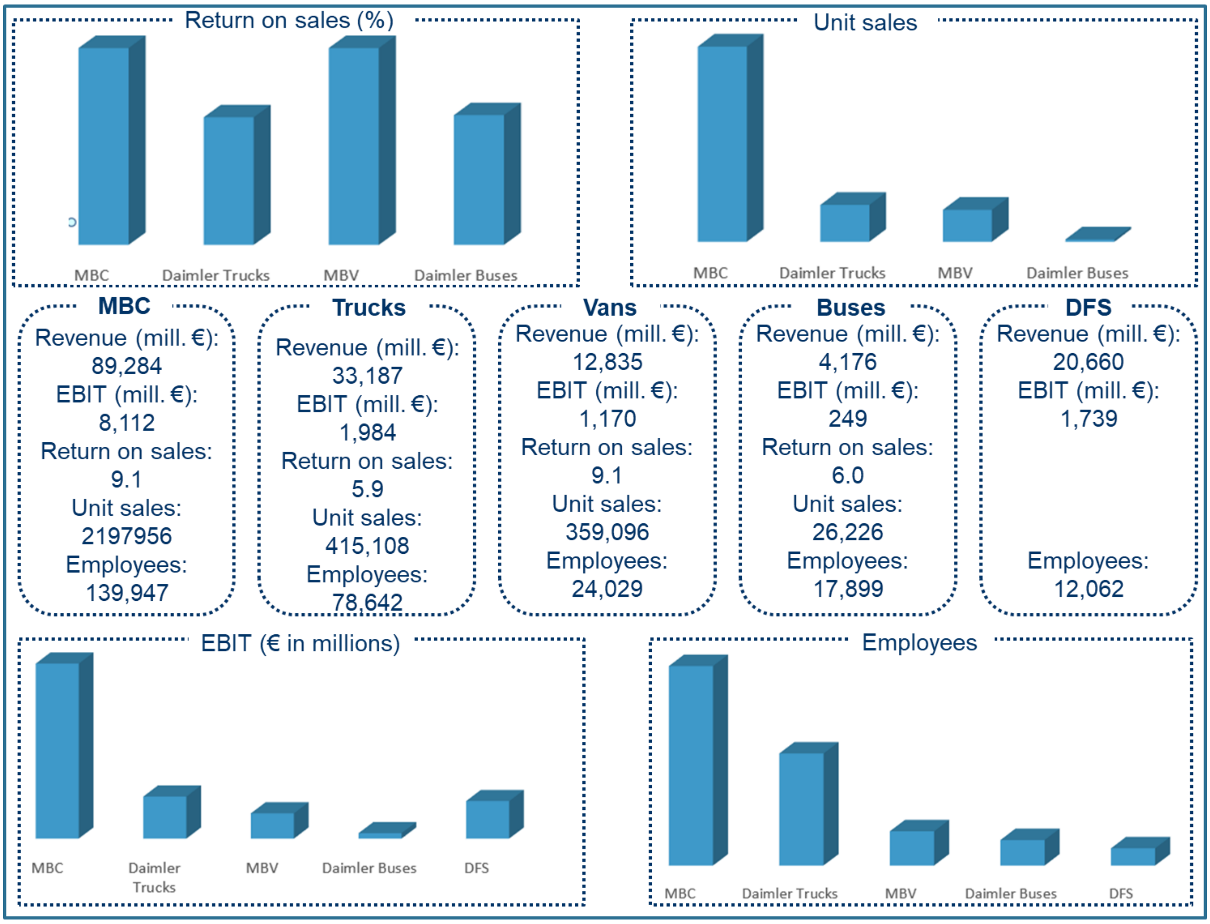


Figure 4.4: Key figures of Daimler AG

Adapted from Daimler AG (2016a:II)

MBC stands out as the most significant business unit with the highest revenue (89,284 million Euros), EBIT (8112 million Euros), return on sales (9.1%), unit sales (2197956) and employees (139947). The other divisions also contribute to the success of the company, covering products with smaller markets. With 9.1%, MBV has a return on sales as high as MBC. Daimler Trucks and Daimler Buses have a slightly lower return on sales, 5.9% and 6.0% respectively, due to the nature of the industries (Daimler AG, 2016a:II). Due to market size, MBC developed a strong position in the company. It also requires a high number of employees and administrative costs to maintain daily operations. Each division of Daimler AG is responsible for several brands and products. Section 4.4 firstly introduces all products and brands of Daimler AG. In the second part, the MBC vehicles are described in more detail.

4.4. Product portfolio

As a globally operating organisation, Daimler AG manages a variety of individual brands and subsidies. The best-known division is MBC. Firstly, this section introduces the complete product portfolio of the holding company. Secondly, a presentation of the individual product lines of MBC provides an overview of all passenger vehicles.

4.4.1. Daimler AG

The corporate group Daimler AG comprises five business units which are briefly introduced in Section 1.1. Each business unit consists of individual brands to cover Daimler AG's broad product line. MBC includes Mercedes-Benz, Maybach, Mercedes me, AMG, smart and EQ. Daimler Trucks manages the brands Mercedes-Benz, Freightliner, Fuso, Western Star, Thomas and Bharat Benz. MBV covers Mercedes-Benz and Freightliner. DFS includes the financing service of the same name, Mercedes-Benz Bank, Daimler Truck Financial, moovel, car2go and my taxi. Figure 4.5 illustrates the product portfolio and the individual business units.

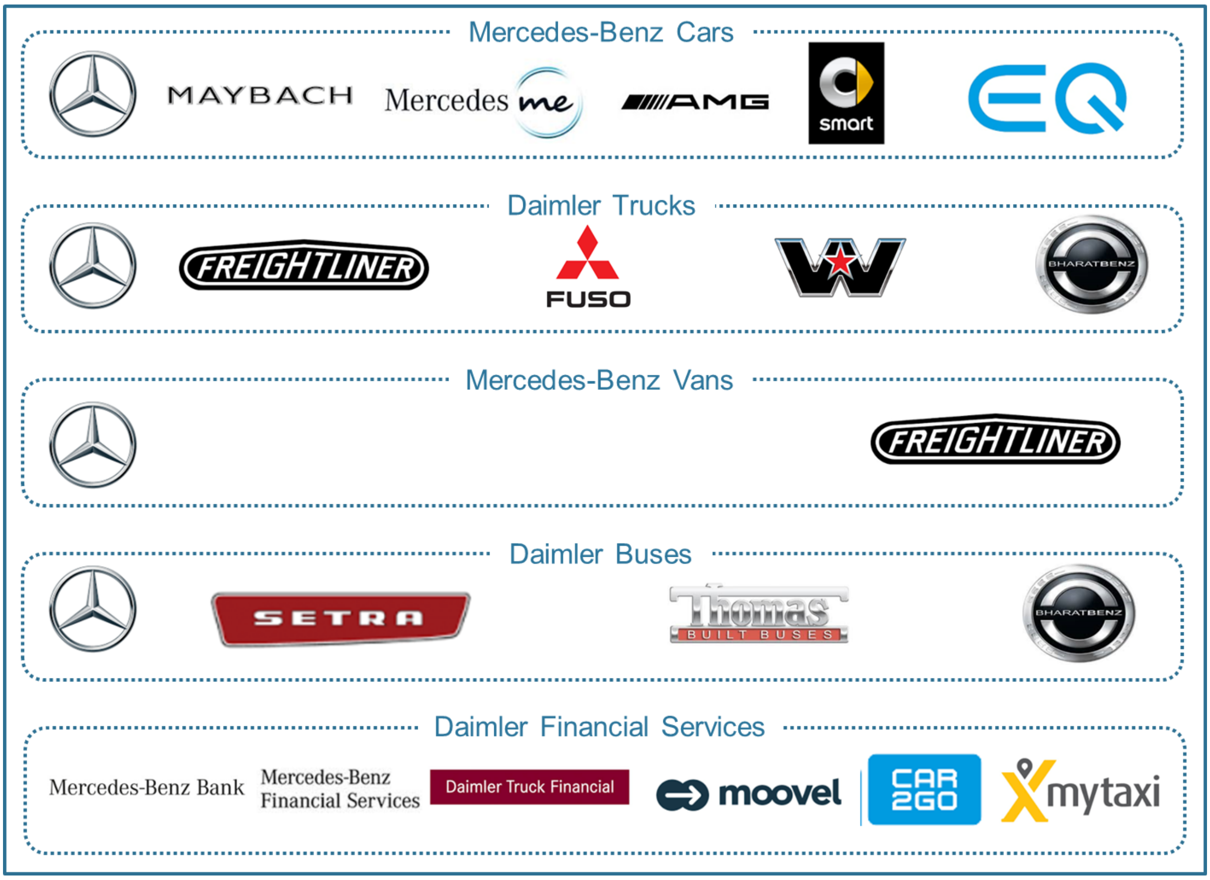


Figure 4.5: The brands of Daimler AG

Adapted from Daimler AG (2017d)

The five different business units operate in various markets and business segments. In total, Daimler AG consists of 23 brands. The brands range from different types of commercial and passenger vehicles to financial services and mobile apps.

MBC offers a wide product range of premium cars, focusing on reducing emissions, safety and connectivity. As this product is the focus of the study, this chapter further discusses the passenger vehicles in the following sections. Other passenger vehicle brands are Mercedes-Maybach, Mercedes AMG and smart. Further, MBC manages the platform Mercedes me which connects a Mercedes vehicle to the owner's smartphone (Daimler AG, 2017d).

Other manufacturing divisions include Daimler Trucks, MBV and Mercedes-Benz Buses. Daimler Trucks manages a number of brands. Some of these brands are specific to a market, such as Western Star for the North American market or Bharat Benz for the Indian market (Daimler AG, 2017d). MBV offers vans for private and commercial uses as well as modified camper vans. Through a co-operation agreement, some models are developed and produced in co-operation with Renault-Nissan. The vans are suitable for short distances as well as long-haul travel for both passengers and goods transportation. Freightliner Vans sells the same models as MBV in the North American market (Daimler AG, 2017d). Mercedes-Benz Buses and coaches offers a product range which includes urban buses, intercity buses, touring coaches, mini buses and chassis for custom-made vehicles. With variations in size and passenger capacity, a common characteristic is the safety and sustainability aspect of the vehicles, offering driver-assistance technology and hybrid engines. Other brands from the bus division are Setra, Thomas Built Buses and Bharat Benz Buses (Daimler AG, 2017d).

DFS offers financing solutions for private and business customers for Daimler AG products in 40 countries. The business unit offers services such as fleet management, financing, leasing and insurance (Daimler AG, 2017p). The division further manages the applications moovel and mytaxi as well as the car rental service car2go (Daimler AG, 2017d).

Throughout Daimler AG's product portfolio, an emphasis on technology, safety and sustainability reflects the strategic direction of the company. This study focuses on the business unit MBC, and more specifically on Mercedes-Benz passenger vehicles. Further, product variety plays an important role in Daimler AG's business environment in order to remain competitive. Where applicable, each business unit developed its own supply chain with mostly independent management and departments. As a result, diversification means additional costs with regard to SCM in order to maintain all supply chains. There are, however, increasing co-operations with other OEMs or within the business units, e.g. common parts for cars and vans.

4.4.2. Mercedes-Benz Cars (MBC)

MBC has constantly diversified their product portfolio from three different models in the 1950's to 18 models in 2017 (Daimler AG, 2015). The diversification of MBC's product portfolio emphasises the need for efficient SCM in order to remain competitive. Available models are the A-, B-, C-, E-, G-, R-, S- and V-Class, CLA, CLS, GLA, GLC, GLE, GLS, SL, SLC, AMG GT and Mercedes-Maybach. The designs of the models are illustrated in Figure 4.6.

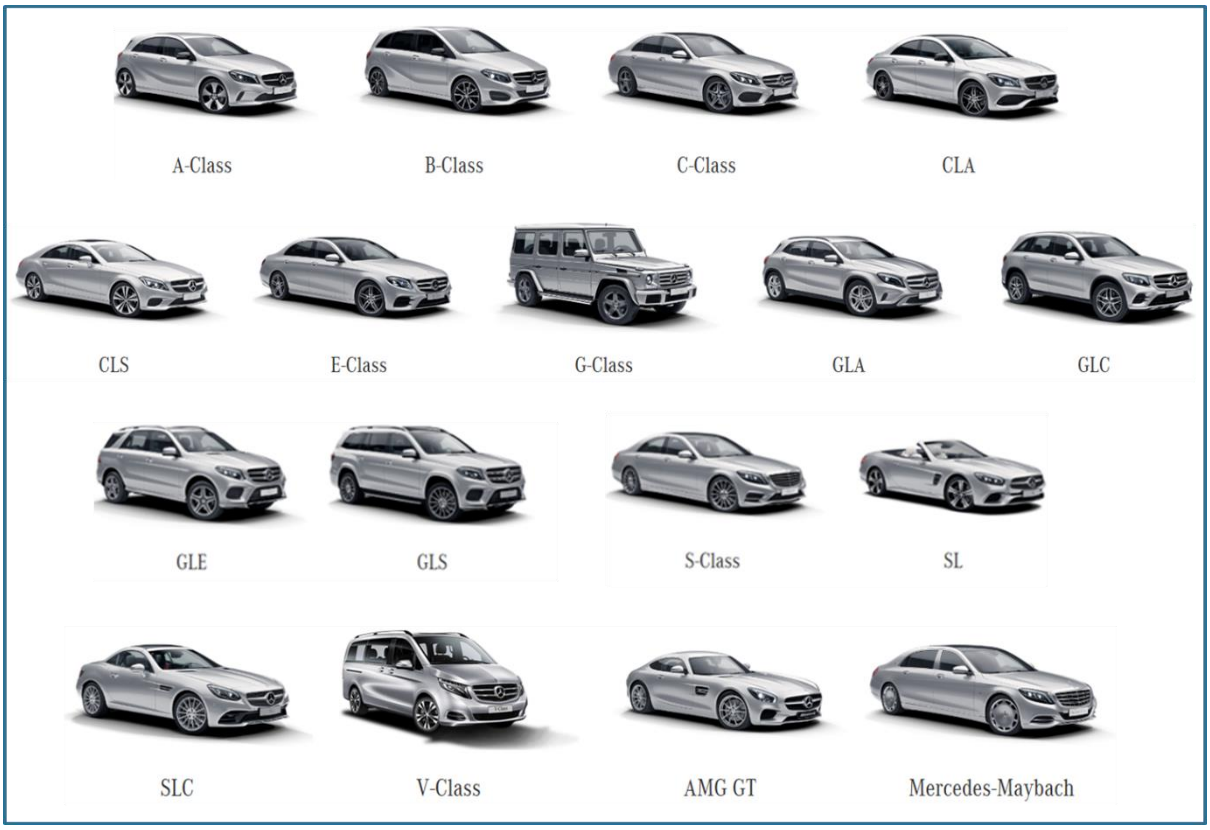


Figure 4.6: Product portfolio of MBC
Adapted from Daimler AG (2016c)

The diversification of the product portfolio is aligned with MBC's strategy of growth. It is MBC's aim to reach out to niche markets in addition to serving the broad market demand. Each model targets a different audience and offers alternative features.

Besides the widely spread standard product portfolio of MBC, the OEM developed and manufactured a variety of customised vehicles, such as several pope mobiles, armoured guard Pullman versions or recently the Mercedes-Maybach G-Class Landaulet limited to 99 models (Daimler AG, 2017q; Mercedes-Benz, 2017a,b). This reflects MBC's motivation to grow and succeed in high premium markets through luxury standards, design and uniqueness. MBC produces a selection of their product portfolio as CKD-vehicles or semi-knocked-down (SKD) vehicles. Table 4-2 summarises all models MBC produces as CKD- and SKD-vehicles, showing the assembly plants and production volumes.

Table 4-2: MBC models assembled as CKD- or SKD-vehices

(SC/WTO2, 2017b)

Model	Main plant	Assembly plants	CKD/SKD
GLA	Bremen (Germany)	Brasil India Thailand	CKD/SKD SKD SKD
C-Class	Bremen (Germany)	Brasil India Indonesia Malaysia Thailand Vietnam	CKD/SKD CKD SKD CKD/SKD CKD CKD
CLA	Rastatt (Germany)	India Indonesia Thailand	SKD SKD SKD
C-Class Coupé	Sindelfingen (Germany)	Thailand	SKD
GLC	Bremen (Germany)	India Indonesia Malaysia Thailand Vietnam	CKD SKD SKD SKD CKD
E-Class	Sindelfingen (Germany)	India Indonesia Malaysia Thailand Vietnam	CKD SKD CKD CKD CKD
GLE	Kecskemét (Hungary)	India Indonesia Thailand	SKD SKD SKD
S-Class	Sindelfingen (Germany)	India Indonesia Malaysia Thailand Vietnam	CKD/SKD SKD SKD CKD CKD
GLS	Tuscaloosa (US)	China/BAIC India Indonesia	CKD SKD SKD

The OEM produces GLA, C-Class, CLA, C-Class Coupé, GLC, E-Class, GLE, S-Class and GLS as CKD- and SKD-vehicles as shown in Table 4-2. The main production plants for CKD-/SKD-kits are located in Sindelfingen, Rastatt and Bremen in Germany. Other production plants that supply CKD-/SKD-kits are located in Kecskemét in Hungary and in Tuscaloosa in the United States. Based on a complex production schedule, MBC produces cars in different plants (SC/WTO2, 2017b).

4.5. Company structure

The organisational structure of a company plays a significant role in understanding how the business works. Due to the size and complexity of Daimler AG's organisational structure, the focus is aligned only with the scope of the study. Therefore, this section focuses on the departments in charge of demand and capacity planning.

Dr. Dieter Zetsche is the head of MBC and a member of the management board. Below the executive board, MBC divides its organisational structure into divisions, sectors, centres and departments and teams. Figure 4.7 illustrates the hierarchical structure at MBC.

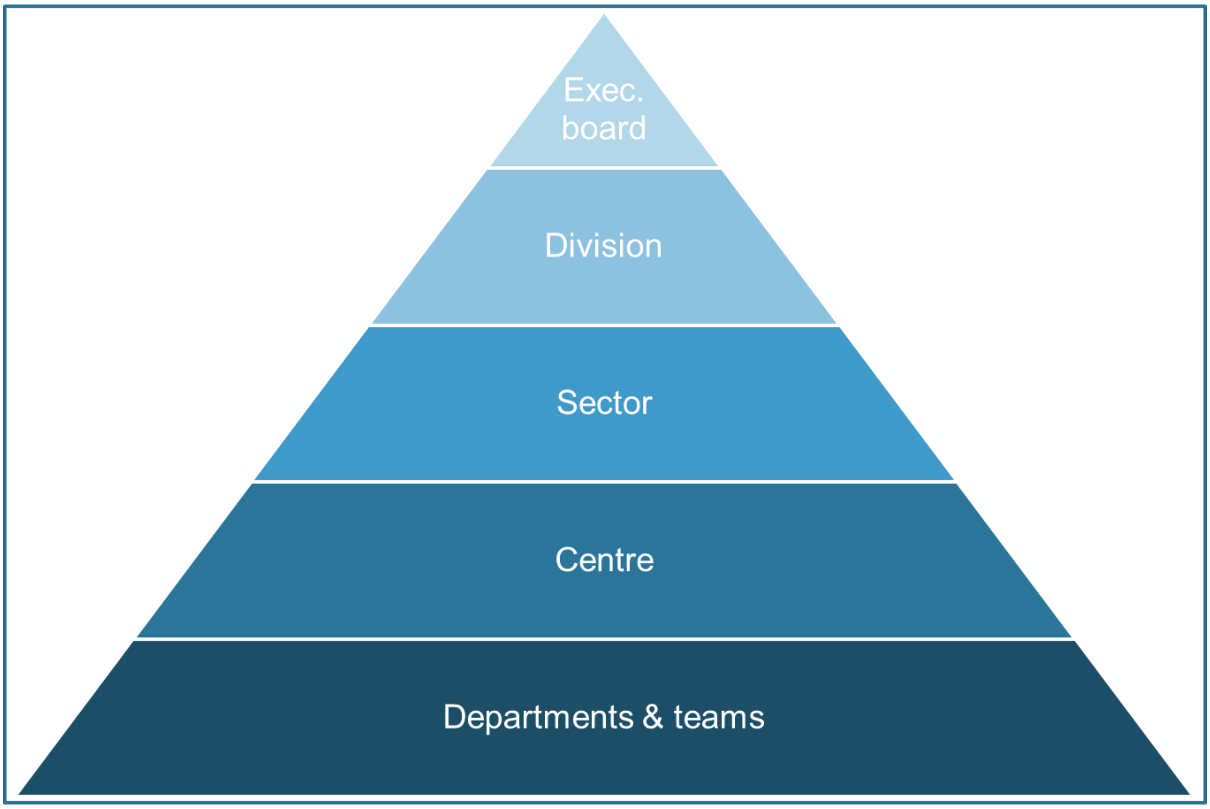


Figure 4.7: Hierarchical structure at MBC

(Daimler AG, 2017r)

The level directly below the executive board, where the divisions are located, addresses SCM, amongst other functions. The *MBC Production & supply chain management* division and *MBC Purchasing & supplier quality* division deal with supplier management as a main component. The *MBC Purchasing & supplier quality* division has to do with immediate supplier management which is not the focus of this study. The *MBC Production & supply chain* *management* division is further divided into the *Supply chain management (SC)* sector and the *Production planning MBC* sector. Other sectors at the same level deal with sales, production planning, technology development, quality management or strategic development and controlling. The next tier describes the different centres which are part of the sectors. The sector *SC* is one of the entities in charge of SCM at this level.

The next level contains the centres. Two relevant centres in *SC* are *Global transport logistics car, truck, van & bus* centre and *Programme capacity planning & methods* centre. *Programme capacity planning & methods* centre is further divided into the *Demand & capacity planning* department, *Project management* department and *Supply chain standards & methods* department. The *Demand & capacity planning* department is divided into teams, each team focuses on demand and capacity planning for a specific car model or a set of models. The department *Project management* steers strategic projects to improve current processes and methods in the field of demand and capacity planning. The *Supply chain standards & methods* team administers approaches for the whole supply chain from end-to-end (Daimler AG, 2017r). Figure 4.8 contains an organisation chart of entities involved in tasks relevant to the topic of this study. The figure omits other business units for reasons of better understanding and clarity.

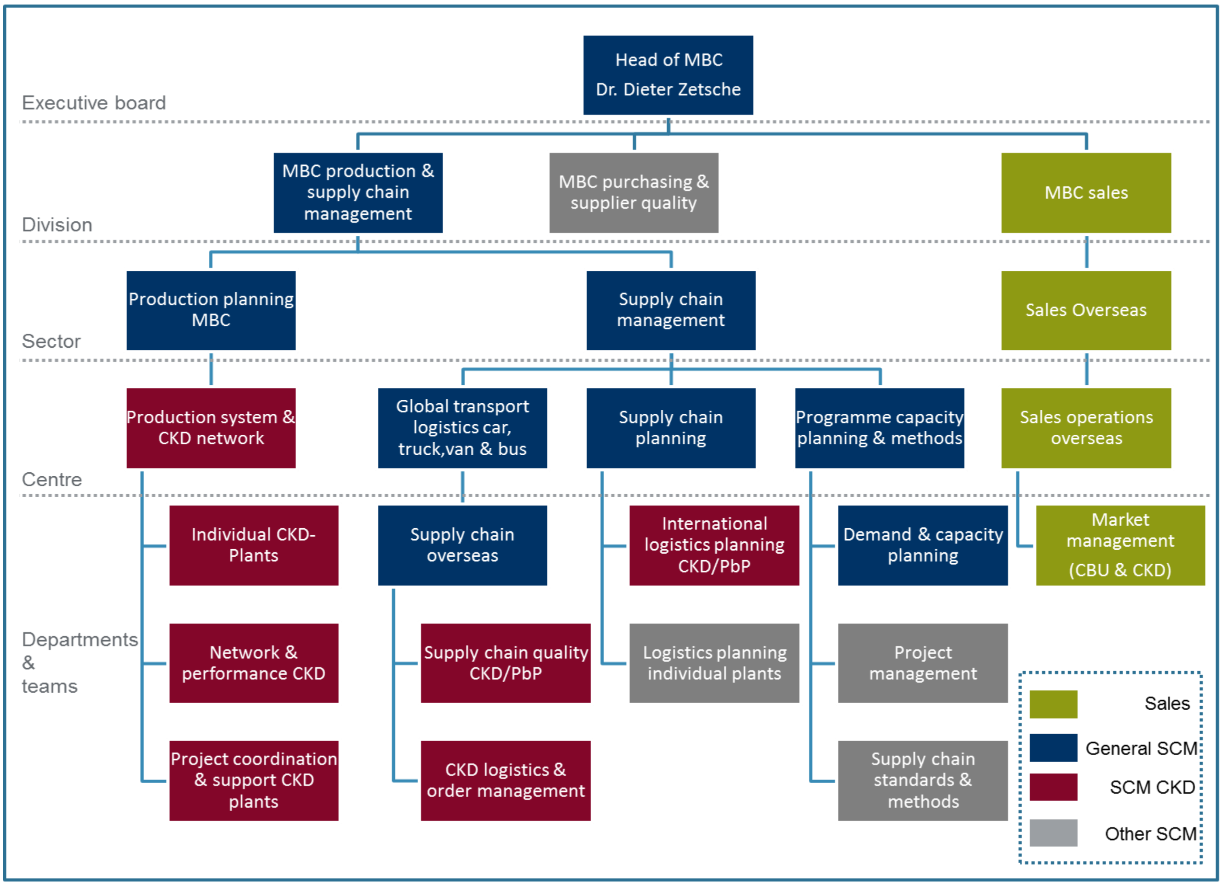


Figure 4.8: Organisation chart Daimler AG

Adapted from Daimler AG (2017r)

While the majority of the tasks in these departments orchestrates the CBU-vehicle business, with CKD-vehicle activities on the side, there are specific departments and teams for the different aspects of CKD-vehicle SCM. The *Production planning MBC* sector is responsible for the management of CKD-vehicle assembly plants. The sector constitutes management of all plants producing MBC cars, both CBU- and CKD-vehicles. The *Production system & CKD-network* centre comprises the departments managing the individual CKD-vehicle plants, a department for *CKD-network & performance* and the *Project coordination & support CKD-plants* department. The management of the individual CKD-vehicle assembly plants is located in a decentralised manner in the country where the plant is located. The area of work of the *CKD-network & performance* department includes performance management, measurements with key performance indicators (KPIs) and strategic network development. The third department, the *Vehicle documentation & local content* department, manages the special equipment (SA) parts for CKD-vehicles as well as local content.

The *Global transport logistics car, truck, van & bus* centre manages all other logistics and SCM activities, more specifically the department *Supply chain overseas*. The *Supply chain quality CKD* team deals with claim management in the consolidation centre (CC) and CKD-vehicle plants. The *CKD logistics & order management* team plays a key role in demand and capacity planning. The tasks of the team consist of order management, shipping and production planning, as well as commercial handling of orders. Strategic planning for CKD-vehicles falls under a third centre in the sector of SC, namely *International logistics planning CKD/PbP* department. In this department, strategic logistics planning is combined for all CKD- and part-by-part (PbP) assembly plants abroad. The same centre manages further departments, each in charge of individual plants, both existing and future ones (Daimler AG, 2017r).

Besides the divisions managing production and purchasing, the *MBC sales* division also exists. Demand and capacity management at MBC relies strongly on information generated by departments integrated in *MBC sales*. For CKD-vehicles, the *Market management (CKD & CBU)* department analyses CKD-vehicle demand for these specific markets. The department is incorporated in the *Sales operations overseas* centre in the *Sales overseas* sector (Daimler AG, 2017r).

The *SC* sector covers most units for demand and capacity planning as well as CKD-organisations. There is, however, a strong link between SCM for CKD-vehicles and production planning. Certain tasks, which fall under the broader field of SCM and logistics, take place in this sector for production planning. The units have been divided according to plants, which leads to many CKD-vehicle-related processes being designed and maintained in a different centre. *MBC sales* functions as a source of information for demand and capacity planning for both CKD- and CBU-vehicles. The *Demand and capacity planning* department is in charge of both CBU- and CKD-vehicles. There is, however, insufficient linkage and communication between the departments specifically designed for CKD-vehicle management and *Demand and capacity planning*. The coordination of operations of all departments involved in demand and capacity planning requires a corporate strategy, mission and vision. The business and supply chain strategy, mission and vision of MBC is discussed in Section 4.6.

4.6. Business and supply chain strategy

A clearly defined vision statement, mission statement and strategy guide a company's operations (Chopra & Meindl, 2007:22; Snowdon, 2008:3). Section 2.6.1 deals with the role of these guiding principles in more detail. Daimler AG does not have an overarching vision for all business divisions. Instead, each division follows individually tailored guiding principles. It is MBC's vision to be the *most successful premium manufacturer* (Daimler AG, 2017s:23). MBC's mission includes the aspects of safety and sustainability. It is described as *shaping the future of mobility in a safe and sustainable manner.*

While MBC have designed both vision and mission statement in a broad manner, the strategy *Mercedes-Benz 2020* specifically names four focus areas of strategic development, broken down into the individual business units. The strategy is divided into strengthening core business, global growth, leading technology and pushing digitisation. The strategy behind a stronger core business is summarised in the acronym CASE, which represents the development areas of connectivity, autonomous driving, shared services and electric driving systems. MBC's strategy to enhance global growth entails the expansion of production and development facilities all over the world, with a market focused on developing countries such as China, India and Brazil. In order to become a leader in technology, MBC focuses on alternative and sustainable battery-powered vehicles. The OEM recently introduced EQ, a new brand for electric mobility vehicles. Lastly, Daimler AG sees digitisation as an opportunity to bring connectivity to their passenger vehicles. The digital platform *Mercedes me connect* allows drivers of a vehicle to access selected functions through their mobile device (Daimler AG, 2016a:84-88).

The *SC* sector developed a vision, mission and strategy on a more operational level. It is the sector's vision to *run world-class supply management*. The vision is focused on supply management rather than SCM. The sector's mission emphasises the link between sales and, as a result thereof, the significance of sales and operations planning (S&OP). It is the sector's mission to ensure that "*every car can be built in time to be sold by the sales department"* (MO/SC, 2016:3).

In terms of supply chain strategy, the *SC* sector focuses on three key areas: Firstly, the strategy targets cost, quality and reliability. *SC* follows a strategy of cost optimisation, both preventive and reactive. Costs considered are total landed costs, including costs for freight, in- and outbound logistics, administration costs as well as costs for intra logistics and logistics service providers. The aspects of quality and reliability focus on safeguarding production requirements, reducing lead times and avoiding damages from transport. The second focus area entails end-to-end responsibility, indicating a holistic and proactive approach to SCM. Lastly, *SC* aspires to reach high fulfilment rates of the production programme. This point includes transparent production capacity and supplier demand planning, clarity on planned and additional capacity flexibilities of the production plans, and a stable production programme (MO/SC, 2016:3-4). Figure 4.9 delineates the strategic pyramid of MBC and the *SC* sector.

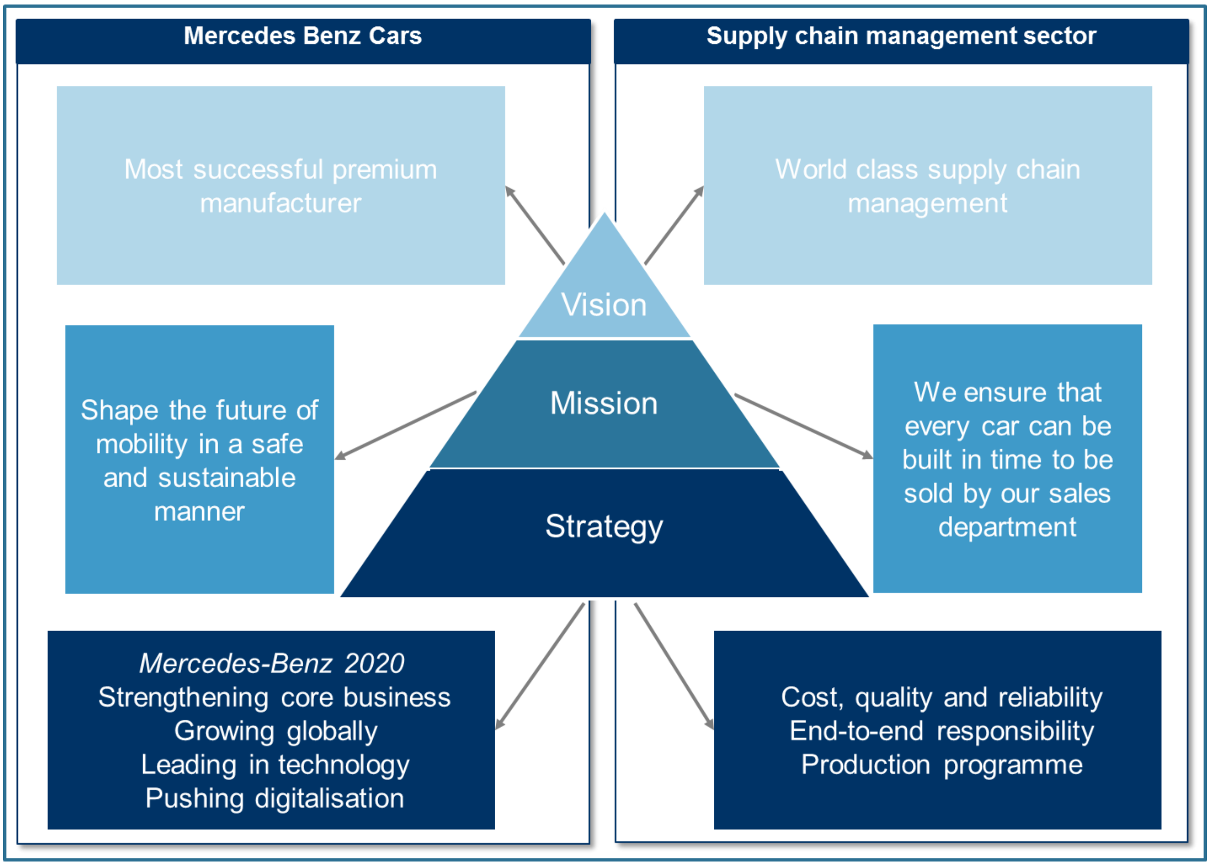


Figure 4.9: The strategic pyramid comparing guiding principles of MBC and *SC*

The pyramid in Figure 4.9 shows that Daimler AG implemented a vision, mission and strategy on business unit level and the strategy on the operational level of *SC*. Moreover, alignment of the vision of MBC and *SC* shows consistency. Vision and strategy, however, lack in complete alignment. All three guiding principles are linked to the product portfolio. The existing business units apply highly developed technology and digitisation to further develop their unique selling proposition further. Increasing numbers of models strengthen the core business and serve niche markets. The creation of different brands for specific high potential markets, such as

India or North America, allow the company to grow globally. On the centre level, an emphasis is put on the aspect of cost-efficient reliability. The mission of *SC* resembles the aspect of S&OP. Section 4.7 explains S&OP at MBC with a focus on demand and capacity planning.

4.7. Sales and operations planning (S&OP)

As describes in Section 2.4, S&OP plays a significant role in the performance of a supply chain. In line with the theoretical approach, this section provides insight into S&OP practices at MBC. This section provides information on tasks and responsibilities of *SC*, key processes, definitions of material planning, planning horizons and the difference between plant and supplier capacities. In order to ensure a complete understanding, the functions of other departments involved are also addressed in this section. The focus of this study, however, is on demand and capacity planning in the *SC*.

4.7.1. Demand and capacity planning at MBC

Demand planning determines the input data for programme management, as well as demand and capacity planning. In a Y-model, two legs determine the planned demand figures: *Market demand*, the so-called “model mix”, and *customer orders*, the so-called “equipment mix”. A process called *sales and programme planning* determines market demand by defining demand for sales models for each market. The second leg describes the *order development process*. This process defines standard and SA take-rates for all models. The order fulfilment process combines the demand developed in both processes in order to develop a production programme and to build the cars to satisfy market demand. Figure 4.10 illustrates the Y-model for order management at MBC.

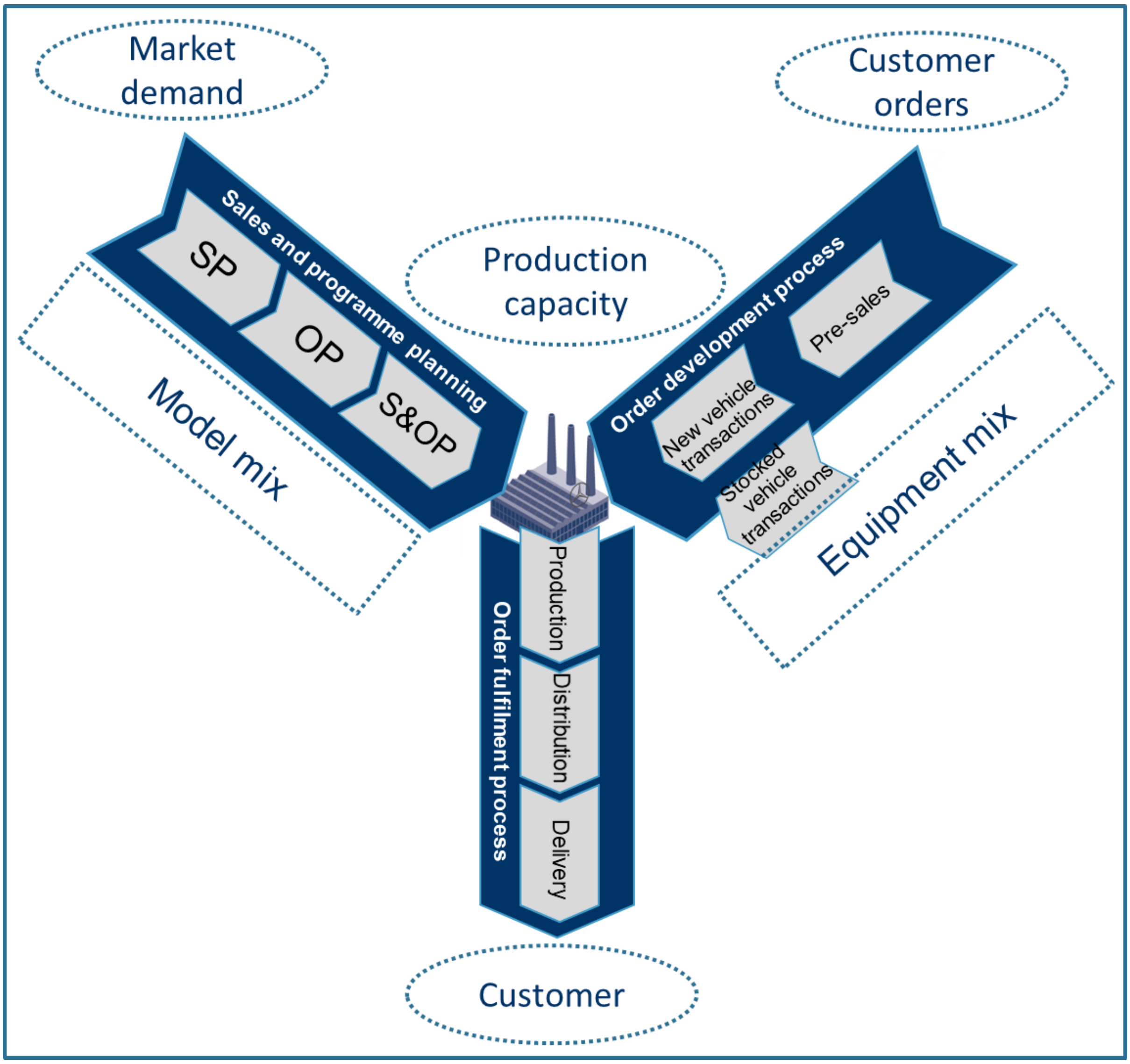


Figure 4.10: The Y-model for order management at MBC

Adapted from Daimler Protics (2017:18)

The structure of the Y-model is the same for CBU- and CKD-vehicles. The significance of model mix in relation to equipment mix, two individual processes, certain planning horizons and procedures differ significantly between the two. The planning processes for CBU- and CKD-vehicles is explained in detail in Sections 4.7.1.1 and 4.7.1.2.

The order development process facilitates the equipment mix at MBC. It is divided into three components: *Pre-sales*, *new vehicle transactions* and *stocked vehicle transactions*. These processes develop SA take-rates. At a later stage, these take-rates are integrated into the production planning process. Besides the existing serial number, pre-sales assigns a code to each part in a vehicle, develops equipment packages and lays the foundation for standard and SA in all car models. Influencing factors are market analyses, information on competitors, information required from development centres, usage- and trend development, feasibility, price-value analyses and customer behaviour. Depending on the vehicle model and market, pre-sales can declare a part as standard or SA or even omitted. There is no universal equipment mix applicable for all cars and markets. For each vehicle's lifecycle, the order development process defines the equipment mix with a time-span orientated at the SP (Daimler Protics, 2017:18).

Within the current year of production, customers and dealerships submit real orders. In selected countries, customers can do so directly through the website or acquire assistance from a dealership. Besides these new vehicle transactions, dealerships also order cars for stock. It is also possible for MBC to produce to stock. Most of the vehicles are, however, built-to-order (BTO) as explained in Section 3.3.3. Depending on the market, the ratio of orders from direct customers and orders through dealerships differs, as well as the ratio of orders for sale or stock placed by dealerships. Even though MBC works with real orders now, it is still possible for a customer or dealership to modify the configuration of a car until the so-called frozen-zone where no changes are possible anymore. Only within the timespan of the frozen zone, SA take-rates are fixed. Therefore, it is of importance that the take-rate forecasts are of a high quality. While the order development process focuses on the planning of take-rates and equipment, the model mix plans the primary demand for cars (Daimler Protics, 2017:18; PBK, 2017:19).

The model mix on the left of Figure 4.10 consists of planned orders based on a complex forecasting system. It entails the planned sales volumes for each car model per year. Components of the model mix are SP, OP, and short-term planning in the form of S&OP. SP, OP and short-term planning is applicable to both CKD- and CBU-vehicles. SP, OP and short-term planning focus on different time horizons.

The shorter the planned time period, the more accurate and detailed the forecast. SP describes the forecasts for the following ten years. The production programme is displayed in vehicles per year based on class type (TKL) for each plant. This means that the produced volumes are divided between all TKLs, showing the individual production programme for each TKL. The production of some models takes place in several plants. In such cases, the production volume for one TKL is divided between all plants where the model is produced. Once a year, MBC publishes the SP. The SP updates the production programme for the years nine to one and adds the tenth year to the forecast. The TKL only contains information on the vehicle model and body shape, e.g. that the vehicle is a C-Class Coupé. Further details are added at a later stage in the OP and short-term planning (Daimler Protics, 2017:23-24).

The OP covers a timespan of two years: The following year and the year thereafter. Similar to the SP, the current year is not included. The main differences between SP and OP are granularity and the degree of detail of the content. The production programme is shown on a monthly basis, categorised in TKL and type of construction (BM). Once a year, MBC publishes the OP in alignment with the SP, updating the predicted volumes for year one, with the addition of year two. Compared to SP, OP includes the type of engine of a vehicle and steering mode. The planning level increases from TKL to BM. It is now determined that the example car is a left-hand drive C-Class Coupé, equipped with an AMG petrol engine. The forecast of all other specifications takes place in the short-term planning (Daimler Protics, 2017:23-24).

The short-term planning consists of a number of planning tools and processes. Besides TKL programme and BM forecast, short-term planning includes sales data used for material forecast (GOP) and SA take-rates. At this stage, an integration of forecasted vehicles from the model mix and actual orders from the equipment mix commences. The GOP supplies the equipment mix with the production programme. A multiplication of take-rates, shown in percentages, together with the production volume reveal the total number of parts for each SA. This task is described as material forecast (TBE), which serves as the conversion of primary demand to secondary demand (Daimler Protics, 2017:32). Table 4-3 summarises the different time horizons of programme planning including information about timespan, planning granularity and content.

Table 4-3: Planning horizons at MBC

(Daimler Protics, 2017:23-24)

Name	Time frame	Granularity	Content	Frequency	Example
SP	Ten years: following year (year 1) plus nine years	Vehicle per year	TKL programme per plant	Once a year	C-Class Coupé
OP	Two years: following year (year 1) and subsequent year (year 2)	Vehicles per month	TKL programme per plant and BM forecast	Once a year	Plus left-hand drive, AMG petrol engine
Short-term planning (S&OP)	Two years: Current year (year 0) and following year (year 1)	Vehicles per week	TKL and BM, GOP, SA take rates	12-24 times a year	Plus SA, fully configured car

The GOP summarises the demand for all parts to build the vehicle for a period of nine months with updates occurring twice a month. In addition to future orders, GOP contains actual production figures from the past month as a point of reference. With this level of accuracy, it is possible to display the production volumes in vehicles per week for the first four months. After that, the granularity reduces to vehicles per month (Daimler Protics, 2017:31). Figure 4.11 shows the composition of GOP.

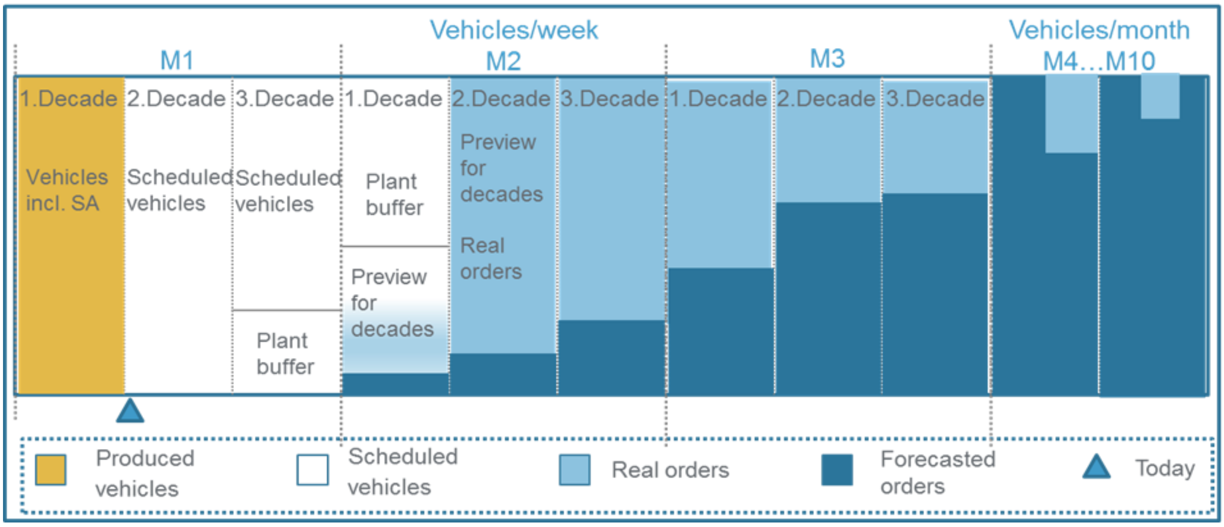


Figure 4.11: Composition of GOP

Adapted from Daimler Protics (2017:31)

The planning horizon of MBC of the next ten months consists of past production output, real orders and forecasted orders. Twice a month, an update of the production programme is published. This means that short-term planning is a continuous planning tool with updates 24 times a year. Each month (M) is divided into three decades as shown in Figure 4.11. The first decade shows production volume for produced cars from the previous decade. The following three decades consist of *scheduled vehicles*, a *plant buffer* and a *preview for decades*. After that, GOP is composed of *forecasted* and *real orders*. The further in the future the production start is, the more planned orders and the less real orders are included in the short-term planning (Daimler Protics, 2017:31). At this stage, the description of the example vehicle has developed into a white, left-hand drive C-Class Coupé, AMG petrol engine, with red seats and many other additional features.

It is the ultimate goal of demand and capacity planning at MBC to ensure an effective order fulfilment process, consisting of production, distribution and delivery. While the processes of demand and capacity planning have a significant impact on distribution and delivery of finished vehicles, *SC* and *Demand and capacity planning* do not directly contribute to these activities. *SC*'s involvement is not until the production phase, where safeguarding supplier capacities is crucial, especially for just-in-time or just-in-sequence suppliers. The task of *SC* to align market demand and capacity supply of capacity forms the basis to steer the production programme as planned and deliver the vehicle to the customer on time. While the ultimate goal of demand and capacity planning is the same for CBU- and CKD-vehicles, individual planning processes differ between the two models. The next two Sections, 4.7.1.1 and 4.7.1.2, further illustrate the specifications for CBU-vehicles and CKD-vehicles.

4.7.1.1. Specifications for CBU-vehicles

MBC views the processes, methods and approaches for CBU-vehicles as standard procedure. This section only describes processes that MBC specifically designed for CBU-vehicles. While the previous Section 4.7.1 introduced standard processes for demand and capacity planning, this section focuses on processes significantly different for CBU- vehicles in comparison to CKD-vehicles.

One of MBC's unique selling points is high order flexibility between different configurations. For the previous C-Class model, a customer could choose between 1.6 x 10^{103} different configurations (Daimler Protics, 2017:31). MBC uses codes to manage the equipment of a car. Each equipment item consists of a number of individual components. Codes describe these components, which means that an equipment item can be described by a number of codes. The rules that manage these combinations are called *code regulations* (CoRe). Before real orders take place, the sales department decides which codes are required for which equipment packages. SA-forecasts determine the percentage of one code that will be required for a vehicle. These forecasts depend on the vehicle's model and country of destination. Depending on the country and vehicle, MBC also uses CoRe to manage constraints. CoRe are applied over three different time horizons from the beginning of a lifecycle during ramp-up, throughout the lifecycle, or for limited shortfalls in between (SC/KP, 2015:1). There are different reasons for MBC to make use of these capacity constraints:

- A limitation of MBC's production capacities,
- restrictions in the production capacities, e.g. only 50% sunroofs,
- a limitation of internal supplies, such as powertrain or engine, or
- a limitation of supplier capacities.

Furthermore, CoRe describe a tool to manage demand and capacity management with the advantage of preventively managing constraints and avoid shortfalls. Contrary to this, CoRe can lead to lost sales if specific equipment or packages are not available. MBC also uses CoRe to limit the amount of work-intensive or low-profit components. In addition, MBC regulates the production programme scheduling. The programme scheduling restrictions (EPV) in terms of production order and limitations of SA or BM allow for a smooth production flow. *Demand and capacity planning* uses CoRe and EPV as a means to measure performance (SC/KP, 2017a). More information on CoRe and EPV as metrics can be found in Section 7.5.2. In addition to the standard practices, MBC follows a number of procedures specific for CKD-vehicles. These specifications are further elaborated on in Section 4.7.1.2.

4.7.1.2. Specifications for CKD-vehicles

Many processes, methods and approaches for CKD-vehicles differ from the operations for CBU-vehicles. This section illustrates the specifications for CKD-vehicles in terms of planning tools, SA, flow of information and goods, information systems and demand and capacity management. In certain instances, additional process steps for CKD-vehicles precede the standard processes. Other processes or steps of a process replace an equivalent from the CBU-world.

While SP and OP are identical for CBU- and CKD-vehicles, the processes involved in short-term planning differ. Preceding planning processes to steer CKD-unit output supply the overarching short-term planning with data input. For the current year and the following year of production, two tools in the form of complex Microsoft Excel sheets plan the quantity of vehicles produced. These tools are the annual programme planning (JPP) and the monthly programme planning (MPP) (SC/WTO2, 2017b:10-11). The JPP covers the planning horizon of the following production year. Divided in several sections, the JPP shows

- explanations regarding volume changes, plant specifications and other elaborations;
- the monthly CKD-volume for each construction type and assembly plant in total numbers and as a percentage of the production programme;
- which vehicles are shipped as CKD- or SKD-vehicles;
- the changes from the previous JPP version to the current version;
- the total capacity of the production plant in Germany/Hungary/United States; and
- the estimated number of containers needed for each BM and country (SC/WTO2, 2017b:10).

Updates of programme planning take place once a month. GOP derives all CKD-units from the JPP. Besides that, the JPP provides the basis for demand and capacity management. Based on the forecasted values, plants construct their production programme. An equal distribution of CKD- and SKD-vehicles has several benefits. The batch-size of six or 24, depending on the model, is high in comparison to a batch-size of one vehicle for CBU-vehicles. Therefore, an unequal planning of CKD- or SKD-vehicles influences the scheduling of CBU-vehicles. The assembly line for CBU-vehicles requires constant supply of parts and body shells. Too many CKD- or SKD-vehicles can lead to parts not being available in time or extended waiting periods due to delayed body shells. The estimated number of containers provides insights into how many shipping runs should be required. This is, however, only a vague estimate. The logistics service provider (3PL) is in charge of container and shipping planning (SC/WTO2, 2017a:10). Addendum B shows an example of a JPP draft.

Planned three months in advance, the MPP covers a period of one month. It shows the following attributes:

- The distribution of CKD-volumes for each foreign assembly plant and construction type for every day. The foreign assembly plant requests specific volumes for each week. Based on these requests, a backward calculation takes place. This calculation considers shipping time, both for truck and ship, as well as lead time. An allocation to a date that matches with the production programme of the production plant takes place.
- The latest possible truck departure, calculated backwards from the shipping dates. For each of the five ships, a specific date is set by when the truck has to depart. The date depends on the departure of the ship as well as the lead time, which is seven working days (WD) for Germany and 10 WD for the United States.
  - The shipping dates. There are four to five ships, depending on the number of WD per month. The shipping dates are used as a starting point to calculate when packing takes place (SC/WTO2, 2017a:11).

A programme planner distributes the CKD-volumes as equally as possible, considering shipment dates and body works for SKD-vehicles (SC/WTO2, 2017c). It is the MPP's function to link packing dates to the production of the mother plant, especially in case of SKD-vehicles. The ships allocated to the assembly plants abroad are scheduled for set days.

Figure 4.12 shows the planning activities for CKD-vehicles within the short-term timeframe of short-term planning. The illustration focuses on the last three months before shipping date. The preparation of JPP takes place 12 to three months before shipping. Two months before packing month, the BM is fixed. This lays the foundation to prepare the MPP in month two before the packing month. The order input begins shortly after the programme planner finalises the MPP. 25 WD before packing month, the order planning determines the equipment and packages available. Codes, which define the equipment and SA in each vehicle, are set at that stage. Now that the volume of cars and parts specifications are determined, the planning of packing can begin. This CC is only applicable to CKD-vehicles. 12 WD before the beginning of packing month, the (CC) sets out the range of parts for packing. Four days later, eight days before packing month, the CC defines the packing lists. The packing lists determine packing order, lot size and the type of packaging. During packing month, the CC packs the individual parts in specific lots. Before the shipping takes place, the lots are loaded in containers. For CKD-vehicles, the packing date is the equivalent of the production date for CBU-vehicles. MBC steers all their activities towards that date. After packing and shipping, it is the foreign assembly plant's responsibility. The International commerce term (Incoterm) used for shipping of CKD-vehicles is Free On Board (FOB) (SC/WTO2, 2017a:8). Further information on Incoterms can be found in Section 3.3.1. In this sense, the assembly plant can be viewed as a customer of MBC. Figure 4.12 illustrates a timeline for CKD-vehicle planning.

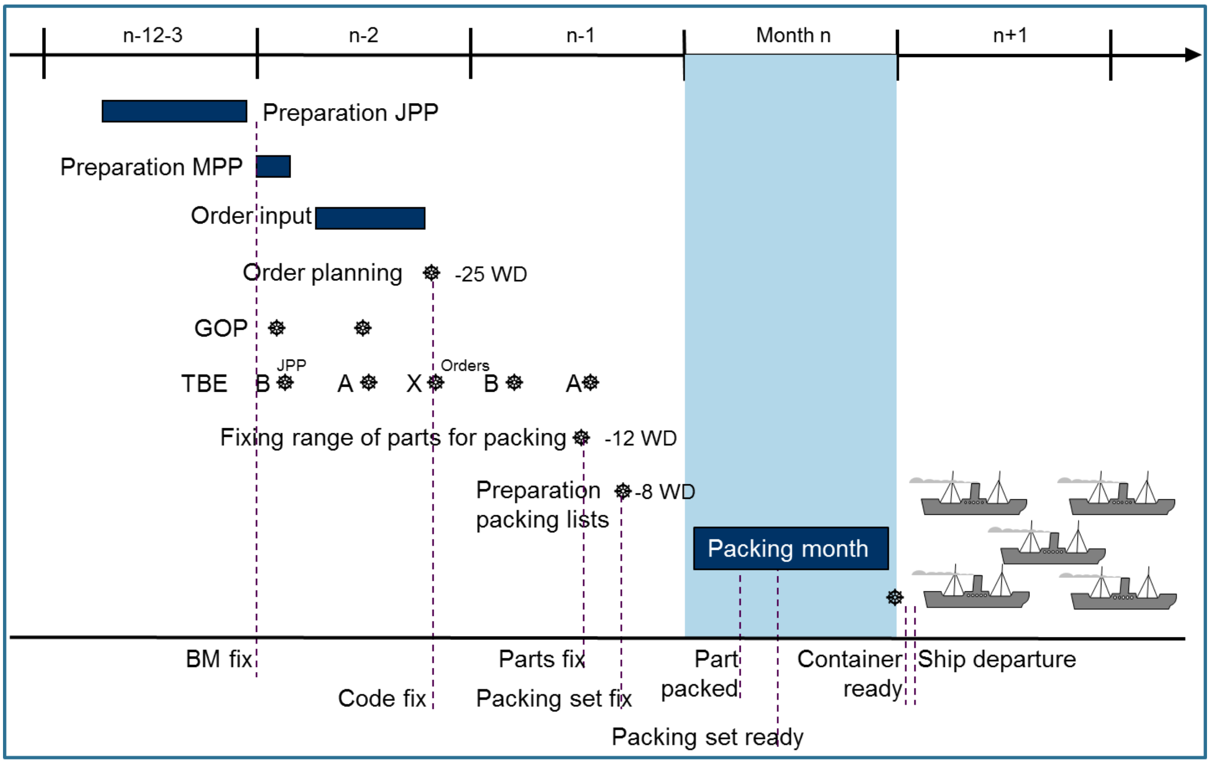


Figure 4.12: Timeline for CKD-vehicle planning

Adapted from SC/WTO2 (2017a:8)

Figure 4.12 shows that significant aspects of the programme planning take place shortly before packing starts. Besides the information flow, the supply chain for CKD-vehicles also differs from CBU-vehicles. The majority of suppliers of CKD-vehicle parts also deliver parts for CBU-vehicles, with certain limitations excluded. For local content parts, the suppliers follow a CKD-vehicle procedure for all modules. The supplier packs the individual parts of a module and sends them to an assembly facility in the country of destination, the supplier's local assembly partner forwards the finished modules to MBC's assembly plant. For all other international parts, a CC manages goods receiving and storage. From the CC, the parts are forwarded to a 3PL in charge of packing for overseas delivery. Close co-operation with the 3PL assures alignment with the production programme which determines the packing dates. The 3PL forwards all packed car parts, as well as the shell construction of a car, to the shipping company for shipping to the foreign CKD-vehicle assembly plant (SC/WTO2, 2017a:8). Figure 4.13 shows the supply chain of CKD-vehicles.

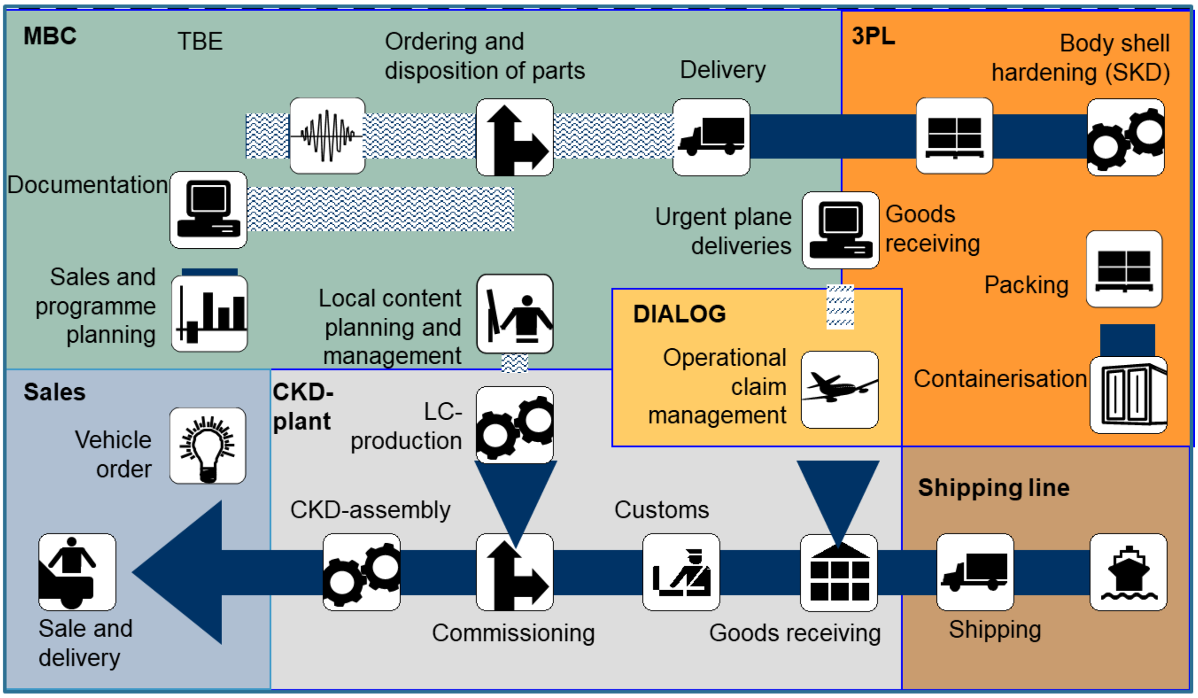


Figure 4.13: Supply chain of CKD-vehicles

Adapted from SC/WTO2 (2017a:7)

At MBC, the management of CKD-vehicles is distributed across different departments, as described in Section 4.5. The breakdown from primary demand to secondary demand takes place in the TBE process. With the calculated volumes of the TBE, ordering and disposition of parts takes place. Suppliers then deliver the ordered parts to a 3PL. The 3PL manages goods receiving, hardening of body shells for CKD-vehicles, packing, and containerisation. The 3PL hands over responsibility to the shipping line in charge of transport via truck and ship. Once the shipping line loads the containerised parts onto the ship, the responsibility is carried over to the CKD-vehicle plant in accordance with the international commerce term (Incoterm) FOB. For claims and urgent deliveries, MBC relies on airfreight, which is managed by MBC and the 3PL through a system named *DIALOG*. In the country of destination, the CKD-vehicle plant manages or assigns the tasks of goods receiving and customs management. After customs, commissioning of imported parts and local content takes place in proximity to the assembly plant to prepare for final assembly. Lastly, the foreign plant assembles the CKD-vehicles. A local sales department manages the ordering, sales and delivery of CKD-vehicles (SC/WTO2, 2017a:7).

Demand and capacity management for all international suppliers, however, takes place in a centralised department together with CBU-vehicle parts. MBC has CCs in close proximity to the plants in Hungary, the US and Germany. This simplifies the delivery process for international suppliers. In terms of production, there is no need to differentiate between CKD-and CBU-vehicle parts from a supplier's side. Only MBC differentiates and stores the parts depending on their purpose (SC/KP, 2017b).

The variety of parts for CKD-vehicles differs from CBU-vehicles. MBC offers each make with a few different engine versions and equipment packages. A document, namely the Code-SA-list, defines which equipment set contains which SA (SC/WTO2, 2017a:12). Addendum D contains a summary of the Code-SA-list. For CKD, there is only a limited number of packages available. Usually, each BM is available in two to three design packages. The customer can only specify the colour of the vehicle and add specific trimming parts. Other forms of SA, such as a tow bar or sun roof, are set for each package. The Code-SA-list consists of approximately 600 different SA. Some of these SA are not available in all vehicles. MBC follows this approach to achieve economies of scale. With relatively low volumes, large variety leads to an increase in cost. Another advantage of a reduced variety is that the packing becomes limited to fewer parts. A personalised configuration, as for CBU-vehicles, is therefore not possible. The centralised order management for CKD-vehicles uses the Code-SA-list to decode the orders sent by foreign assembly plants. This step equals the conversion of primary demand to secondary demand. An employee manually converts the order into individual parts and manually enters secondary demand into the system that combines demand for CKD- and CBU-vehicles (SC/WTO2, 2017a:12).

The supply chain, and as a result thereof, demand and capacity planning, significantly differs for CKD- and CBU-vehicles. Section 4.7.2 provides a summarised comparison of CBU- and CKD-vehicle practices.

4.7.2. Comparison of CBU- and CKD-vehicle practices

Demand and capacity planning for CBU- and CKD-vehicles differ in certain aspects but are also characterised by similarities. This section conflates the specifications for CBU-and CKD-vehicle processes. Table 4-4 summarises the information regarding volume planning, goods and information flow as well as SA.

Table 4-4 Comparison of CBU- and CKD-vehicle planning processes

Specification	CBU	CKD
Volume planning	Programme planning	MPP/JPP for packing and shipping of parts
Goods flow	Supplier delivers to production plant	Supplier delivers to 3PL in CC, 3PL packs parts and delivers to assembly plant
Information flow	Dealers submit orders to *Central sales* department, centralised planning	Local sales division submits orders manually to *Logistics and order management*
System integration	High level of integration	High level of manual data handling
Special equipment	Take-rates (Percentage of total volume), management with CoRe	Code-SA list

The planning of volumes is a significant component of production planning. For CBU-vehicles, programme planning designs a schedule for the timeframes of OP and short-term. For CKD-vehicles, JPP provides volumes for yearly figures and MPP for monthly figures. Demand and capacity planning integrates CKD-volumes into the planning for CBU-vehicles to obtain the overall volumes of MBC (SC/WTO2, 2017a:10-11).

In terms of goods flow, suppliers directly deliver components and modules to the production facilities of MBC. The same suppliers usually serve the CKD-vehicle supply chain. The structure, however, differs. There are two ways of goods flow for CKD-vehicles. On the first route, a 3PL manages a CC which is involved in the handling and packing of parts in proximity of the production plant. The 3PL then ships the packed parts to the foreign assembly plant. The second option entails the flow of local content. Suppliers pack the parts for CKD-vehicle assembly and ship them to a local assembly plant, which forwards the assembled modules to the car assembly plant. MBC manages suppliers and order quantities corporately and a specialised department further maintains contact with suppliers for local content (SC/WTO2, 2017a:7).

The information flow takes place in accordance with the goods flow. In addition to the information which steers the goods flow, MBC manages orders from customers. For CBU-vehicles, this process takes place in the sales department. Dealers submit orders to the sales department, who then uses the orders as input for S&OP. For the CKD-vehicle business, the foreign assembly plant submits the orders received from customers to a centralised planning department and the team enters the orders into the system. This additional process step is limited to CKD-vehicles (Daimler Protics, 2017:18; SC/WTO2, 2017a:7).

The level of system integration also differs between CBU- and CKD-vehicle demand and capacity planning. Demand and capacity planning for CBU-vehicles mostly takes place in computer systems with a high level of automation. Opposed to that, CKD-vehicle demand and capacity planning heavily depends on manual handling of data in Microsoft Excel. The majority of planning tools, such as MPP, JPP and Code-SA list, are managed manually (SC/WTO2, 2017a: 10-12).

The last specification considers the management of SA. For CBU-vehicles, MBC uses take-rates which show the SA-rate as a percentage of the total volume. Demand and capacity planning manages constraints with CoRe, a tool which limits the volumes of an equipment package or SA. For CKD-vehicles, a document named Code-SA-list contains all SA for each BM. This document is the foundation for take rates. It does, however, only contain information on whether or not a code is part of a vehicle. The Code-SA-list also changes if parts or components should or should not be a part of a package. Therefore, the document can be seen as an equivalent to CoRe in an elementary sense. EPVs do not affect the CKD-vehicle business. In extreme cases, an EPV on a type of bodywork can however have an impact on SKD-vehicles (SC/KP, 2017a; SC/WTO2, 2017a).

MBC is aware of the majority of differences in the handling of CBU- and CKD-vehicle demand and capacity planning. In addition, MBC constantly develops business operations through projects focusing on specific areas of development. Current development at MBC is summarised in Section 4.8.

4.8. Current development at MBC

Ongoing growth requires administration, processes and systems that work and develop in line with the MBC's growth. Regarding the CKD-vehicle business, two current projects develop the current business practices, namely *PBK* and *CKD-Redesign*.

The PBK project is a cross-company initiative that restructures the sales data used for material forecast currently in place (PBK, 2016:4). The project's aim is to lay the foundation for more efficient demand and capacity management (SC/KP, 2014:50). For the CKD-vehicle business, the most significant change is the implementation of the *BCAP* tool for SA-planning and take-rates. The tool replaces current take-rate planning procedures where *Sales operations* manually calculates take-rates in Microsoft Excel (PBK, 2016). BCAP aggregates the data of 17 key markets to calculate take-rates for all markets. Currently, MBC uses a forecasting model for take-rates which is based on the eight biggest markets of each car model (PBK, 2016). The project intends for BCAP to copy real orders for CKD-vehicles but not to update or validate the data (PBK, 2017:10).

While the focus of PBK is on the CBU-vehicle business, the CKD Redesign project specifically looks at the system integration of a system called *Global Ordering* (GO) for CKD-vehicle business purposes. In a first step, CKD-Redesign plans to replace the Code-SA list with an automated tool. The newly-developed tool operates in conjunction with DIALOG and GO (MS/SOP, 2017:17). In addition to the Code-SA Tool, CKD Redesign introduces the ordering system *Cesar*, which is currently in use for CBU-vehicle markets. It is currently only planned to introduce Cesar to the new CKD-vehicle plant in Russia in 2019. Russian dealerships are already familiar with the programme due to CBU-vehicle sales, while other markets are excluded from the changes (MS/SOP, 2017). There is currently no known release date for the Code-SA tool.

The PBK and CKD-Redesign projects are aimed at improving the business operations of MBC. In alignment with these developments, this aims to contribute to the improvements of business operations. The case description of Daimler AG lays the foundation for potential improvements. Conclusions made from the case description are summarised in Section 4.9.

4.9. Concluding remarks

Chapter 4 contains the case description of Daimler AG, more specifically of demand and capacity planning for CKD-vehicles at MBC. Daimler AG is a premium car manufacturer with a strong influence on the development of the automotive industry. The company is characterised by a history of growth and development from a local entrepreneurial business to a global organisation. The history of the CKD-vehicle business as a whole is in line with the global development within the company.

MBC is the largest division of Daimler AG, specialising in the manufacturing of passenger vehicles. MBCs products range from compact cars to sport utility vehicles (SUVs) and sports cars. MBC aspires to grow and develop further by increasing production volumes of vehicles until 2026. Furthermore, the CKD-vehicle business is planned to grow by tripling the percentage of total vehicle units.

Constant growth requires supporting structures such as management and administration. In terms of organisational structure, MBC is characterised by high hierarchical structures with logistics and SCM taking place in a mostly decentralised manner. Co-operations between departments are required to manage complex processes for demand and capacity planning.

The business vision, mission and strategy of MBC and *SC* guide daily operations towards growth. The guiding statements are, however, vague and SC’s statements partially lack alignment with the corporate ones. SC's mission resembles the significance of S&OP by including the co-operation with sales into the mission statement.

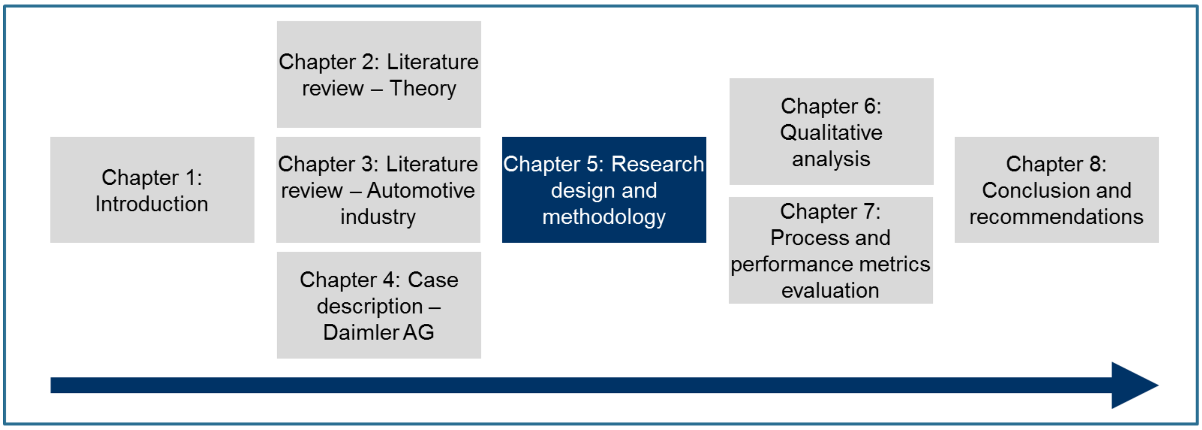
In terms of demand and capacity planning, the handling of CBU- and CKD-vehicles differs in many instances. MBC's main operations clearly focus on the CBU-vehicle business. The Y-model, which combines the planning of market demand and internal capacities, illustrates the approach to demand and capacity planning. Within the model, the planning is divided into the three different time horizons of SP, OP and short-term planning. The detail of planning increases with increasing proximity to the production date. Similarly, the forecasting accuracy increases closer to the production date as real orders are incorporated into the forecast. Especially during short-term planning, CKD-vehicle planning differs in terms of volume planning, goods flow, information flow, system integration and SA. MBC currently manages projects focusing on the improvement of demand forecasts and the Code-SA list used to plan SA for CKD-vehicles.

The significant differences between CKD- and CBU-vehicle planning suggest the need for further investigation and development of the CKD-vehicle planning processes. The investigation requires a structured approach in the form of a design and methodology. Chapter 5 defines the research design and methodology of this study.

Chapter 5. Research design and methodology

"We must be guided by faith. If we are guided by fear we lock ourselves and our expansion."

(Yogi Bhajan)



5.1. Introduction

Research philosophy, *research design* and *research methodology* are three major areas which will be contextualised in this chapter. In business studies, research philosophy is the approach a researcher follows in order to understand research findings. The philosophy describes the researcher's view on the world as a whole, including assumptions on knowledge development. The philosophy is not specific to a single research project (Saunders, Thornhill & Lewis, 2016:124). The research design is the plan or guideline of this study which connects the initial research question to the collected data with the aim of answering the research question. Research methodology describes the tools applied in doing research, assisting in collecting and analysing data (Yin, 2014:28; Saunders *et al.*, 2016:163). Figure 5.1 shows the definition and differences of the three terms in more detail.

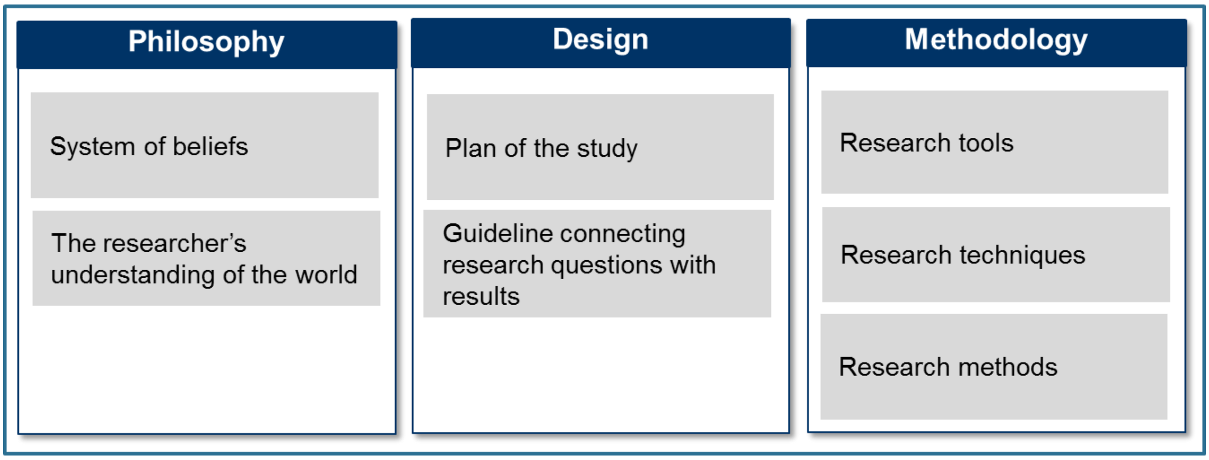


Figure 5.1: Research philosophy, design and methodology

Adapted from Yin (2014:28); Saunders et al. (2016:124)

Besides the information on philosophy, design and methodology, this chapter contains additional details about secondary and primary data which include data collection and analysis and limitations. Furthermore, the method behind process mapping and evaluation as well as performance evaluation is described.

5.2. Philosophy

Philosophers developed different theories on the existence of reality and how one knows and sees reality. Thought processes developed over hundreds of years, still form the basis for today's social and management research. Depending on the way of thinking, a researcher's mindset has a different view and understanding of reality. The way reality is seen and understood is based on philosophical approaches, either consciously or unconsciously.

In order to define the researcher's understanding of reality, it is necessary to define *reality*. Aristotle defined the philosophy of the nature of reality as *ontology*. The word is a combination of the Greek words for *being* ("ontos") and *study* ("logos"), collectively the study of being (New World Encyclopedia, 2015). Further studies lead to a division into different views with the most predominant branches being *objectivism* and *subjectivism*. Objectivism, on the one hand, sees the existence of social entities in reality detached from social actors and their concerns regarding existence. Subjectivism, on the other hand, focuses on the social phenomena, stating that social actors create social phenomena through their perception and consequent actions (Byrne, 2016; Saunders *et al*., 2016:110). Figure 5.2 illustrates the concept of ontology.

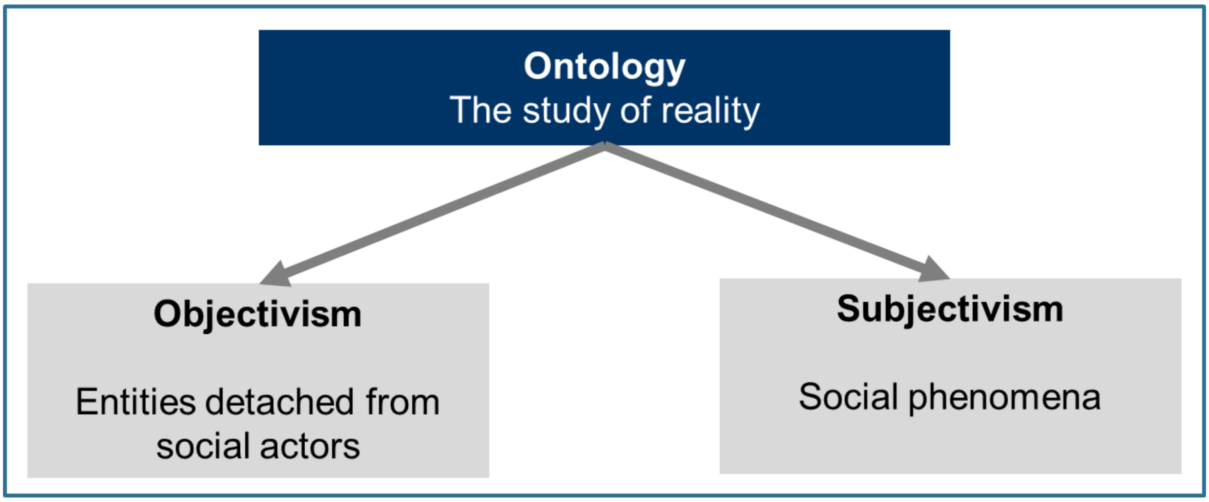


Figure 5.2: Ontology

Adapted from Saunders et al. (2016:129)

Applied to management science and the area of research of this study, objectivism portrays supply chain management in its structure and aspects in a similar way across all organisations, only differing in individual functions (Saunders *et al.*, 2016:129). Contrary to that, subjectivism renders SCM as a result of perceptions and actions of the social parties involved. As a consequence, SCM is under constant revision, based on social interaction and development of the social actors involved (Saunders *et al.*, 2016:129). This research study follows an approach of subjectivism with SCM and all other linked areas of management as phenomena under constant revision.

Once the viewpoint on reality is defined, it is necessary to clarify the idea of the grounds of knowledge especially with reference to its limits and validity. *Epistemology* is the philosophy of how we understand reality and how we can make claims in research (Byrne, 2016). The term has its origin from the Greek words for *knowledge* ("episteme") and *study* ("logos") (Harper, 2001). The four most relevant forms of epistemology described in this section are *positivism*, *interpretivism*, *realism* and *pragmatism*. Positivism only accepts observable phenomenon as credible data and therefore focuses on generalisations, which reduce phenomena to their simplest elements, as opposed to interpretivism which rather focuses on social phenomena and subjective meanings, offering a deeper insight into the reality behind an observable phenomenon. Realism sees observable phenomena as a source of credible data with a focus on explaining the phenomenon within its social context, using subjective meanings. The fourth form of epistemology, pragmatism, includes both observable phenomena and subjective meanings as sources of acceptable knowledge (Saunders *et al.*, 2016:127). The different types of epistemology are graphically depicted in Figure 5.3.

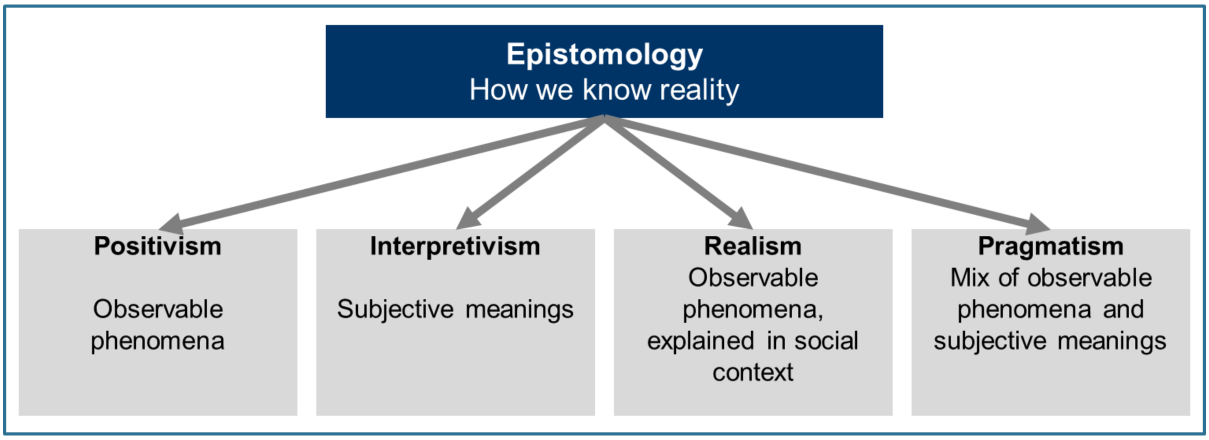


Figure 5.3: Epistemology

Adapted from Saunders et al. (2016:129)

Applied to the field of study, long established theories in SCM can be linked to observations made (Saunders *et al*., 2016:127). There are, however, limits to theories and observations, especially when dealing with disciplines that involve social factors. Different companies operate based on different values or cultural characteristics. In order to fully analyse the case and answer the research question, subjective means yield interpretative information which cannot be provided through hard data. Pragmatism leads to a research design that works with both quantitative and qualitative data. The research philosophy therefore lays the foundation for research design and methods which are described in this chapter.

5.3. Design

The application of a research design that is specifically suitable for logistics, supply management or operations management is still a field with limited information available. Voss, Tsikriktsis & Frohlich (2002:196) identified *case study research* as a suitable method in the field. Halldórsson & Arlbjørn (2005:108-110) confirm their argumentation that it is a suitable method. In general, case studies are classified as a suitable method for research in a business environment or strategic management, especially when an organisation is the focus of the research (Adams, Khan, Raeside & White, 2007; Gibbert, Ruigrok & Wicki, 2008).

Yin (2014:16) defines a case study in a twofold definition, focusing on the scope and the features of a case study. The author defines a case study as an empirical enquiry, investigating a contemporary phenomenon, which he names "the case", within its context in the real world. Often, the boundaries between phenomenon and context are not evident. From a technical point of view, there are more relevant variables than data points. Therefore, multiple sources of evidence are recommended for data collection and it is beneficial to use theories developed beforehand to lead the data collection and analysis.

Exploratory case study design as described by Yin (2014) has emerged as the most suitable design for this study. Based on the definition of Yin (2014), the case is defined as the Mercedes-Benz Cars (MBC) division of Daimler AG. The real-world context relates to the situation described in the problem statement in Section 1.3 regarding completely-knocked-down (CKD) vehicles and demand and capacity planning. The sources of evidence emerge from the current MBC demand and capacity planning processes where demand forecasting for suppliers plays a significant role.

Time-wise, a study can be characterised as *cross-sectional* or *longitudinal*. The term cross-sectional describes a study conducted at a single point in time, as if the researcher takes a slice (cross-section) of the case (Bryman & Bell, 2015:40; Saunders *et al.*, 2016:200). Contrary to that, a longitudinal study design observes the study object over an extended period of time, focusing on dynamic issues such as the effect or impact of a development to investigate changes (Bryman & Bell, 2015:43; Saunders *et al.*, 2016:200). This study is classified as an intra-case cross-sectional study. Data were collected from different departments within MBC and the focus was on the need for a process and metric, it is not within the scope of the study to observe the acceptance, usability in daily business, or overall impact of processes and metrics at different points in time. Data collection took place in the form of secondary and primary data as described in the Sections 5.4 and 5.5.

5.4. Secondary data

Secondary data are defined as data that have been recorded by a different researcher for a purpose other than this study (Zikmund, Babin, Carr, Adhikari & Griffin, 2013:160; Saunders *et al.*, 2016:316). The application of different methods of data collection and analysis leads to a broad coverage of background information. The secondary data analysis of Daimler AG is explained in this section.

The case study focusses on MBC, the passenger vehicle division of Daimler AG. Background information about the company itself, the business model as well as the departments in charge of SCM are relevant to understand the study. This information is available online, in the company's annual reports or through internal presentations and documents on the internal online employee platform. A structured summary in the form of a *SWOT analysis* identifies internal factors (strengths, weaknesses) in combination with external factors (opportunities and threats) of Daimler AG (Cadle, Paul & Turner, 2010:14). The SWOT analysis is suitable because it is a summary which reduces focus to four key aspects, therefore giving an overview of Daimler AG's current situation.

Secondary data further support the findings of the primary data analysis as described in Section 5.5. For the process component of the study, secondary data provide information on process design, activities in each process and the relation between different activities or departments. Secondary data offer information on potential improvements for processes by providing an overview of MBC as a whole, bringing the results of the qualitative analysis in context.

Regarding performance management, research depended on secondary data as options for primary data collection were limited. Internal documentation of performance management with a focus on metrics, such as monthly performance reports, represent the main source of information for the analysis of performance metrics.

Besides secondary data, primary data in the form of observations, personal communication and interviews, yield further qualitative data about Daimler AG and the function of demand and capacity management within the company. These research tools are described in Section 5.5.

5.5. Primary data

Primary data is necessary in order to achieve the research objectives of the study and to answer the research questions. Primary data is also required to fill the gap of knowledge from secondary data, due to the topic of this study being very specific. Saunders *et al.* (2016:316) define primary data as information collected and analysed specifically for the purpose of the study. Primary data collection took place in co-operation with Daimler AG in Germany, particularly in Stuttgart and surroundings. A placement of six months in Böblingen allowed for site visits and direct contact with employees and the business itself. The selection of participants and collection and analysis of primary data in the context of this study is described in the following Sections 5.5.1 to 5.5.3.

5.5.1. Participant selection

For primary data, successful data collection and analysis depends on the appropriate selection of participants. The first decision to make is whether to use *probability* or *non-probability* sampling. Probability sampling assigns every unit in the sample a known probability unequal to zero. On the contrary, non-probability sampling works with unknown probabilities (Zikmund *et al.*, 2013:395). The selection process for participants of this study took place according to the principles of non-probability sampling. The number of employees at Daimler AG who have sufficient knowledge of this research topic was very limited. In particular instances, there was often only one person with sufficiently knowledgeable on a topic. Due to the limited number of potential participants and strict selection criteria, the number of possible participants is too little to assign probabilities and randomly select suitable candidates.

Non-probability sampling describes the selection of participants based on predefined criteria. The precise techniques applied were *purposive sampling* and *snowball sampling* (Given, 2008; Saunders *et al*., 2016:301). For *judgement sampling*, a version of purposive sampling, the personal judgement of the researcher or an individual who selects the participants is required (Zikmund *et al.*, 2013:396; Saunders *et al.*, 2016:301). The authors further define snowball sampling as a method where initial respondents mention other possible respondents (Zikmund *et al.*, 2013:398; Saunders *et al.*, 2016:303). The selection criteria to qualify as a participant for the study were defined as follows:

- The participant has to be an employee of Daimler AG (internal or external employee).
- The participant needs to be involved in CKD-vehicle planning, demand and capacity planning or sales planning at Daimler AG.

- The participant needs to be able and willing to participate in the study.

Based on these criteria, the selection of participants started in the *Demand and capacity planning* department. With the manager's assistance and the job description of each employee, suitable participants were pre-selected. In a second step, possible participants from other relevant departments were suggested based on knowledge of the team members and job descriptions. This sampling strategy developed a network of participants who provided insight during the process of data collection. Section 5.5.2 introduces the different research tools applied to collect data.

5.5.2. Data collection

The collection of qualitative primary data took place at Daimler AG, focusing on demand and capacity management for CKD-vehicles. Different functions and departments of the MBC division are involved in the demand and capacity planning process. Thus, data collection took place in different departments involved in the process in order to avoid a biased view. As described by Yin (2014:16), the use of several sources of evidence, or research tools, provides a better coverage, reduces bias and enables a control system to verify the quality of the data collected. Data triangulation facilitates the support of the case study's findings by more than one type of source. It is the aim of data collection to achieve a high level of convergence of evidence. Convergence of evidence describes the use of several different sources which support the same arguments and findings and therefore increase the credibility of a study's results (Yin, 2014:121-122). It is, however, unlikely to achieve complete convergence of evidence, as there are always minor differences. Divergence, different findings from different sources, allows for more in-depth explanations which highlights the rationale of the study (Farquhar, 2012:95).

All sources of evidence, namely observations, personal communication, phone calls and conversations, individual interviews, both semi-structured and in-depth, as well as a focus group interview contribute to the same findings and results. Figure 5.4 summarises the data collection process.

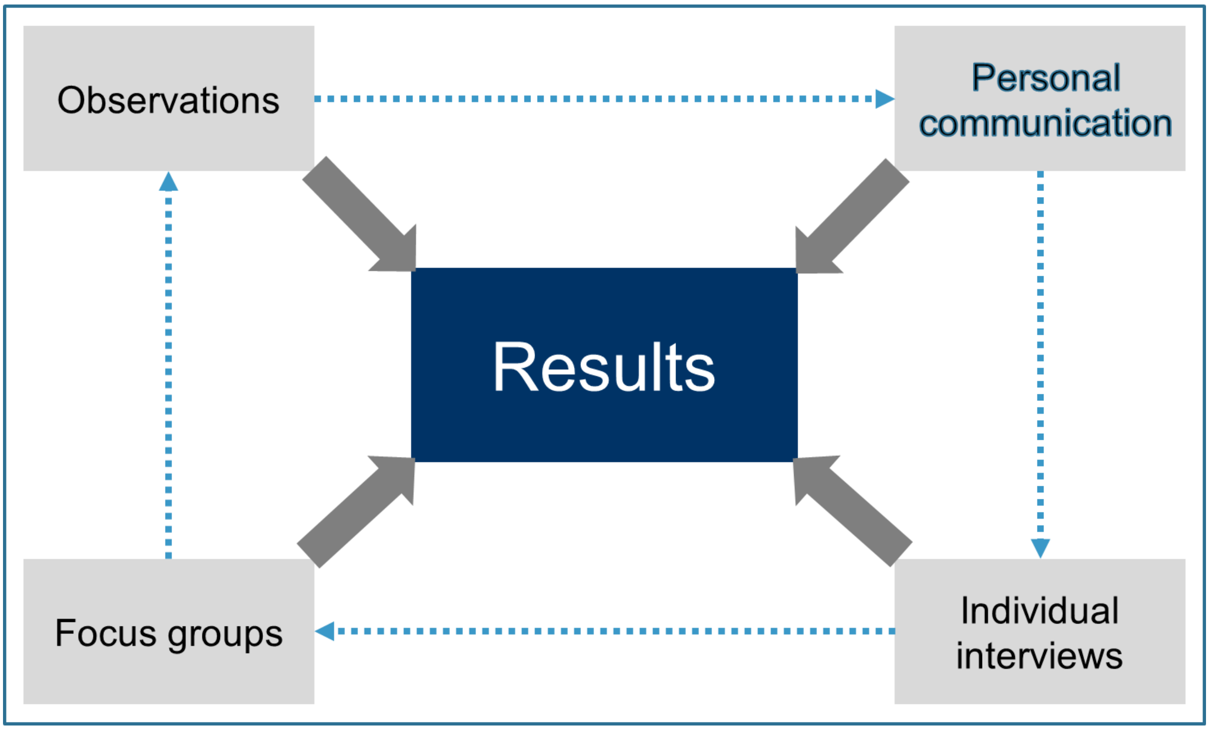


Figure 5.4: Data triangulation leading to convergence of evidence

Figure 5.4 illustrates a link between the different research tools. The intensity increases with the type of research tool, from a sole observation from interaction with a single individual to the dynamics of a whole group of participants. The level of detail also varies from research tool to research tool. All combined, the different sources of evidence support the findings of the study.

When dealing with human participants, bias or personal preference need to be identified and treated in a manner that allows for a neutral evaluation. Data triangulation provides insight on several occasions and therefore verifies that the information is objective. Similar to that, data triangulation allows the researcher to verify whether the information given is true and of sufficient quality. The sources of evidence selected are observations, direct communication in the form of phone calls, emails and conversations, in-depth interviews and a focus group session. These means of data collection are discussed in Section 5.5.2.1 to 5.5.2.4.

5.5.2.1. Observations

Observations of daily business procedures and tasks provided initial insight into the research topic. The observations were aimed at indicating the context in which the topic of the research study falls. The different entities who are in contact with demand and capacity planning at Daimler AG were observed in their handling of both CBU- and CKD-vehicle planning.

Additionally, meetings in person or telephonically were used to gather data. On such occasions, there was no direct communication between the researcher and the employees. The researcher took notes during and after the observation in order to ensure complete documentation. Observations can be time-consuming and only provide an overview as a starting point. (Zikmund *et al*., 2013:240; Yin, 2014:106). Personal communication and other research tools therefore provide further insight on topics relevant to the study.

5.5.2.2. Personal communication

Personal communication such as conversations, emails and phone calls offer a fast, inexpensive and straightforward source of data. This form of communication usually requires little preparation and takes place in an unstructured manner (Zikmund *et al.*, 2013:141). As this research took place over a period of six months at the main branch of the company, daily interactions with employees provided many insightful conversations about the research topic. Emails were saved in electronic format and the researcher took notes during telephonic or direct personal conversations. The interaction with other departments involved in demand and capacity planning mostly took place via email and phone calls. Often, the initial contact via phone, electronic communication or in person developed into further contact points in the form of interviews.

5.5.2.3. Interviews

Unstructured and *semi-structured interviews* with employees further intensified the data collection process. The interviews took place in person at the facilities of the company. Both semi-structured and in-depth interviews were held. Semi-structured interviews are characterised through a predefined set of open-ended questions, requiring a detailed answer from the participant. Due to the structure of the interview, inquiries about details cannot be incorporated without losing track (Zikmund *et al.*, 2013:142; Saunders *et al.*, 2016:391). Unstructured interviews are interviews that cover specific topics rather than using predefined questions as a set guideline (Bryman & Bell, 2015; Saunders *et al.*, 2016). Unstructured interviews provide a better opportunity to apply *probing*. Probing describes a research technique where a researcher aims at receiving more detailed information from a participant through specific inquiries for more elaborate explanations (Zikmund *et al.*, 2013:656). Semi-structured interviews have the possibility to cover a broader array of topics within one interview and therefore are more time-efficient and less costly than unstructured in-depth interviews (Zikmund *et al.*, 2013:142). The interviews took place in a verbal manner and the researcher took notes or recordings during the interview. The interviews took place in style of the *Delphi method*. In several rounds, the information provided by employees of Daimler AG was verified by groups of experts. After the first interview, an analysis of the information received was used to design the layout for the second interview. After an evaluation of the second interview, a third round of interaction closed the interviews. This measure was taken to verify the content of information given and to avoid the transfer of incorrect information (Linstone & Turoff, 2002:80-83; Saunders *et al.*, 2016:38). Addendum E contains the interview guides for all three rounds of interviews. Interviews shed light on both explanations of facts and personal views, but can also be biased due to the human interaction (Yin, 2014:106). A focus group interview was used as a source of evidence to distinguish objective explanations from subjective views of individual employees.

5.5.2.4. Focus group

A *focus group* interview is defined as a small group discussion led by an instructor. Participants of the focus group are selected based on their function in the company and their role regarding demand and capacity management. Compared to the interviews, the focus group interview is more free-flowing and requires interaction between the individual participants. Personal views can be compared to each other and explanations can be verified and further complemented by individuals from different departments (Saunders *et al.*, 2016: 416-417). For this study, the focus group interview was conducted in an unstructured manner with a list of specific topics to cover rather than predefined questions. For the purpose of this research, an in-depth focus group interview was held to gather information on the current practices in CBU- and CKD-vehicle planning, before moving to problem situations and expectations on the new processes for CKD-vehicle planning. Addendum F illustrates the full agenda of the focus group meeting.

All primary data collected through observations, personal communication, interviews and a focus group session need to be analysed in order to draw a conclusion from raw data. Section 5.3 explains the data analysis of this study.

5.5.3. Data analysis

Data analysis entails the processing of data by developing raw primary data into findings. Zikmund *et al.* (2013:68) describe data analysis as understanding the gathered data through the application of reasoning. In this research study, the analysis of data resembles the bridge between data collection and process assessment. Data analysis is further divided into three subsections, namely data organisation, data exploration and the actual analysis of data. This study employed *Computer Assisted Qualitative Data Analysis Software* (CAQDAS), more specifically ATLAS.ti version 8.

5.5.3.1. Organisation

To begin the analysis, the data needed to be organised in order to be suitable for further processing. The organisation of data partly took place simultaneously with data collection, ensuring that the process is structured. The results from data collection were partly hand written, partly recordings and partly computer written. An overview of all interviews, similar to a directory, summarises information about the source of evidence in the form of a Microsoft Excel sheet. Recorded information include type of information source, date, location, name of participant, topic and key themes. An overview of the directory can be found in Addendum G.

Part of the organisation of data also included the organisation of notes in a comparable format. Handwritten notes taken during data collection, for example during observations or interviews, were typed out. Recordings, from interviews or the focus group discussion were transcribed in electronic format to save in a uniform way in ATLAS.ti. Part of the transcription is to superficially validate the results from each source of evidence by ensuring that the recordings from the interview correspond to the transcriptions.

5.5.3.2. Exploration

The full validation of data takes place in the phase of data exploration. By further familiarisation with the data, the researcher verifies that the results are conclusive. The verification ensures that statements by one participant do not contradict with other stated facts by the same participants in the process of data collection. This gives the researcher the opportunity to fully understand the data collected.

The phase of exploration also assists with the reduction of data irrelevant to the study. The research objectives and main research question function as a guideline for this reduction. Once the gathered data have been reduced to relevant data only, the analysis can commence in the final stage of data analysis.

5.5.3.3. Analysis

The final analysis of data applies the method of *constant comparison*, *coding* and *content analysis*. Constant comparison, according to Corbin & Strauss (2012:65), is defined as comparing different units of data for similarities and differences in an analytic manner. It is the aim of the constant comparison method to suggest and develop categories or properties about a general problem (Glaser & Strauss, 1967:105-113). Constant comparison analysis is divided into four steps: The comparison of incidents, the integration of categories and properties, the delimiting of theory, and the writing of theory. For the purpose of this study, the first two steps of constant comparison were employed. The delimiting and writing of theory is subject to further research and excluded from the scope of this study.

The first step, comparing individual incidents, entailed the categorisation of all incidents. Each incident was categorised through coding. Incidents include statements made by interviewees, specific terms used in these statements, explanations given and sentiments expressed by a statement. Every incident was compared to previous incidents and the assigned categories. Detailed notes taken ensured clarity and delimitation.

Based on the comparison of incidents, the integration of categories and properties could begin in step number two. Theoretical properties of a category, including dimensions, conditions, consequences and relations to other categories needed to be developed. Regarding the mapping of processes, this step assisted in the relationship between departments and activities.

Coding and developing theories was done already during data collection to better integrate the theory. Section 5.5.3.4 further introduces coding in the context of content analysis. For the purpose of this study, this step leads to the identification of process flow, links between activities, as well as input and output. In addition, the integration of concepts provides the basis to map and evaluate demand and capacity planning processes for CKD-vehicles. Content analysis was applied to identify key theories. This quantitative analysis includes the level of soundness and co-occurrence tables. Content analysis is further explained in Section 5.5.3.4. Figure 5.5 illustrates how constant comparison is integrated in the process of primary data collection and analysis.

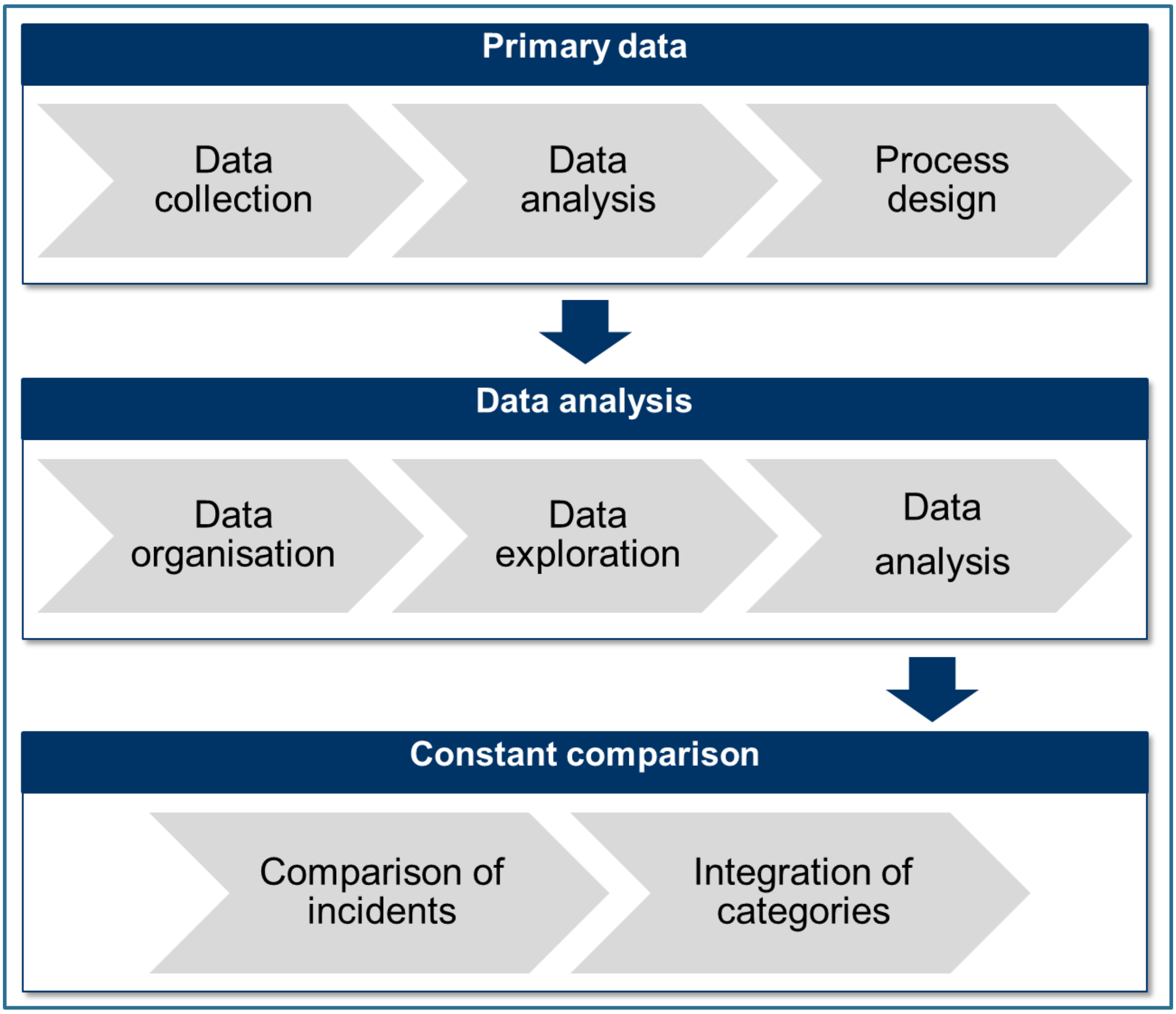


Figure 5.5: Constant comparison integrated in data collection

The main phases of research conducted with primary data are summarised as data collection, data analysis and process design as shown in Figure 5.5. Data analysis is further divided into three steps: data organisation, data exploration and data analysis. One component of data analysis is the constant comparison method, which consists of the two steps of comparison of incidents and integration of categories. The application of constant comparison provides a foundation for mapping and evaluating demand and capacity planning for CKD-vehicles. Further qualitative research methods applied in the analysis are coding and content analysis. Section 5.5.3.4 further elaborates the means of coding and content analysis.

5.5.3.4. Content analysis

Content analysis is a qualitative research method. Another example of a qualitative research method is grounded theory where theories can be derived from the repetition of questions asked in interviews (Hsieh & Shannon, 2005:1278; Zikmund *et al.*, 2013:139). Content analysis refers to the systematic, objective and quantitative description of content (Berelson, 1952:18; Saunders *et al.*, 2016:608). Content analysis was selected as a suitable research method for this study because of the systematic, quantitative approach to analysing qualitative data (Kabanoff, Waldersee & Cohen, 1995:1080; Saunders *et al.*, 2016:612). The systematic approach depends on the classification process of coding in order to identify themes and patterns (Hsieh & Shannon, 2005). In detail, coding describes the activity of assigning a characteristic description to data (Zikmund *et al.*, 2013:465). Based on the assigned codes, the frequency count of codes was determined and the relationship between themes was identified through co-occurrence tables. The ATLAS.ti software, a CAQDAS, provides the technical foundation for coding and content analysis. The use of CAQDAS reduces time and the risk for errors. The system also offers a database to store all documents for analysis (ATLAS.ti, 2017).

For a better understanding and easier application of the coding process, codes were designed as key words rather than numbers or symbols. The variables in the analysis were of nominal, categorical nature as these variables cannot be ranked or ordered (Bryman & Bell, 2015:244). The use of key words replaces the need for a coding manual as key words are descriptive and can be understood without additional information (Bryman & Bell, 2015:229). The analysis followed a strategy of *inductive coding* where the researcher develops codes by reading through the document (Silver & Lewins, 2014:6). The codes can be divided into different categories, namely *significant actors*, *subjects* and *themes* as well as *dispositions* (Bryman & Bell, 2015:224-226). Significant actors refer to departments and teams responsible for certain activities, while subjects and themes refer to activities that are part of the process as well as systems or other themes that cannot be further assigned to other categories. Dispositions refer to sentiments of interviewees regarding CKD-vehicle demand and capacity planning or the CKD-vehicle business as a whole. Codes and categories aim to be mutually exclusive to avoid double counts and exhaustive to avoid content to be left out (Bryman & Bell, 2015:232).

Each document was coded manually in several phases. The complete coding process consisted of three phases, starting with exploratory coding, then in-depth coding and finishing with a validation of codes and verification that all codes were assigned correctly. The coding process took place interview by interview.
Figure 5.6 illustrates the approach to coding applied in this study.

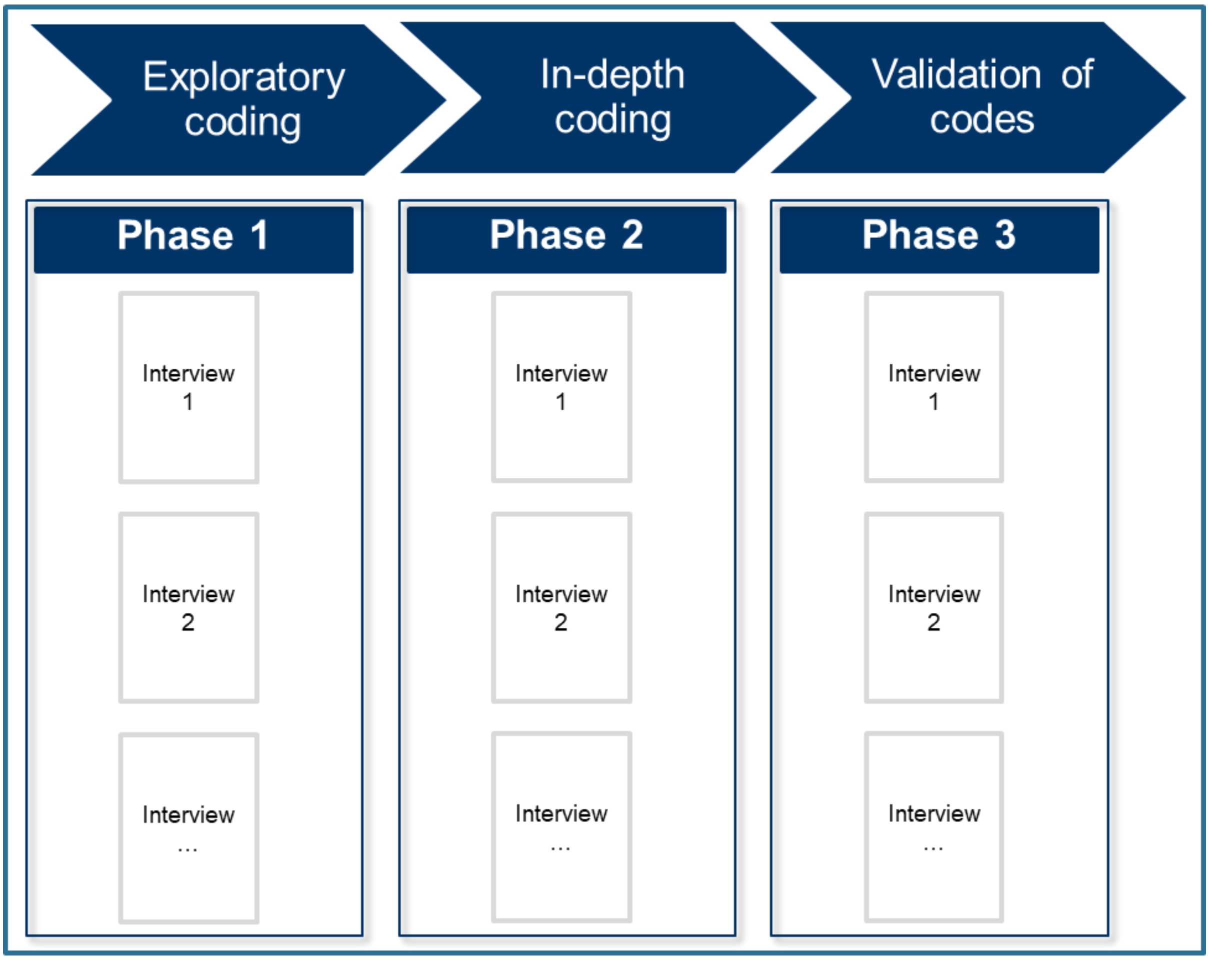


Figure 5.6: Approach to coding

The first phase describes the assignment of broad codes to identify significant actors, activities, themes and sentiments. It is the aim of this exploratory coding phase to discover all relevant information. The second phase involves in-depth coding. Similar codes were grouped together in categories and in doing so the number of codes could be reduced by eliminating duplications. After the second stage, the number of codes was reduced and all codes were categorised. The third phase consisted of a validation of codes, allowing for an identification of concepts, themes or patterns which can later be supported by frequency counts and co-occurrence tables (Friese, 2015).

Based on the codes assigned, the frequency of codes was counted to determine the significance of a code and level of groundedness. The frequency tables show the number of quotations linked to a code, indicating the level of groundedness (ATLAS.ti, 2015:6). The frequency tables show how often an entity mentioned a code, providing information on the significance or the involvement of a department. The level of groundedness is of great significance in order to determine whether a statement is relevant. It assists in highlighting relevant statements which can further be analysed by the means of content analysis and co-occurrences, complementing these methods.

Another means employed in the course of content analysis was the development of code co-occurrence tables. The co-occurrence is displayed by an absolute number to indicate the frequency of these two codes co-occurring in one quotation or in surrounding quotations (Lewis, 2012:11). The code co-occurrences confirm the relationship between two codes. For the context of this study, code co-occurrences are of significance as the frequency confirms the relationship between departments, activities and themes. This verification is necessary to map and evaluate processes. Section 5.6 describes the methods applied to evaluate demand and capacity planning processes.

5.6. Process mapping and evaluation

It is one of the aims of the study to map and evaluate selected demand and capacity planning processes for CKD-vehicles. Based on the results from primary and secondary data, a new process is developed in accordance with the Plan-component of the Supply Chain Operations Reference (SCOR) model and the SIPOC framework from Six Sigma process management. Further information on the reference model maintained by APICS Supply Chain Council can be found in the literature review under Section 2.5.1. Section 2.5.2 introduces the Six Sigma process management and SIPOC framework.

The SCOR model is a suitable reference model for process mapping. It is an overarching reference model, including other parties involved in the supply chain, such as key suppliers and clients. The process mapping and evaluation takes place on the fourth level of process design, namely the level of implementation, as defined in the SCOR model. This level involves tasks and activities. The SCOR model describes processes and metrics in order to implement these accordingly (Lawrenz, Hildebrand, Nenninger & Hillek, 2001:123). The variability of the fourth level ensures that the processes are adjusted to MBC's specific requirements. The reference model allows a universal evaluation of MBC's supply chain due to the evaluation criteria and standardised process design. Only the most detailed level of the model is company-specific. The reference model is therefore a great stepping stone to optimise supply chain processes (Lawrenz *et al*., 2001:144-123).

The gathered and analysed data provide the basis to evaluate the selected processes for demand and capacity planning for CKD-vehicles. The first step is to map and describe the processes currently in place. The SIPOC framework provides structure to the identification of key components of the processes. These key components include suppliers, input, output and customers of the process as well as the process itself. The mapping of processes took place in Microsoft Visio 2016. Due to the number of actors involved, the processes were mapped in a swimlane diagram.

The evaluation of processes for demand and capacity planning for CKD-vehicles identified good practices of processes as well as areas for improvement. The evaluation of these processes took place in alignment with best practice at MBC and under the consideration of relevant theories in literature. The current existing processes for CBU-vehicle demand and capacity planning processes are viewed as best practise at MBC. Further, the literature review in Chapter 2 provides the required knowledge of theories and concepts. Figure 5.7 illustrates the input factors for process evaluation of demand and capacity planning processes for CKD-vehicle planning.

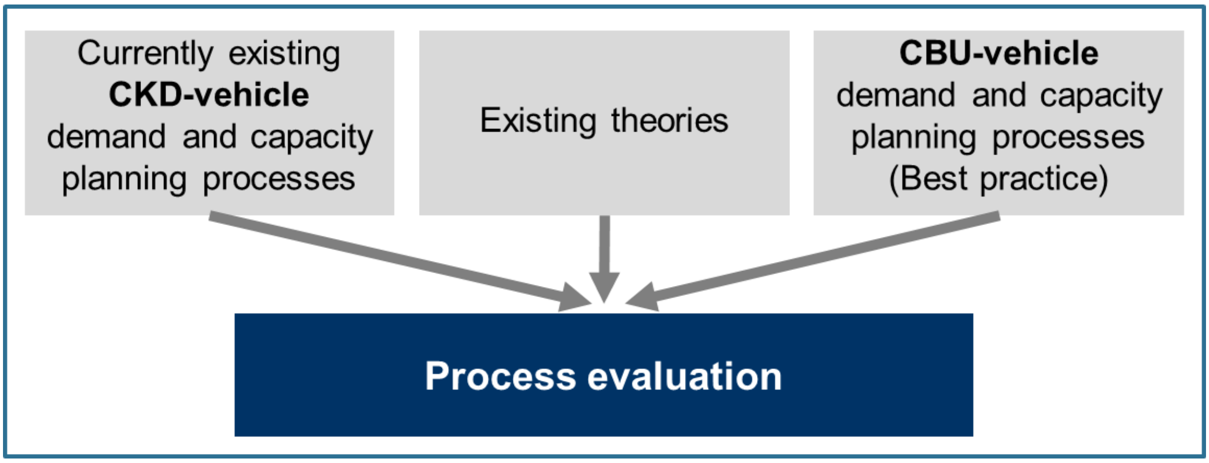


Figure 5.7: Process evaluation

Based on current practices at MBC and existing theories, this study suggests improvements to improve processes for demand and capacity planning with the ultimate goal to increase supply chain performance. Performance metrics play a crucial role in the measurement of process and supply chain performance. Section 5.7 explains the methods applied to research performance metrics for demand and capacity planning processes at MBC.

5.7. Performance metrics

One of the research questions focuses on the recommendation of suitable performance metrics to measure performance of the processes for CKD-vehicle demand and capacity planning. The evaluation of performance metrics accounts for a minor component of the study since the major focus is on process mapping, evaluation and the suggestion of improvements.

In alignment with the evaluation of processes, this study takes into account existing metrics already in place, metrics from CBU-vehicle planning as well as existing theories in literature. Chapter 2 provides background information on theories relevant to this study. Figure 5.8 illustrates input factors for performance metrics evaluation.

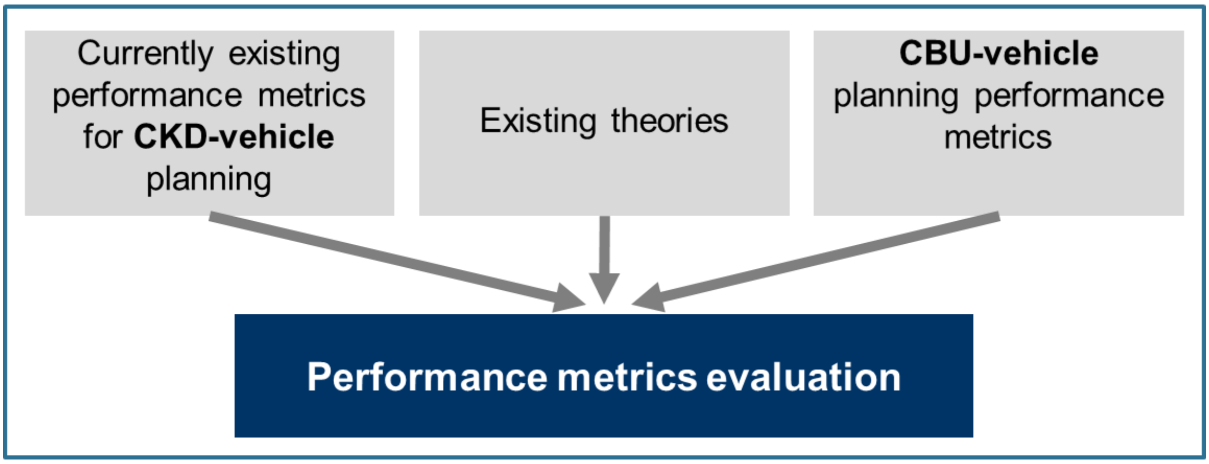


Figure 5.8: Performance metrics evaluation

The existing performance metrics for CKD-vehicle planning form the foundation for suggestions of performance metrics. Further, performance metrics currently used to measure performance of CBU-vehicle planning guided the evaluation. The evaluation was mostly based on theories regarding performance metrics suggested within the SCOR model and by Aberdeen group. The measures for supply chain performance suggested in the SCOR model are standardised and therefore offer the possibility of comparability across companies (Lawrenz *et al.*, 2001:118-120). The metrics introduced by Ball (2015b:2) for the Aberdeen Group summarise best practice metrics of successful companies, providing further inspiration for metrics suitable to measure performance of CKD-vehicle demand and capacity planning processes.

5.8. Research questions

Data collection and analysis are means employed to answer the research questions. As this thesis employed a variety of different techniques and approaches, this section highlights the link between research design, methodology and the individual research questions. Table 5-1 summarises the data collection and data analysis employed to answer the research questions.

Table 5-1: Data collection and analysis employed to answer research questions

Research question	Data collection	Data analysis
RQ1: Current processes for CKD-vehicles	Secondary research Observations Interviews Focus group	Content analysis Level of groundedness Co-occurrences
RQ2: Positive aspects of current processes	Secondary research Observations Interviews Focus group	Content analysis Level of groundedness
RQ3: Complications of current processes	Secondary research Observations Interviews Focus group	Content analysis Level of groundedness Existing theories & best practices
RQ4: Potential improvements of processes	Secondary research Observations Interviews Focus group	Content analysis Level of groundedness Existing theories & best practices
RQ5: Potential performance metrics	Secondary research (Interviews)	Existing theories & best practices

The research questions build on each other. The first research questions require to be answered in order to be able to proceed to the subsequent questions. As a result, the data collection and analysis also build on each other.

For the first, second, third and fourth research question, the means of data collection include secondary research, observations, interviews, and a focus group discussion. For the fifth research question, the data collection mainly depended on secondary research. Due to data protection, interview questions could not directly aim at gathering information on performance metrics. The information gathered through interviews was, however, a foundation for answering the fifth research question.

In terms of data analysis, the first, second, third and fourth research question rely on content analysis and an analysis of groundedness. In addition, the first research question compliments these means of data analysis with an analysis of co-occurrences. As the third and fourth research questions rely on best-practices at MBC and existing theories, these components of secondary literature contribute to the answer of these questions. The answering of the fifth research question is based on existing theories and best practices at MBC.

5.9. Research quality

It is in the interest of the researcher to ensure that the research study leads to high quality results. A structured approach in ensuring quality facilitates the quality assurance process. Reliability and validity are two criteria which facilitate qualitative results. Four different criteria, namely construct validity, internal validity, external validity and reliability, are the most applicable to the evaluation of case study research (Gibbert *et al*., 2008:1466; Yin, 2014:45). However, as this research study is exploratory in nature and does not aim at establishing causal relationships, internal validity is not applicable (Yin, 2014:46).

Reliability describes the fact that research conducted yields the same results if done again by a different researcher at a different time but under the same circumstances (Carmines & Zeller, 1979:10; Yin, 2014:46). *Validity* is strongly linked to reliability. The validity test measures to what extent a study measures what it is intended to measure (Carmines & Zeller, 1979:12). The criterion of validity is further divided into three different aspects, out of which two aspects are relevant to this study: *Construct validity* and *external validity*. Construct validity evaluates the quality of the measures applied. It defines the extent to which operational tools have been chosen and applied appropriately in order to measure a concept (Zikmund *et al.*, 2013:304-305; Yin, 2014:46; Saunders *et al.*, 2016:450). External validity, or transferability, focuses on the accuracy of generalisations, and it describes the possible level of accurate generalisation of a study's results (Yin, 2014:46; 2015; Saunders *et al.*, 2016:451). Due to the specific scope of this study, generalisations are limited unless further research with more units of observations is conducted. There are different measures to achieve a high level of research quality. Figure 5.9 summarises the means applied in this study.

	Philosophy	Design	Methodology
Construct validity		Data triangulation	Review by key informant
Reliability		Adherence to research design	

Figure 5.9: Means to ensure research quality

During the research process, construct validity is relevant in the phase of data collection as shown in Figure 5.9. Yin (2014:47) suggests two methods to increase the level of construct validity. Firstly, that data is collected through multiple sources of evidence. Interviews, focus groups and observations lead to convergence of evidence. Secondly, key informants review the case study report frequently. This reviewing process also provides a control system to avoid misunderstanding and misinterpretations, and is linked to increasing reliability.

Reliability can be ensured in the phase of data collection (Yin, 2014:47). During data collection, adherence to the research methodology and design ensures structure and sets procedures to be followed. In addition to the systematic approach, all notes, data and information collected are stored in a case study database.

A number of factors influence the quality and credibility of research. One of these factors is the assumptions under which research was conducted. Section 5.10 summarises the main assumptions relevant to the study.

5.10. Assumptions made in research

Assumptions in research can be divided into general assumptions and assumptions specific to data collection. The majority of assumptions relevant to this study is linked to MBC. The assumptions relevant to this study are listed in this section to avoid misunderstandings.

An underlying assumption is that Daimler AG has sufficient funds available to incorporate the changes suggested. A financial evaluation, for example in the form of a cost-benefit-analysis, did not take place. Despite the assumption of no financial restrictions in terms of implementation, the study only suggests improvements. It is Daimler AG’s decision to implement the suggestions, since one of the deciding factors could be costs.

With regard to CBU-vehicle planning processes, it is assumed that the processes are currently working sufficiently. These processes are seen as best practice at MBC. This assumption was made due to the fact that the CBU-vehicle business is the main business of MBC and the organisation aspires an assimilation of CKD- and CBU-vehicle planning processes.

Furthermore, it is assumed that there is interest and willingness to change at MBC. During the placement at MBC, co-operation was required both at employee and management level. The study was conducted under the assumption that MBC will further develop the ideas in the study to improve and measure demand and capacity planning processes.

When interviewing only one employee about a specific case or topic, results can differ from the actual situation. The participants' answers might be influenced by their own opinion or they might simply not have sufficient knowledge about the topic. From a management's point of interest, serious problem areas as well as well-functioning practises might be omitted from the answer for reasons of competitiveness. It is, however, assumed that all employees tell the truth. In order to avoid personal opinions, interviews were conducted with several employees. Open questions enquiring follow-up details to clarify doubtful answers were used to reduce such misinformation. Verifying the answers with a key informant, available data or other interview partners was taken as a measure to reduce this risk.

5.11. Closing remarks

This chapter introduces the philosophical viewpoints, design and methodologies applied in this research study. Figure 5.10 depicts the research "onion" as developed by (Saunders *et al.*, 2016:124). The research onion provides a framework to summarise the methodology and design developed.

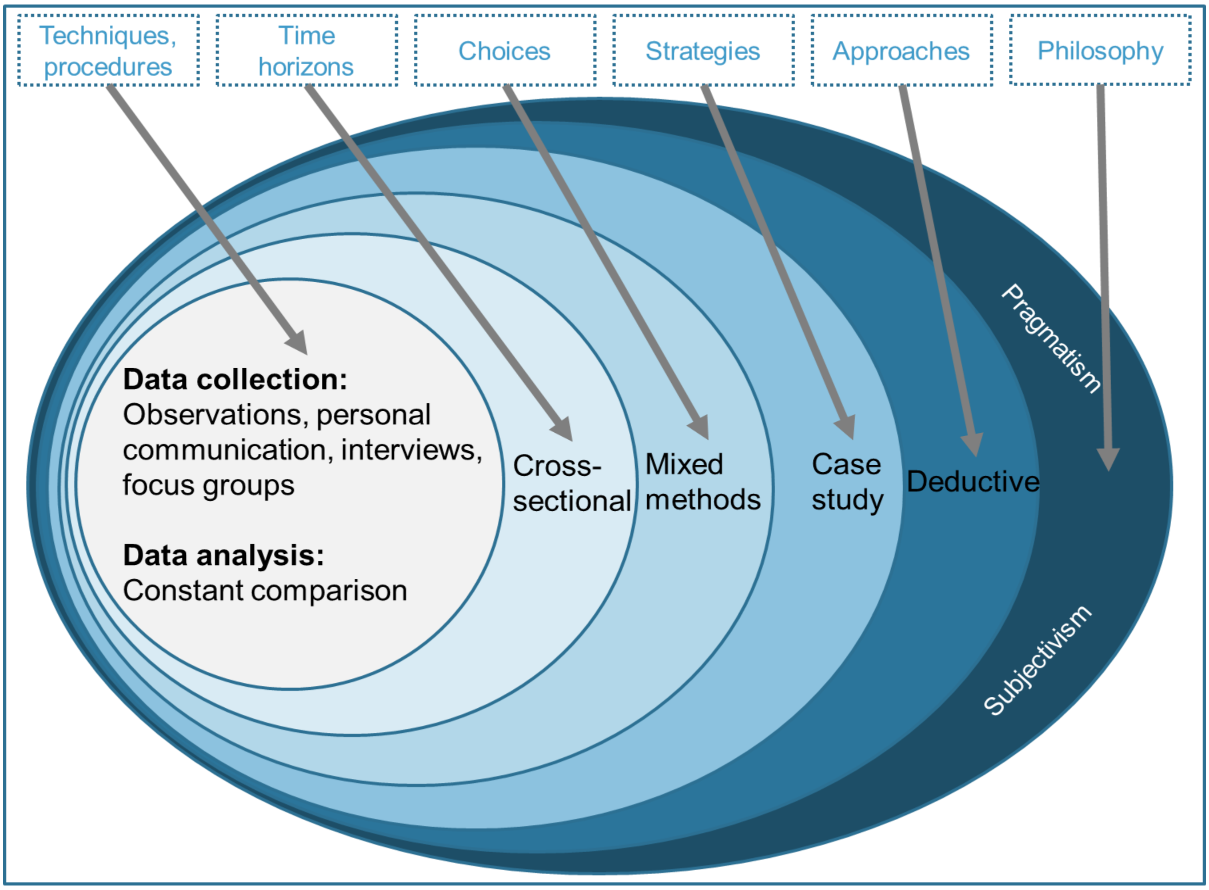


Figure 5.10: Summary of research design and methodology

Source: Adapted from Saunders et al. (2016:124)

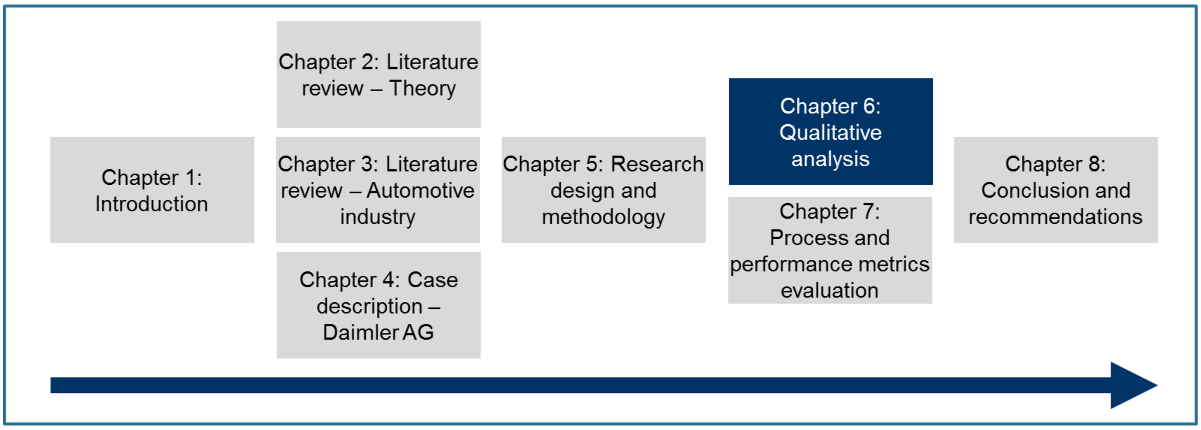
Methodology and design is divided into six layers. Beginning from the outside layer on the right of the graph, the philosophy is described. This study follows a philosophy of subjectivism with an epistemological view of pragmatism. The research approach followed is deductive, ranging from theories and concepts to real observations. In order to achieve the research objectives, a mixed methods approach was decided on. Qualitative data, derived from primary and secondary data, provides information for the study. The focus, however, is on primary data. The time horizon of the study is cross-sectional, focusing on a single event in time.

The centre of the 'research onion' contains the techniques and procedures applied. Data was collected through observations, personal communication, interviews and focus groups. The qualitative data was analysed according to the method of constant comparison. Once all data was analysed, the process and performance metrics evaluation took place. Suggestions to improve demand and capacity planning processes for CKD-vehicles and performance metrics to measure these processes were made according to theories identified in the literature review in a way that provides best usage for demand and capacity planning for CKD-vehicles at MBC.

Chapter 6. Qualitative analysis

"I need to listen well so that I hear what is not said."

(Thuli Madonsela)



6.1. Introduction

Chapter 5 defined a research design and methodology for this study with the aim of answering all the research questions. In addition to secondary data, primary data were collected to receive sufficient information to identify the existing processes, in order to enable an evaluation of these processes. This chapter describes the results of the data collection and data analysis in a twofold manner. Firstly, three SWOT analyses provide general results of the study. Secondly, the qualitative analysis of interviews provides specific results with regard to planning processes for completely-knocked-down (CKD) vehicles as described in Chapter 7.

6.2. SWOT analysis

In order to compile the deductions from the case description, three SWOT analyses summarise the key strengths, weaknesses, opportunities and threats of Daimler Aktiengesellschaft, referred to as Daimler AG (Cadle *et al*., 2010:14). As described in Section 5.4, the analysis is based on secondary data from the company. Data includes internal documents, reports, presentations and computer systems as well as openly accessible information in the form of annual reports or online sources. In addition, personal communication with employees and management as well as various observations contributed to the findings. This section elaborates on the results of three SWOT analyses conducted on the company Daimler AG, supply chain management (SCM) at Mercedes-Benz Cars (MBC) and the CKD-vehicle business at MBC.

6.2.1. Daimler AG

The first SWOT analysis summarises key elements of Daimler AG. The method investigates the overall performance of the whole organisation. Figure 6.1 shows a summary of the SWOT analysis of Daimler AG.

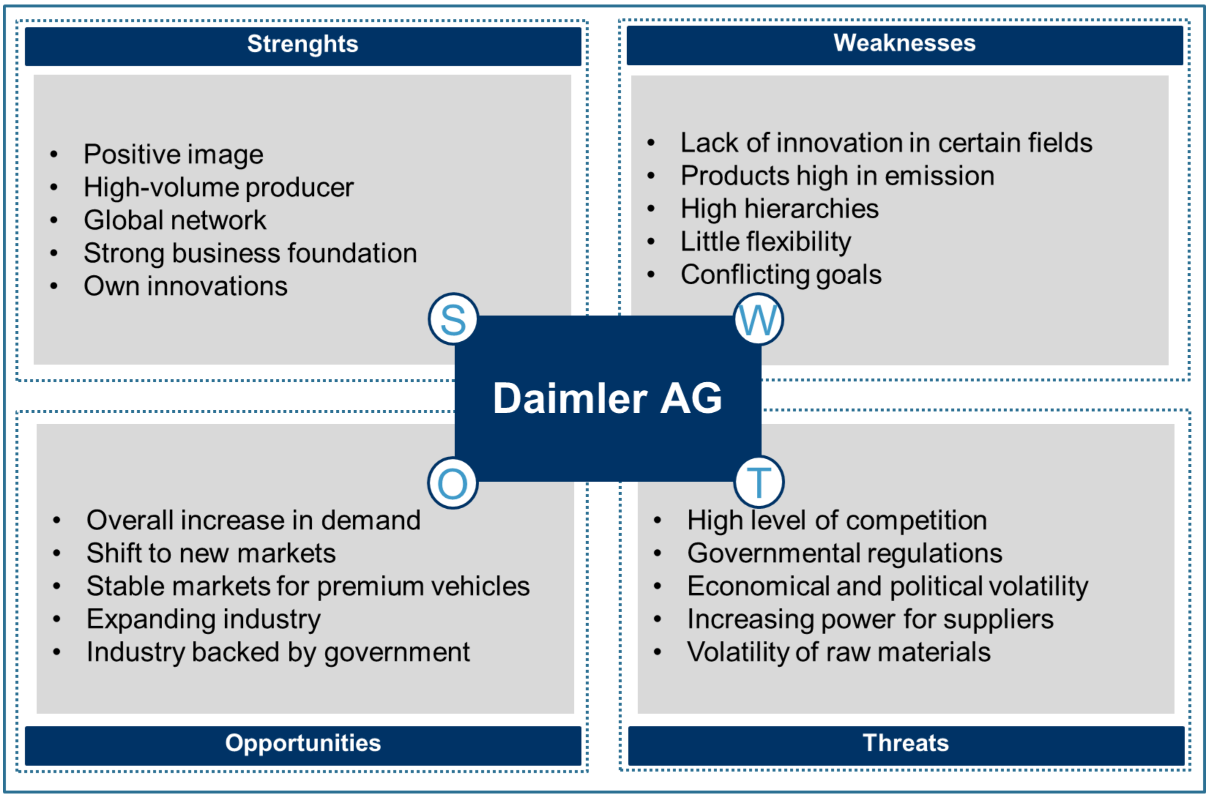


Figure 6.1: SWOT analysis Daimler AG

The original equipment manufacturer (OEM) demonstrates a number of strengths as illustrated in Figure 6.1. Daimler AG, especially MBC, benefits from an overall positive image and public opinion. The premium brand stands for quality, safety and innovation. Customers purchase the cars because the brand exemplifies a prestigious lifestyle (Daimler AG, 2013: 5-8). Other OEMs and suppliers see Daimler AG as a preferable business partner (MO/SC, 2016:7). Besides the image of a premium OEM, Daimler AG is a high-volume producer of vehicles. The OEM balances its product portfolio with very exclusive products, which are characterised by high costs for research and development, long development periods, and more affordable products aimed at mass markets. A global network aids Daimler AG with the development, production and sales of all products (Fahrzeug-Programm-Online, 2017).

Nevertheless, not just the internal network is beneficial. Co-operation and strong ties with other OEMs or suppliers allow Daimler AG to focus on its core strengths, which increases competitiveness in the industry (Daimler AG, 2016a:157). The ability to adapt to changing business environments is another one of Daimler AG's strengths. The company benefits from a strong business foundation. A diverse brand and product portfolio covers both mass and niche markets, giving the business stability and balance (Daimler AG, 2017d). The company has also accumulated a solid financial basis, which allows for further development and innovation (Daimler AG, 2016a:II). Daimler AG focuses on innovation in terms of driving comfort, safety and driver assistance systems. Many of these innovations come from Daimler AG and are protected by patents. These innovations characterise the exclusive products of Daimler AG (Daimler AG, 2017s:23).

Besides the strengths, Daimler AG has a number of weaknesses which offer potential for improvement and growth. Despite great innovations in the fields of driver assistance systems, safety, and driver comfort, Daimler AG is left behind in the field of e-mobility and alternative fuel power. There is limited involvement in battery-driven cars and hybrid engines. The OEM, however, lacks innovation in comparison with other premium brands or international manufacturers (Daimler AG, 2013:6). The majority of Daimler AG's fleet is high in carbon dioxide emissions, especially its sports cars and exclusive vehicles (Fahrzeug-Programm-Online, 2017). High emissions can negatively influence the public's perception or result in conflict with governmental regulations. Daimler AG's organisational structure is built in high hierarchies with little decision-making power at lower levels (Daimler AG, 2017r). As a result, decision-making is a slow process and many decision-making bodies need to be involved. Another result is reduced flexibility and agility. This also applies to other sectors of the business, such as process design, supply chain and operations. The planning is usually set and structures are difficult to change, even when necessary. Lastly, there are conflicting goals between individual business divisions and departments. This is partly applicable to the vision, mission and strategy statements described in Section 4.6.

The external circumstances provide great opportunities for Daimler AG. The automotive industry benefits from almost constant growth and increasing demand, a few minor periods of depression excluded. Besides growth in existing markets, new markets constantly develop, offering opportunities for existing cars and new models. The demand for premium vehicles, specifically, is stable and growing. The premium sector is less affected by economic volatility in comparison to mass markets. The automotive industry can be described as permanently expanding (Daimler AG, 2016a:86). Autonomous driving, alternative engines and different user habits allow the company to expand and create new products. In addition to that, the automotive industry is backed by many governments. It is in a state's interest that the population benefits from mobility. This accounts for private, public and commercial transportation (Daimler AG, 2016a:96).

On the opposite, certain threats pose a challenge to Daimler AG's business operations. The automotive industry is highly competitive. Existing OEMs grow and expand all over the world. Strong competitors in Asia benefit from lower costs for production and services, as well as closer proximity to growing markets (OICA, 2017). Despite overall governmental support for the automotive industry, the industry also faces strict regulations. Carbon dioxide emissions need to be constantly reduced and cars with lower emissions are financially favoured in terms of taxes. In addition, diesel vehicles suffer from a bad reputation due to pollution. Besides overarching agreements, every government or even city has the power to regulate requirements individually in order to achieve a more environmentally sustainable automotive industry (McKinsey&Company, 2016:3).

In addition to economic volatility, political volatility becomes an increasing factor of concern. A trend towards protectionism indicates uncertainty in terms of expanding to new markets. It is uncertain whether foreign plants can utilise their full potential due to local and international market conditions (Dudenhöffer, 2017). The uncertainty inhibits plans for further expansion which puts Daimler AG in a difficult position. Another shift in the automotive industry is the gain of power for suppliers due to vertical integration. Suppliers increase their involvement in research and development and do not simply produce and deliver a part but often develop an invention and market it. Structures change from OEMs assigning suppliers, where the OEM is the initiating party, to suppliers offering products to OEMs (Verband der Automobilindustrie, 2016:6; PricewaterhouseCoopers, 2014b:2). Therefore, there is a risk that Daimler AG can lose its strong position based on innovation.

Another threat is the volatility regarding price and availability of raw materials. This accounts for petrol as well as raw materials used to build the car, such as in the battery or engine. Increasing fuel prices motivate customers to rethink their purchasing decisions and to orientate towards a fuel-efficient or alternative propulsion (McKinsey&Company, 2016:3). Increasing prices for raw materials used to build cars can create a problem that stretches over the full market cycle of a vehicle. Daimler AG determines the price for a vehicle before production starts. With a product life-cycle of a few years, the price of raw materials can change and therefore influence the profit margin of a supplier or the OEM itself. If the supplier is affected, liquidity issues, resulting in non-delivery, can create further problems impacting demand and capacity planning at Daimler AG (SC/KP, 2017a).

The SWOT analysis of Daimler AG shows relations between strengths, weaknesses, opportunities and threats as illustrated in Figure 6.1. The OEM focuses on certain aspects only and therefore neglects others areas. The automotive industry mostly offers opportunities, some of which are, however, linked to risks and threats. Certain weaknesses, such as a lack of innovation in environmentally friendly propulsion create a potential risk in combination with the threat of increasingly strict governmental regulations for sustainability. The company has, however, managed to differentiate itself thanks to great innovations in other fields and therefore manages to grow and leverage expanding markets.

6.2.2. Supply chain management at Mercedes-Benz Cars (MBC)

The second SWOT analysis investigates SCM at MBC from the OEM's perspective. The method looks at the work of MBC departments involved with SCM, as well as SCM as a whole. Figure 6.2 summarises the results of the SWOT analysis for SCM at MBC.

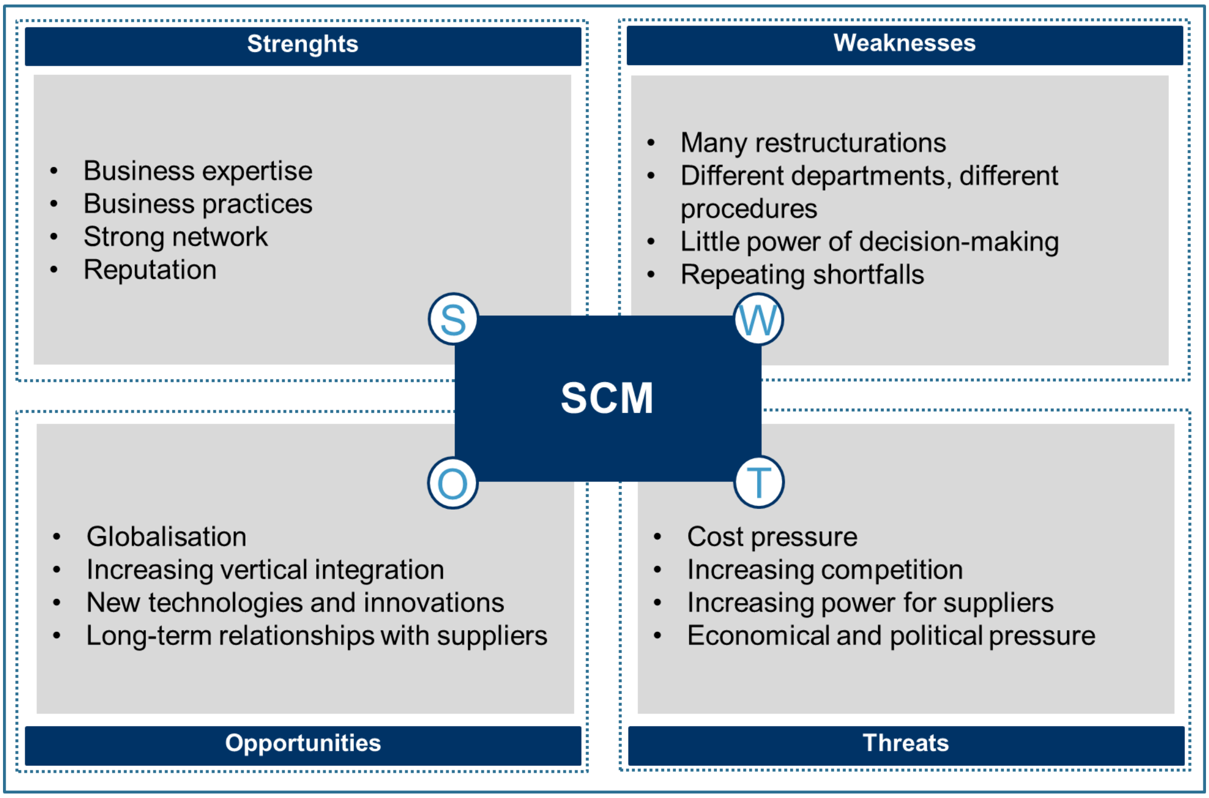


Figure 6.2: SWOT analysis SCM at MBC

A number of strengths are prevalent in SCM at MBC as shown in Figure 6.2. SCM at Daimler AG benefits from excellent business expertise. Many employees know the company and are familiar with different fields and aspects of MBC. Their work experience is combined with academic and practically oriented formation, which provides good business expertise to the employees (SC/KP, 2014). In addition, reliable business practices provide a strong backbone for a successfully functioning SCM. An OEM alone is not able to manage some of the overarching activities for SCM. Over the years, MBC developed a strong network of cooperating OEMs, suppliers and logistics service providers (3PLs). This global network is under constant development, aimed at sustainable growth and efficiency. A positive reputation is another strength of MBC. Thus other businesses, ranging from other OEMs to suppliers to 3PLs, see the OEM as an attractive business partner (MO/SC, 2016).

On the other hand, SCM at MBC experiences several weaknesses. The organisational structure has been redesigned many times, exposing SCM to constant changes (Daimler AG, 2017r). Many departments at MBC are involved with SCM. Even though MBC has general processes, each department follows procedures and processes differently or makes use of tools in a different way. Due to the large size of the organisation, it is difficult to manage and ensure standardised adherence. The large number of different combinations of departments involved poses another obstacle. Administrators and lower management have little power in decision-making. Decision-making bodies or higher levels of management need to be involved in the decision-making process. This is time-consuming and can cause delays in urgent cases such as shortfalls. As in most supply chains, shortfalls can occur. It is, however, the task of SCM to reduce shortfalls by learning from previous experiences. Often, MBC experiences shortfalls caused by the same suppliers. These shortfalls are managed proactively with investments or reactively (SC/KP, 2015:2). In many cases, these interferences do not solve the problem in the long term.

A variety of external circumstances provides opportunities for improvement of SCM at MBC. Increasing globalisation offers new potential for co-operations. Supply chains can be spread all over the world, benefitting from local expertise and working conditions. MBC also grows globally with new plants opening far away from the head office. These expansions are a result of increasing globalisation. Procuring from abroad does not lead to potentially lower labour costs only. Depending on the country, technologies can be more advanced or local expertise can exceed the knowledge of employees in the head office (Daimler AG, 2016a:85). This goes hand in hand with increasing vertical integration. Suppliers gain responsibility and increasingly develop their own parts, which allows MBC to focus on their core business. It is attractive to both the OEM and the supplier to foster long-term relationships instead of short-term contracts for supplying a part requested by the OEM. In the automotive industry, the business environment develops towards longer, more sustainable relationships, which is an excellent opportunity for SCM at MBC.

Furthermore, SCM at MBC faces a variety of threats, many of which come hand in hand with globalisation. Even as a premium manufacturer, cost pressure determines SCM at MBC. OEMs compete for suppliers, offering better contracts, while prices for vehicles tend to decrease. The cost pressure is linked to increasing competition. Local OEMs co-operate with international OEMs and suppliers, whilst international suppliers enter local markets. With increasing vertical integration, even suppliers compete against OEMs in certain fields (Verband der Automobilindustrie, 2016:6). The downside of vertical integration is that suppliers increase their power, becoming a controlling force in the market. These three factors are strongly linked to each other. Additionally, economic and political volatility and pressure pose a risk to SCM at MBC. Political instability as well as new policies can necessitate adjustment in the supply chain. Moreover, foreign countries operate differently from each other. Economic obstacles in a supplier's country can affect the supply chain in ways that are difficult to predict. Section 6.2.3 contains a SWOT analysis on the CKD-vehicle business at MBC, a means to deal with deal with external influences.

6.2.3. The CKD-vehicle business

The third SWOT analysis examines the CKD-vehicle business of MBC. Some of the strengths, weaknesses, opportunities and threats concern the CKD-vehicle business in general, while others are specific to MBC. Figure 6.3 illustrates the results of the SWOT analysis.

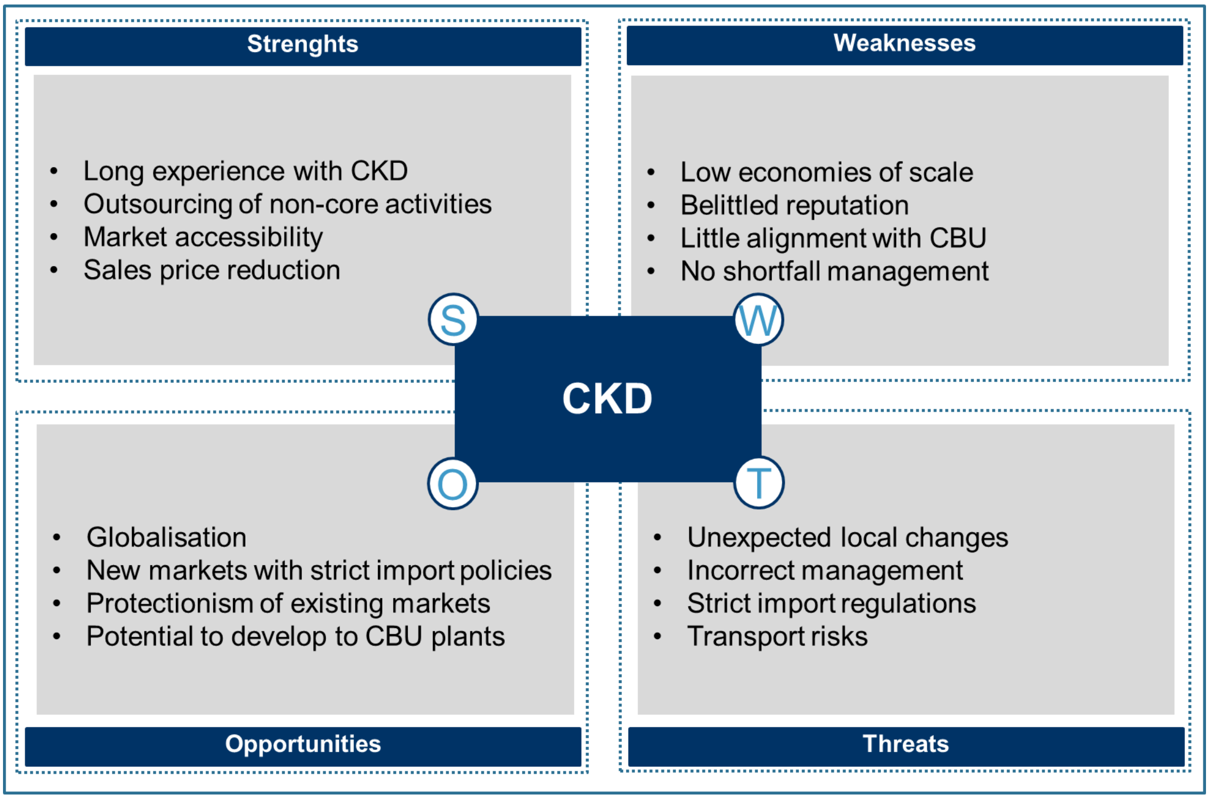


Figure 6.3: SWOT analysis of CKD-vehicle business at MBC

One of the strengths of the CKD-vehicle business is the extensive business experience of MBC. Daimler AG entered the CKD-vehicle business over 60 years ago in 1952 as described in Section 4.2. Since then, many changes and improvements further developed the CKD-vehicle business at MBC. One of the developments is the outsourcing of non-core activities such as packing. MBC assigns certain tasks in long-term relationships to 3PLs with a positive impact on the supply chain performance. The CKD-vehicle business allows MBC to access markets with strict import regulations. MBC therefore focuses its CKD-vehicle business on markets with relatively strong demand, where completely-built-up (CBU) vehicles would be too expensive because of the added tariffs and taxes. Therefore, the CKD-vehicle business facilitates a reduction of sales prices for MBC's finished vehicles, achieved through the import strategy of CKD-vehicles. Being able to offer cars for competitive prices increases the sales volumes of the OEM (SC/WTO2, 2017b).

The CKD-vehicle business is also characterised by certain weaknesses. The biggest difficulty is that small production volumes achieve low economies of scale, especially in comparison with CBU. The relatively small production output is responsible for an overall belittled reputation of CKD-vehicles within the company. The focus of MBC lies on CBU-vehicles, CKD-vehicles are seen as a rather small side project (Fahrzeug-Programm-Online, 2017). As a result, there is little alignment between CBU- and CKD-vehicle planning processes. MBC uses different systems, tools and processes for demand and capacity planning, resulting in forecasts with low quality which makes them unsuitable for further planning. Because of these unreliable processes and forecasts, shortfall management for CKD-vehicles is not possible. MBC works with restrictions for CBU-vehicles only, which creates a strong imbalance (SC/KP, 2017b:4).

The CKD-vehicle business arose in response to external circumstances. There are a variety of opportunities for the CKD-vehicle business to grow further. As for the whole automotive industry, the ongoing trend of globalisation and worldwide economic growth creates new markets for passenger vehicles. Demand in existing markets increases and new markets with very limited demand in the past, start to develop positively. Many of these new markets protect their own economy with import duties which makes them difficult to access for finished goods. A local subsidiary in the form of a CKD-vehicle plant gives the OEM access to the markets (Luethge & Byosiere, 2009:114). A similar development can be observed in existing markets (Dudenhöffer, 2017). Protectionism or international trade restrictions increase complications for CBU-imports. This creates an opportunity for CKD-vehicles. Lastly, a CKD-vehicle assembly plant always has the potential to develop into a CBU plant, such as the plants in South Africa and China (Fahrzeug-Programm-Online, 2017). The CKD-vehicle business is an ideal opportunity to enter a market. MBC can familiarise itself with the market and production conditions to evaluate the feasibility and economic value of a plant in the foreign country.

The CKD-vehicle business also entails a number of threats. Often, MBC is not very familiar with the foreign country where the CKD-vehicle assembly plant is located. The local management in the foreign country might have a different understanding of processes and approaches. In addition, local changes in the foreign country strongly affect the CKD-vehicle plant. These changes can for instance be in local governmental regulations or cultural instances. Because one CKD-vehicle plant serves a single market, such instances can seriously affect production and storage backlog. The combination of local government and centralised planning can create issues of mismanagement. MBC and the management of the foreign plant do not necessarily see each other as one company. Incorrect management in the favour of an entity is a risk. The centralised demand and capacity management usually follows a different strategy in comparison to the local management (SC/WTO2, 2017a).

Another threat is changes in import regulations. CKD-vehicle assembly plants create job opportunities in the foreign country, but not as much as in case of a CBU-vehicle plant. Additionally, a CBU-vehicle plant has the potential to improve the economy in the local country by creating value and export business. It is a constant threat that foreign countries develop a strategy to tax CKD-vehicles to force foreign OEMs into opening CBU-vehicle plants (Dudenhöffer, 2017). Lastly, the CKD-vehicle business involves long-distance transport, via both ship and truck. The transport risks increase with factors such as piracy and fuel price volatility. The situation of transport needs to be permanently observed by the CKD-management at MBC.

The SWOT analysis of the CKD-vehicle business shows significant potential for improvement at Daimler AG. The most significant areas of improvement are better alignment with CBU and a modernisation of processes and systems. If MBC ignores the problem areas, the company might miss opportunities to increase performance and grow and threats might become imminent risks.

6.3. Qualitative data analysis of planning processes

This study investigates the processes of CKD-vehicle planning in accordance with the research questions. Qualitative data was collected through the means of interviews as described in Section 5.5. The results of the qualitative analysis described in this section form an essential component for the identification and evaluation of processes in Chapter 7. Figure 6.4 illustrates the connected process of data collection and data analysis.

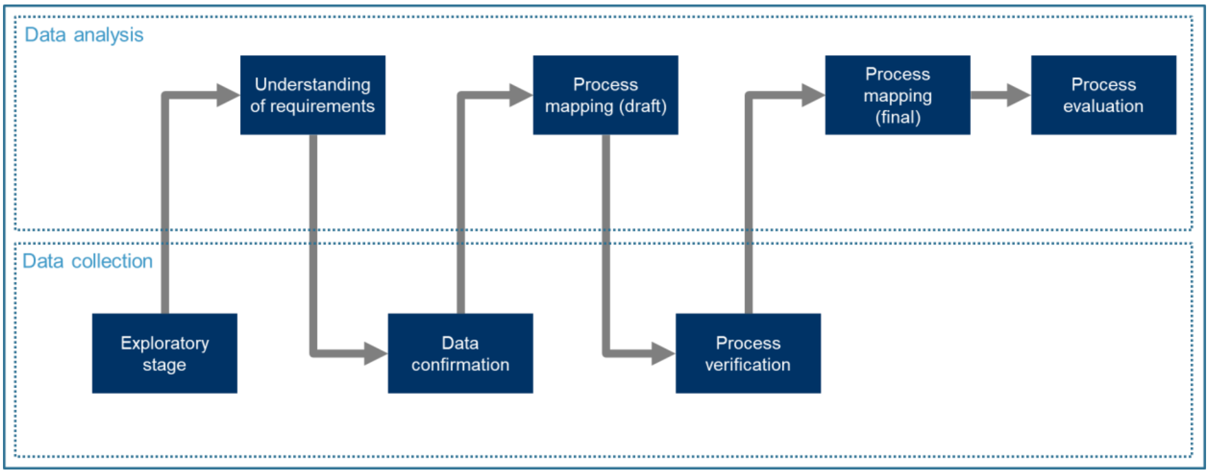
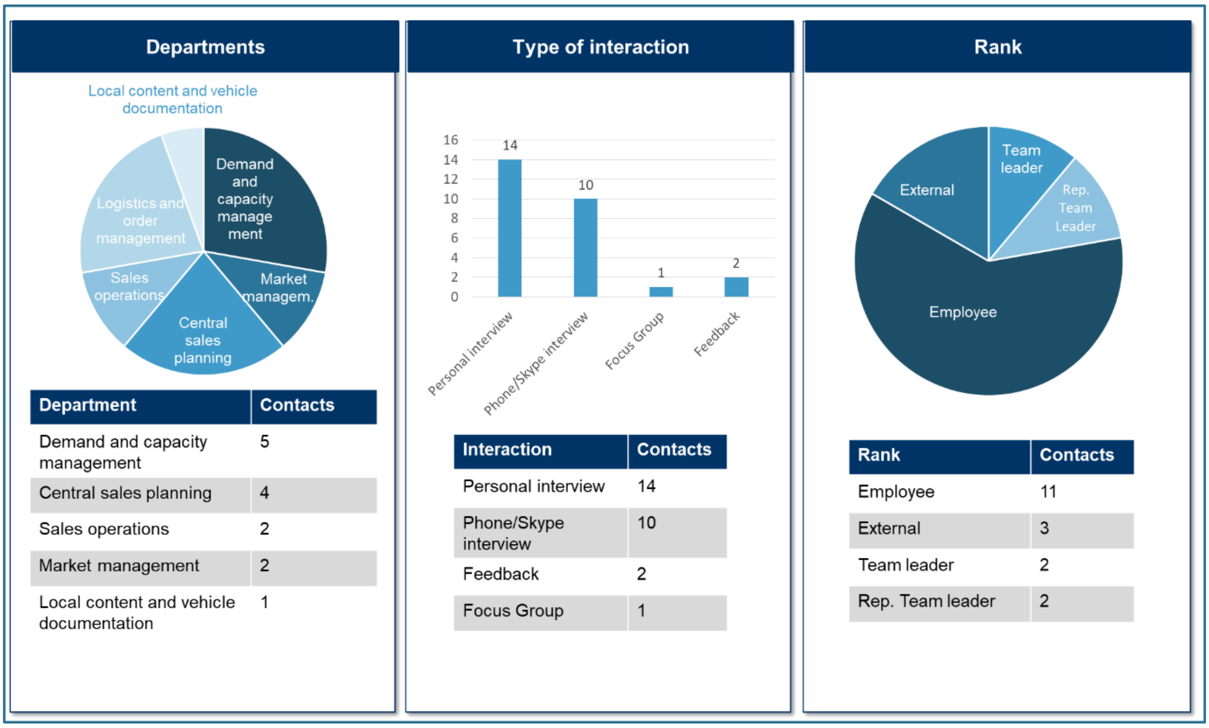


Figure 6.4: Data collection and data analysis

Due to the application of the Delphi method as introduced in Section 5.5.2.3, several rounds of interviews took place. After every interview phase, an analysis of the collected data provided additional insight, leading to the final analysis with the result of mapped processes. In an exploratory stage, data collection consisted of a first round of interviews to gain a general overview on the topic of sales and operations planning (S&OP) for CKD-vehicles at MBC, especially in terms of processes in place and performance measurements. An analysis of the collected data provided a general understanding of requirements. Based on the results of the first analysis, a second round of data collection was conducted with the same interviewees or representatives of these employees according to availability. After completion of the second round, the analysis yielded sufficient information to document a first draft of processes currently in place. The final round of data collection was based on the newly mapped processes. The processes were shown to interviewees from round one and two to confirm accuracy and suitability. Results from the analysis of this round of data collection were improvements required to map representative and complete processes. Based on these suggestions, a final version of processes was mapped for CKD- and CBU-vehicle processes. In addition, all three rounds of data collection provided data on problems with currently existing processes and practices as well as potential for further improvements. Section 6.3.1 describes how data collection took place and Section 6.3.2 further elaborates on the data analysis with a focus on groundedness and co-occurrence of codes.

6.3.1. Qualitative data collection

Data collection took place at MBC in Germany over a period of six months from February to July 2017. A total of 27 interviews was conducted with 18 participants. The application of the Delphi method required for specific participants to be interviewed more than once to verify the interview content. Addendum G contains the interview schedule. All interviews took place in a semi-structured manner with open-ended questions. Figure 6.5 summarises the distribution of data collection, describing the departments the researcher interacted with, the type of interaction and the rank of the participants.



Department	Contacts
Demand and capacity management	5
Central sales planning	4
Sales operations	2
Market management	2
Local content and vehicle documentation	1

Interaction	Contacts
Personal interview	14
Phone/Skype interview	10
Feedback	2
Focus Group	1

Rank	Contacts
Employee	11
External	3
Team leader	2
Rep. Team leader	2

Figure 6.5: Summary and source of data collection

Departments interacted with during the research process include *Demand and capacity management*, *Market management*, *Central sales planning*, *Sales operations*, *Logistics and order management* as well as *Vehicle documentation and local content*. Section 4.5 previously introduced the company structure and the hierarchical relation between departments. Involvement of other disciplines besides logistics provided the researcher with the ability to understand the demand and capacity planning processes in place at MBC. The second column of Figure 6.5 describes the types of interaction. The interactions include one focus group session, twelve interviews conducted face-to face, eleven interviews conducted telephonically or via Skype as well as two feedback sessions to review the research. Lastly, column three of Figure 6.5 shows the rank of each participant within MBC. Two team leaders, two representative team leaders, eleven employees and three external staff working for MBC participated in the study. All participants are experts in their field of work, approached as the most suitable candidate in their department or field of work at MBC.

In addition to the interviews, a variety of observations, emails and conversations took place in the business environment of MBC. The researcher was part of a team in the *Demand and* *capacity planning* department, attending routine meetings and assisting in daily tasks to gain an overview of the business. At the end of the six-month-period, the researcher presented all results from data collection to team leaders and the department manager of *Demand and capacity planning*.

6.3.2. Qualitative analysis of interviews

Data analysis took place using the CAQDAS ATLAS.ti. Content analysis allows for a qualitative analysis of the gathered interview data. Codes were used to identify key themes. Further, codes were divided into the following five categories:

- **Activities**: This category describes activities that take place during demand and capacity planning at MBC. The processes mapped show the flow and connection between all activities identified during data collection.
- **Complications**: This category consists of problems pointed out. Further, the complications offer a foundation to suggest potential improvements of processes for CKD-vehicle demand and capacity planning.
- **Perceptions**: In this category, the participants' opinion or reactions featured in an interview are collected. Here, the focus is on the employee's attitude or sentiments towards the CKD-environment.
- **Responsibilities:** The category of responsibilities involves the departments in charge of activities relevant to demand and capacity planning for CKD-vehicles. Based on these responsibilities, the mapping of processes assigned activities to respective departments.
- **Themes:** This category gathers all codes that do not fit in other categories but are linked to activities. This can either be output in the form of documents, systems in use or projects or relevant background information.

Content analysis took place based on the codes summarised in these five categories. The codes are described together with the analysis in Section 6.3.2.1, introducing the results of the analysis of frequency for all categories.

6.3.2.1. Analysis of frequency

A frequency count of all codes provides the groundedness of each code. It is counted how often participants mention or indicate an aspect. In addition, the interviews are assigned to specific categories depending on the interviewee's department at MBC. These departments are *Demand and capacity planning, Central sales planning*, *Logistics and order management*, *PBK*, *Vehicle documentation and local content*, *Market management*, *Sales operations* and a focus group, consisting of members of different departments.

The foundation for all mapped processes lies in this data analysis. Sections *a* to *e* describe the outcome of the data analysis for each category. Chapter 4 introduced departments, demand and capacity planning at MBC as well as specific themes to the reader. Chapter 7 discusses the outcome of the analysis, leading to the mapping and evaluation of processes for demand and capacity planning.

a. Activities

Activities describe process steps that are part of one of the three processes subject to this study. There are different processes in place for CKD-vehicle planning and CBU-vehicle planning. For codes, there is no differentiation between the processes. This means that the same code applies for CBU- and CKD-vehicle processes if the activity exists in both processes. Due to the number of codes relating to activities, the analysis is divided into three sections: codes for volume planning, codes for SA-planning, and codes for the planning of ordering and shipping. Some codes are relevant to more than one process and are therefore included more than once. Figure 6.6 points out the activities relevant to the volume planning process, taking into account the number of quotations by each department. Addendum H contains a table with all quotations.

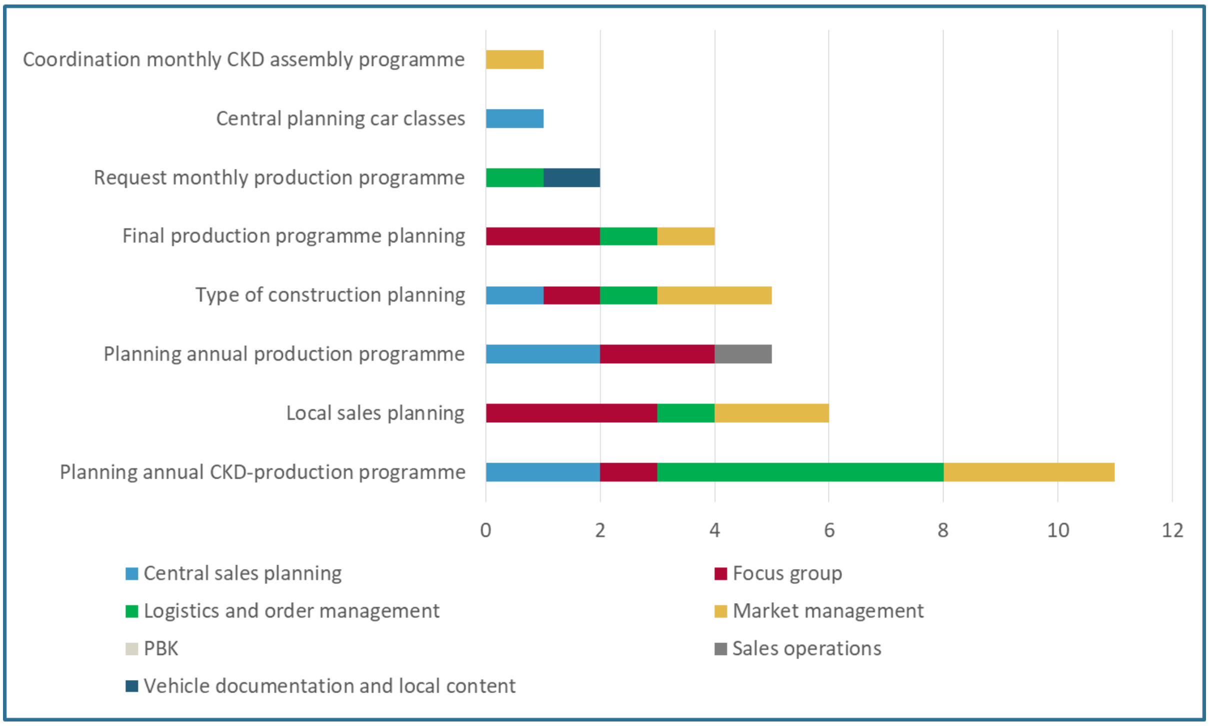


Figure 6.6: Groundedness of activities in the volume planning process

The codes for activities relevant to volume planning are

- planning annual CKD-vehicle production programme;
- local sales planning;
- type of construction planning;
- planning annual production programme;
- final production programme planning;
- request monthly production programme;
- coordination monthly CKD-vehicle assembly programme; and
- central planning car classes.

The codes for planning annual CKD-vehicle production programme, local sales planning, type of construction planning and planning annual production programme reach the highest levels of groundedness with eleven, six, five and five quotations respectively. Participants mentioned the activities of final production programme planning and request monthly production programme four and two times respectively. Two other activities, coordination monthly CKD-vehicle assembly programme and central planning car classes account for one quotation each. Planning annual CKD-vehicle production programme and type of construction planning have been quoted by four departments, followed by planning annual production programme, local sales planning and final production programme planning with three departments quoting these activities. Two departments quoted request monthly production programme. Central planning car classes and coordination monthly assembly programme were each quoted by one department.

Central sales planning quoted the activities type of construction planning, planning annual production programme, planning annual CKD-vehicle production programme as well as central planning car classes. Except for the planning of the annual CKD-vehicle production programme, *Central sales planning* is responsible for the activities listed above. The planning of the annual production programme for CKD-vehicles is relevant to activities the department is in charge of.

Logistics and order management quoted the activities type of construction planning, request monthly production programme, planning annual production programme, local sales planning and final production programme planning. The department accounts for many quotations due to their significant involvement in this process. Further, all activities quoted are the responsibility of the department or relate to an input or output to the department.

The focus group mentioned type of construction planning, planning annual production programme, planning annual CKD-vehicle production programme, local sales planning and final production programme planning. This further stresses the main activities of the process as the focus group members come from different departments and therefore cover all views.

Market management quoted type of construction planning, planning annual CKD-vehicle production programme, local sales planning, final production programme planning and coordination monthly CKD-vehicle assembly programme. The interviewees from these departments focussed on the activities conducted in *Market management* as well as customer supplier activities of these steps.

The *PBK* project did not quote any of the activities relevant to volume planning, possibly due to the fact that *PBK* is not involved with volume planning of CKD-vehicles. Similar to that, *Vehicle documentation and local content* only quoted the request of the monthly production programme. *Vehicle documentation and local content* is not directly involved with volume planning. *Sales operations* is documented with one quote of planning annual production programme as this activity represents an input factor to the department's daily operations.

Planning annual CKD-vehicle production programme receives the most quotations; the activity can thus be seen as the main component of this process. Overall, there is an even distribution of groundedness between most activities. The focus group, *Logistics and order management* as well as *Market management* show the highest involvement and expertise in these activities.

The second process analysed is the planning process for SA for CKD-vehicles. The activities relevant for this process are

- generation of planned orders;
- material forecast (TBE);
- planning of packaging;
- plausibility check of orders;
- local sales planning;
- local market analysis;
- type of construction planning;
- planning annual production programme;
- buildability check;
- validation of technical feasibility;
- market analysis; and
- planning of equipment.

Addendum I contains the number of quotations for each category. Figure 6.7 describes the activities in the SA planning process and their frequency count.

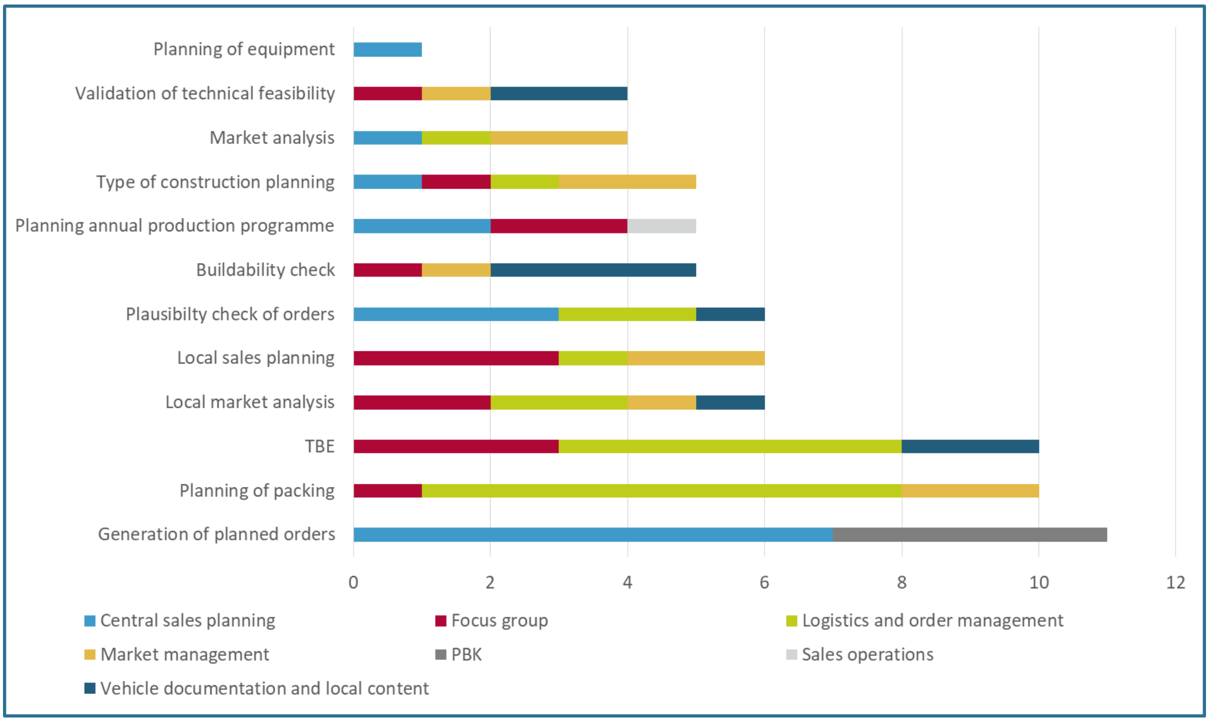


Figure 6.7: Groundedness of activities in the SA planning process

Generation of planned orders reaches the highest frequency count with eleven quotations, followed by TBE and planning of packing with ten quotations each. Plausibility check of orders, local sales planning and local market analysis account for six quotations each, followed by type of construction planning, planning annual production programme and buildability check with five quotations each. Four quotations refer to market analysis and validation of technical feasibility each. *Central sales planning* quoted planning of equipment once. Generation of planned orders was quoted by two departments, namely *Central sales planning* and PBK. Most activities are quoted by three departments, these activities include the validation of technical feasibility, TBE, plausibility check, planning of packing, planning annual production programme, market analysis, local sales planning and buildability check. Four departments referred to the activities of type of construction planning and local market analysis.

Market management quoted the validation of technical feasibility, type of construction planning, planning of packing, market analysis, local sales planning, local market analysis and buildability check. *Market management* is either directly or indirectly involved with these activities quoted, except for planning of packing which takes place at the 3PL. Most other activities describe process steps conducted by *Market management*, such as type of construction planning and market analysis. The remaining activities describe steps conducted by surrounding departments.

Vehicle documentation and local content quoted validation of technical feasibility, TBE, plausibility check of orders, local market analysis and buildability check. Besides the activities conducted by *Vehicle documentation and local content*, such as validation of technical feasibility and buildability check, other activities either depend on the department's input or the department's activities depend on these activities.

The focus group accounts for the largest variety of quotations due to the diversity of members. For the processes for SA planning, the focus group quoted validation of technical feasibility, type of construction planning, TBE, planning of packing, planning annual production programme, local sales planning, local market analysis and buildability check.

Logistics and order management quoted the type of construction planning, TBE, plausibility check for orders, planning of packing, market analysis, local sales planning and local market analysis. The majority of these activities is within the responsibility of *Logistics and order management* or linked to the activities of the department.

Members of *PBK* quoted the generation of planned orders several times as this is the focus of the project. Sales operations quoted the planning annual production programme as the activities of the department depend on this activity.

The majority of activities relevant to the process of SA-planning achieve a relatively high level of groundedness with mostly three different departments confirming the quotations. It becomes clear that there is a good level of awareness of activities and process steps. For SA, most information comes from logistics and order management, market management, the focus group and central sales planning.

The third process describes the planning process for ordering and shipping for CKD-vehicles. Activities involved are

- local content management;
- TBE;
- planning of packing;
- planning of containerisation and shipping;
- order processing;
- planning of containerisation and shipping local content;
- planning of assembly of parts supplier;
- packing of local content parts;
- ordering of local content parts;

- order planning; and
- manual order input.

Addendum J contains the number of quotations for this planning process and each category. Figure 6.8 illustrates the groundedness of activities in the ordering and shipping process.

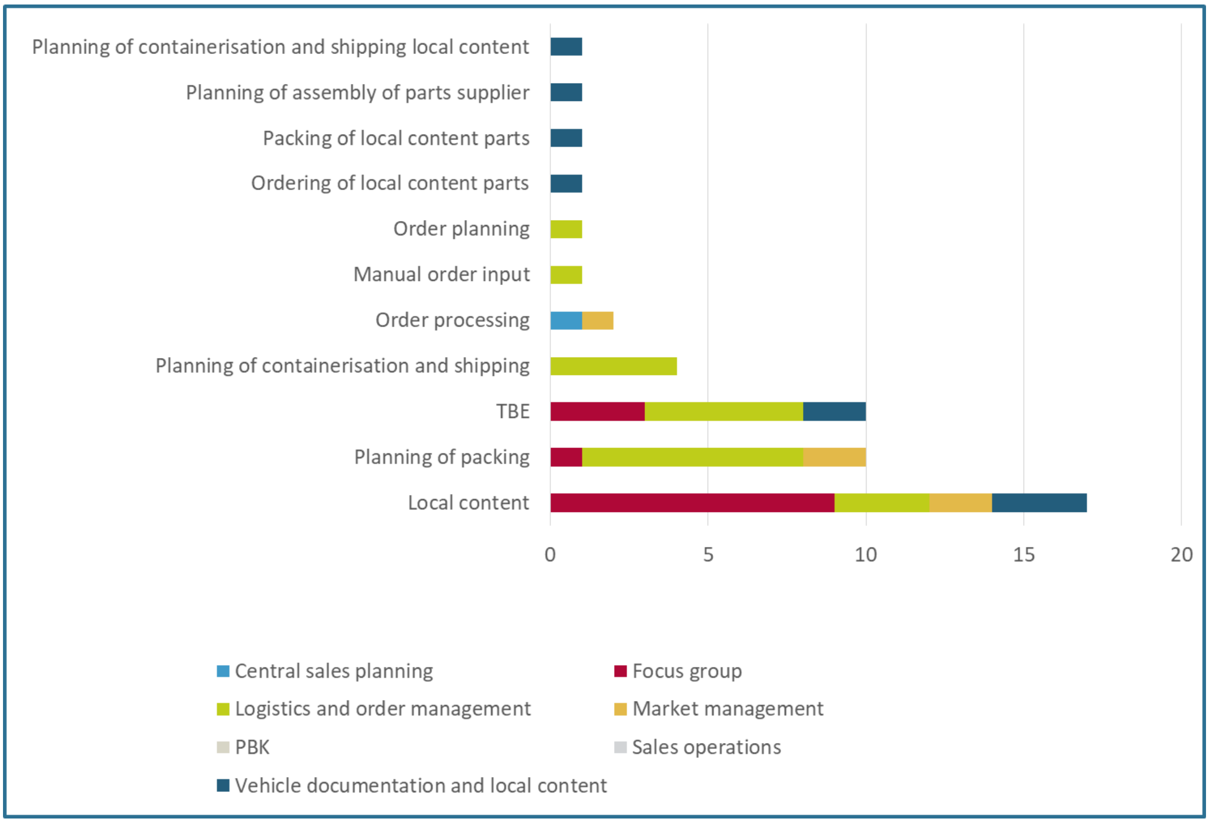


Figure 6.8: Groundedness of activities in the ordering and shipping process

Local content management achieves the highest level of groundedness with 17 quotations by four different departments, followed by TBE and planning of packing with ten quotations by three departments respectively. Planning of containerisation and shipping was quoted four times by the same department, while order processing received a groundedness of two with quotations from two different departments. The other activities, namely planning of containerisation and shipping local content, planning of assembly of parts supplier, packing of local content parts, ordering local content parts, order planning and manual order input received one quotation by one department respectively.

Central sales planning, quoted the activity of order processing once. *Sales operations* and *PBK* did not quote any of the activities relevant to this process. The few to no quotations of these departments can be explained by the limited involvement of these departments in this process.

Logistics and order management quoted several activities, namely TBE, planning of packing, planning of containerisation and shipping, order planning, manual order input and local content. *Logistics and order management* is strongly involved with this process together with *Vehicle documentation and local content*.

Vehicle documentation and local content accounts for the same number of quotations as *Logistics and order management*. Activities quoted are TBE, planning of containerisation and shipping local content, planning of assembly of parts supplier, packing of local content parts, ordering of local content parts and local content. *Vehicle documentation and local content* is the only department at MBC that is fully involved with local content management, therefore the expertise in this field.

Compared to the activities in the process of volume planning and SA-planning, the level of groundedness is relatively low for the majority of activities in this process due to high unawareness in the main business of MBC. The departments in charge of CBU-vehicle business are familiar with the term local content and the activity of local content management, which explains the high frequency of quotations for local content management. The detailed content of the process is, however, mostly known to CKD-vehicle specific departments such as *Vehicle documentation and local content* and *logistics and order management*. *Vehicle documentation and local content* is responsible for local content management, there is no involvement of other departments. Therefore, most of the expertise in this topic comes from this department.

Based on the results of the analysis and the co-occurrence analysis in Section 6.3.2.2, the description and mapping of processes is possible. There are, however, further details that can be derived from the interviews in addition to the activities described in this section. The Sections *b* to *e* further investigate these additional themes.

b. Complications

In the interviews, participants pointed out different complications related to the current processes and practices in place. The complications identified are

- lead time;
- manual editing;
- an inaccurate forecast for CKD-vehicles;
- unforeseeable changes in demand; and
- an increase of derivates for CKD-vehicles.

Addendum K shows the results of the analysis in table format. Figure 6.9 summarises the most prevalent complications.

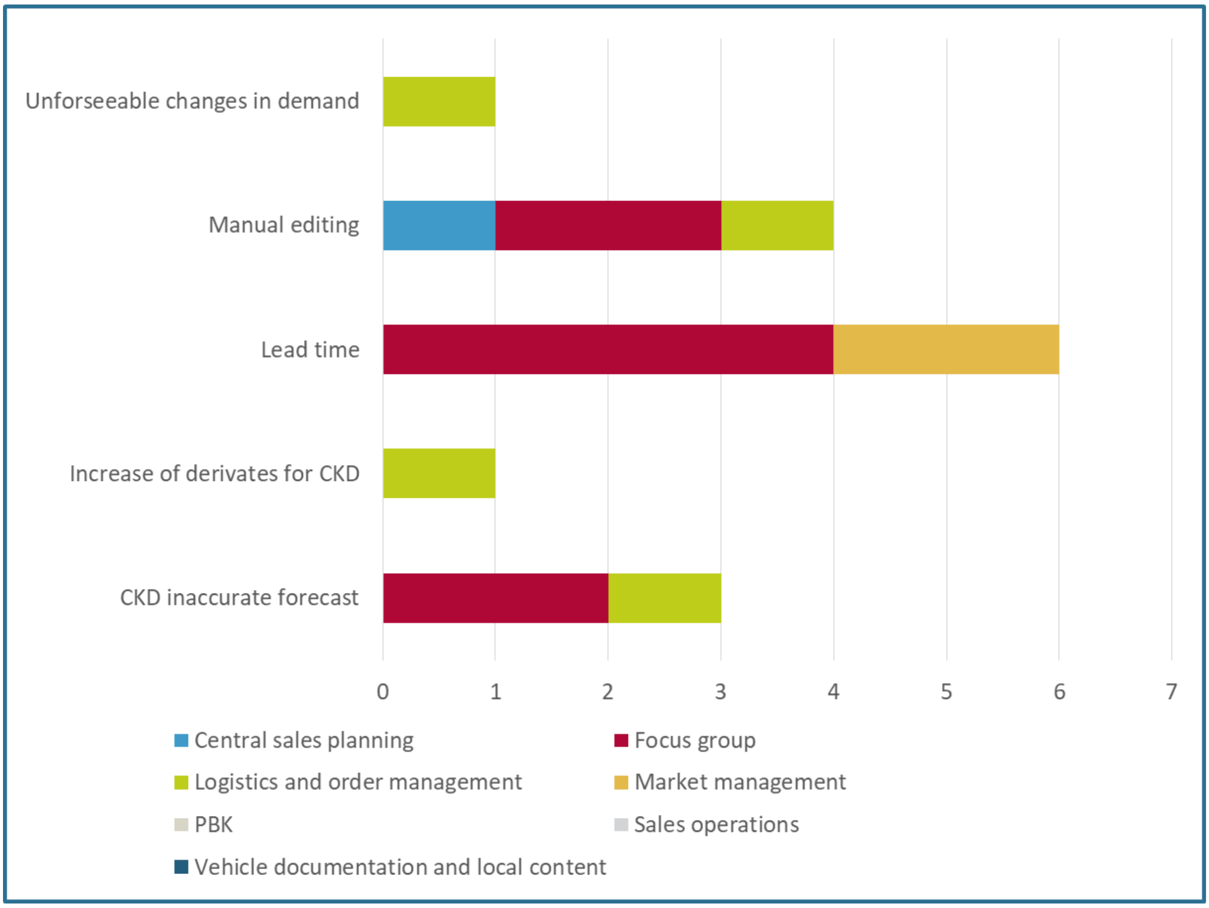


Figure 6.9: Groundedness of complications

Lead time reaches the highest level of groundedness in this category with six quotations by two different departments, followed by the complication of manual editing which was quoted four times by a total of three different departments. The inaccuracy of the forecast of CKD-vehicles received three quotations by two departments combined. The increase of derivates for CKD-vehicles as well as unforeseeable changes in demand were quoted once respectively by *Logistics and order management.* Further, *Logistics and order management* quoted manual edits and the inaccuracy of the CKD-vehicle forecast as relevant complications. The activities conducted at *Logistics and order management* strongly rely on manual edits and the department sees the difference between real orders and forecasted ones once real orders are available, hence the awareness of these complications.

The focus group addressed most complications, followed by *Logistics and order management*. The focus group quoted manual edits, lead time and forecasting inaccuracy. The atmosphere of the focus group allowed for a critical view of the subject which lead to the identification of several complications.

Market management and *Central sales planning* pointed out potential improvement area respectively, namely lead time and manual edit. The activities *Market management* conducts are extensive in lead time while *Central sales planning* is unable to implement the CKD-vehicle forecast due to the manual handling.

In their interviews, *PBK*, *Vehicle documentation and local content,* as well as *Sales operations* did not address any complications. As a project implemented to improve the current forecasting system, *PBK* should have had the expertise to address complications related to forecasting. These departments, however, chose not to address complications outside of the focus group.

During the focus group session with several employees, the atmosphere developed in a way that supported the discussion of current complications. Except for *Logistics and order management*, the other departments avoided to openly address existing problems in their own business practices. The number of complications openly addressed by MBC employees is therefore limited. Based on additional observations, the mapping of processes and existing theories from literature, further complications and areas of improvement arose.

c. Perceptions

Based on the interviews, the attitude of individual departments towards the CKD-vehicle business could be identified. The content of specific statements, but also the wording of such statements indicates

- a negative perception of the CKD-vehicle business;
- a positive perception of the CKD-vehicle business;
- a neutral perception of the CKD-vehicle business; or
- the idea of the CKD-vehicle business as its own world.

Figure 6.10 illustrates the distribution of perceptions. Addendum L contains the results of the analysis in table format.

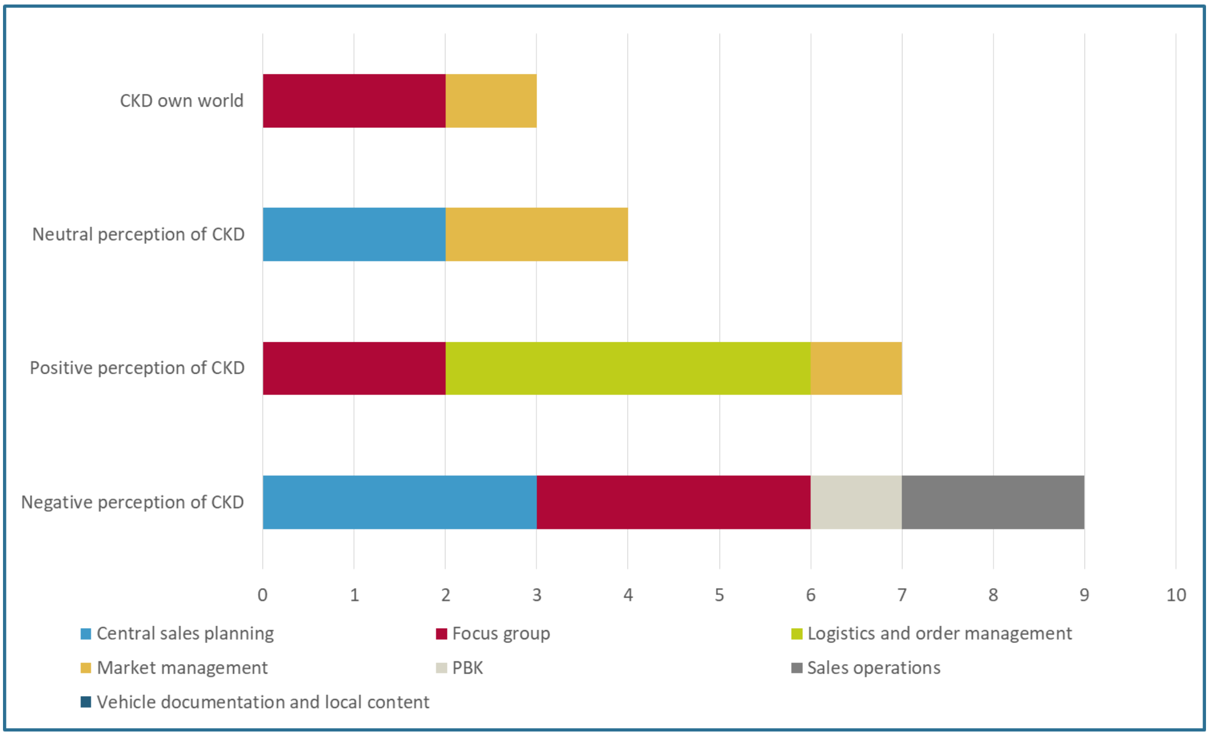


Figure 6.10: Groundedness of perceptions

Most quotations identified a negative perception of the CKD-vehicle business, totalling to nine quotations by four departments combined. On the contrary, seven quotations referred to the CKD-vehicle business in a positive way, distributed over three departments. Five quotations by two departments combined are neither positive nor negative, depicting the CKD-vehicle business in a neutral way. Two departments, totalling up to four quotations, describe the CKD-vehicle business as "its own world" detached from the CBU-vehicle business.

Central sales planning indicated in the interviews that there is a negative to neutral perception of the CKD-vehicle business. This department works with both CKD- and CBU-vehicle forecasts and CKD-vehicle forecasts regularly suffer from inaccuracy due to the input factors being inaccurate. As a result, *Central sales planning* might not see the CKD-vehicle business in a positive light.

Market management indicated a positive perception of the CKD-vehicle business, a neutral perception of the CKD-business as well as a statement that the CKD-vehicle business can be seen as its own world. Although *Market management* works with both CBU- and CKD-vehicle markets, the interviewees are mostly involved with CKD-vehicle planning. The combination of both enables a comparison of the two strategies, leading to the conclusion that the CKD-vehicle business is seen as its own world with a positive to neutral connotation.

The focus group mentioned a positive as well as negative perception, and further described the CKD-vehicle business as its own world. The variety of opinions is due to the different departments of the participants of the focus group. The atmosphere of the focus group might have led to more extreme opinions rather than a neutral view on the CKD-vehicle business.

Both *PBK* and *Sales operations* indicated a negative view of the CKD-vehicle business. The negative view is likely a result of the daily operations of the project and the department. *PBK* aims to improve vehicle forecasting where CKD-vehicle forecasting also plays a role in it. *Sales operations* is limited in their operations due to the differences in handling of CKD-vehicle SA.

Logistics and order management has a positive perception of the CKD-vehicle business. The department's daily operations focus on CKD-vehicle planning, and there is no direct involvement with the CBU-vehicle business. The interviewees feel a strong connection to the CKD-vehicle business at MBC.

The only department that did not indicate a perception of the CKD-vehicle business was *Vehicle documentation and local content*. All other departments specifically designed for CKD-vehicle business generally show a positive attitude towards the CKD-vehicle business, while departments mostly concerned with CBU-vehicle planning have a rather negative perception of the CKD-vehicle business. A neutral perception can mostly be observed by departments that deal equally with CBU- and CKD-vehicles. Mostly departments strongly involved with the CKD-vehicle business describe the business as its own world, detached from the CBU-vehicle business, most likely due to the fact that these entities are familiar with both procedures and aware of the differences.

d. Responsibilities

Activities are assigned to departments within MBC or external parties in the form of responsibilities. The departments or entities are responsible for the management of these activities. Responsible entities are:

- *Logistics and order management*;
- *Vehicle documentation and local content*;
- *Central sales planning*;
- *Market management*;
- local sales company;
- local production company;
- 3PL;

- local suppliers CKD;
- international suppliers;
- *Demand and capacity planning;* and
- suppliers in the country of origin.

Figure 6.11 illustrates the groundedness of the responsibilities. Addendum M supports the Figure with all information in table format.

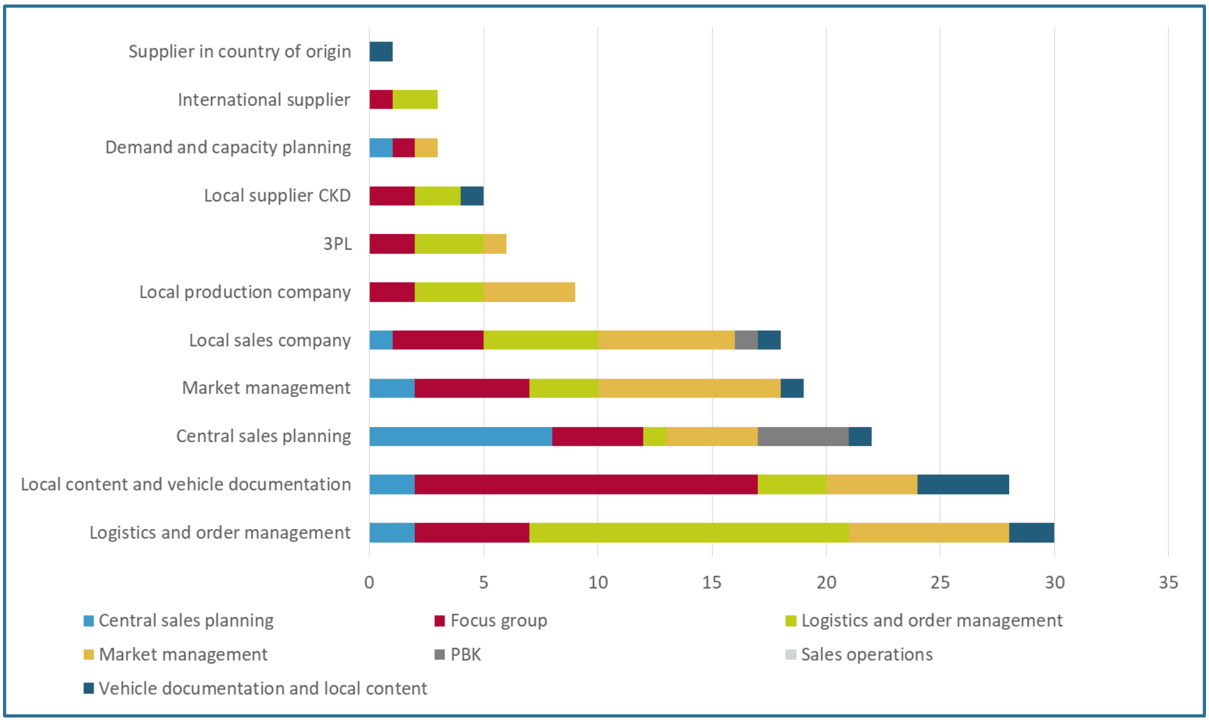


Figure 6.11: Groundedness of responsibilities

Logistics and order management receives the highest level of groundedness with 30 quotations by five departments combined, followed by *Vehicle documentation and local content* with 28 quotations by five departments combined. *Central sales planning* was quoted 22 times by six different departments, followed by *Market management* and the local sales company with 19 and 18 quotations, quoted by five and six departments respectively. The local production company received nine quotations by three departments combined while six quotations by three departments identified responsibilities of the 3PL. Three departments identified the local supplier CKD-vehicle as the responsible entity for an activity in five different quotations. *Demand and capacity planning*, as well as the international supplier, received three quotations by three and two departments respectively. The supplier in country of origin was quoted once by *Vehicle documentation and local content*.

The distribution of responsibilities show that *Logistics and order management*, together with *Vehicle documentation and local content*, are the key players for CKD-vehicle planning processes. *Central sales planning* and *Market management* also play major roles, but these departments are involved in both the CBU-and CKD-vehicle planning activities while *Logistics and order management* as well as *Vehicle documentation and local content* specialise in CKD-vehicle planning. Due to the focus of the study, the significance of the local sales and local production company is relatively low compared to their overall significance in the CKD-vehicle business. It is also noticeable that *Demand and capacity planning* receives very little responsibilities for planning activities, due to the fact that the department is not actively involved in these planning processes but uses the outcomes of these processes for its daily operations.

e. Themes

The category of themes consists of all categories that do not fit in any of the other categories. Due to the significance of computer systems and planning tools, these themes are shown separately, including the themes

- Code-SA list;
- annual programme planning (JPP);
- sales data used for material forecast (GOP);
- Global Ordering (GO);
- Cesar;
- monthly programme planning MPP; and
- Integrated Sales Planning for Daimler (ISP4D).

Figure 6.12 focuses on programmes and planning tools. Addendum N contains the results of the analysis.

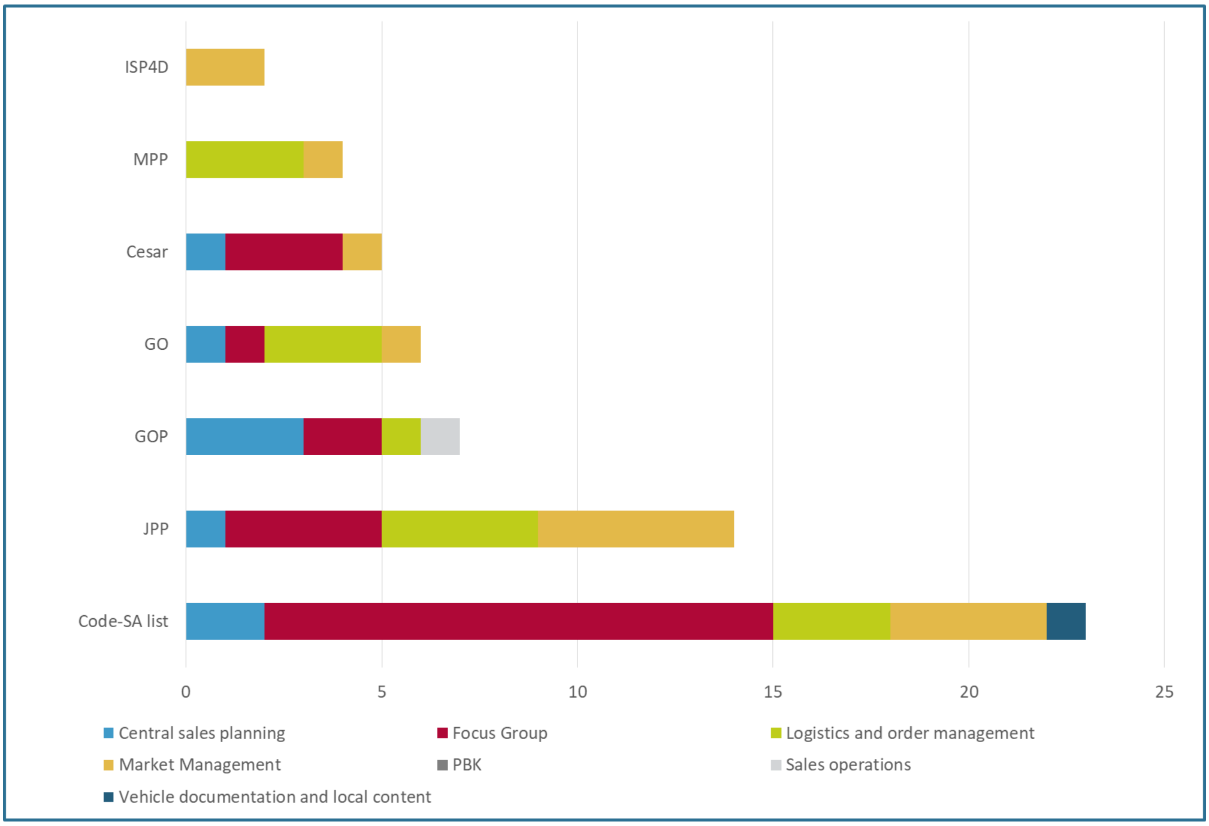


Figure 6.12: Groundedness of computer programmes and planning tools

The most quotations received is Code-SA list with 24 quotations from six different departments, followed by JPP with 14 quotations by four departments. GOP received seven quotations by four departments, followed by GO with six quotations by four departments. Cesar was quoted five times by three different departments while MPP received four quotations by two departments. *Market management* mentioned ISP4D in one quotation.

Central sales planning quoted the computer systems JPP, GOP, GO, Code-SA list and Cesar. *Central sales planning* develops the GOP and operates with GO and Cesar. JPP and the Code-SA list are input factors to the GOP and therefore relevant to the department.

Market management quoted all systems except for GOP. The department uses ISP4D and works with GO and Cesar. Code-SA list, JPP and MPP depend on information from *Market management*. The department is not directly involved with the GOP.

Vehicle documentation and local content only quoted the Code-SA list. The department develops and manages the tool and is not directly involved with any other computer systems and planning tools.

The focus group mentioned JPP, GOP, GO, Code-SA list and Cesar. The programmes JPP and Code-SA list are unique to the CKD-vehicle business. Cesar is of relevance to the CKD-vehicle business as the system is being introduced with the opening of the new CKD-vehicle plant in Russia. Cesar allows for an integration of orders into GO, which is used to develop the GOP.

In alignment with the focus of the project, *PBK* quoted GOP once. *Sales operations* did not mention any of the systems and planning tools. The daily operations of the two entities do not include CKD-vehicle planning, possibly leading to fewer quotations in this area.

Logistics and order management, together with the focus group, provided the most quotations. *Logistics and order management* quoted MPP, JPP, GOP, GO and Code-SA list. The department develops MPP and JPP and further works with the Code-SA list. *Logistics and order management* provide information for the development of GOP and is aware of the significance of GO for order management.

Code-SA list and JPP are important components of CKD-vehicle planning. Besides their importance and application in different process steps, several departments make use of these planning tools or the results thereof. The same applies for GOP with the limitation that GOP is mostly used in CBU-vehicle planning. Other systems, such as GO or ISPD4, are only in use by a limited number of departments.

Summarising all aspects that do not fit in any other category, themes include

- SA take-rate;
- national sales type (NST);
- type of construction (BM);
- PBK;
- GO Redesign;
- real orders;
- class type (TKL);
- short-term planning;
- equipment list;
- volume planning;
- Shortfall;
- rest of world; and
- CoRe.

Figure 6.13 illustrates the groundedness of these themes. Addendum O summarises the results of the analysis.

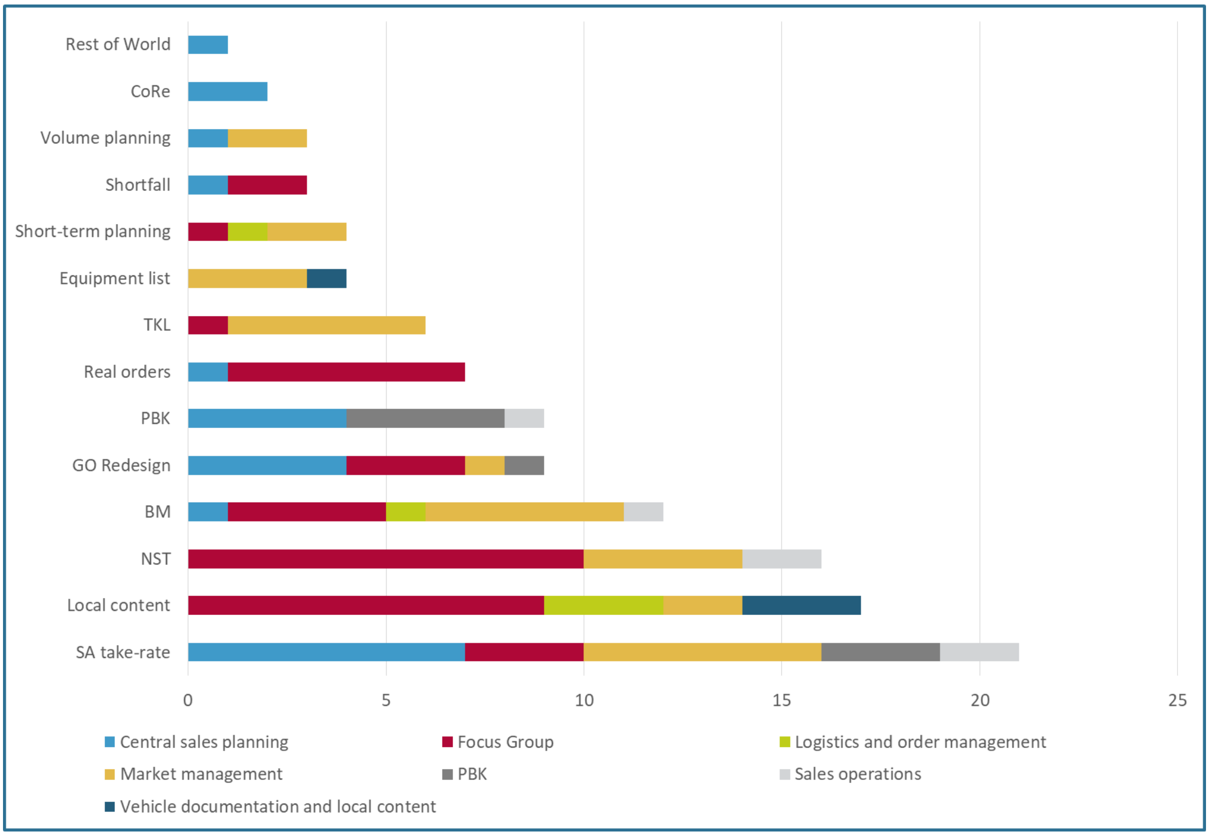


Figure 6.13: Groundedness of themes

SA take-rate reaches the highest level of groundedness with 21 quotations by five different departments, followed by NSTs with 16 quotations from three different departments and the theme of BM with twelve quotations from five departments combined. The projects PBK and GO Redesign received nine quotations from three and four departments respectively. Two departments quoted real orders and TKL, adding up to seven and six quotations respectively. Equipment list and short-term planning both received four quotations by two and three departments respectively, followed by shortfall and volume planning with three quotations by two departments respectively. *Central sales planning* referred to CoRe twice, while quoting rest of world once.

Furthermore, *Central sales planning* quoted volume planning, shortfall, SA-take rate, real orders, PBK, GO Redesign and BM. Central sales planning's key task is volume planning and demand forecasting, which takes into account SA take-rates and real orders. The project PBK has an impact on *Central sales planning* as the project improves the systems and tools used by the department.

Market management quoted volume planning, TKL, short-term planning, SA take-rate, NST, local content, Go Redesign, equipment list and BM. The department is mostly involved with short-term planning, TKL, BM and NST, while the equipment list is a crucial input factor. SA take-rates can be calculated based on the information developed by *Market management*.

Vehicle documentation and local content quoted local content and the equipment list. The department is in charge of the management of local content. Additionally, the equipment list functions as a guideline to design the Code-SA list and is therefore relevant to the department.

The focus group quoted almost every code of this category, namely TKL, short-term planning, shortfall, SA take-rate, real orders, NST, local content, GO Redesign and BM. The participants of the focus group are directly involved with these themes and therefore cover such a broad base. The most quotations, however, go to NST and local content as these two themes are important and required extensive discussion.

The *PBK* project quoted SA take-rate, PBK, Go Redesign and equipment list. As PBK is a project rather than a permanent department, the significance of the project itself as well as another existing project, namely GO Redesign, was stressed in the interviews. Furthermore, the equipment list and SA take-rates are of relevance to the project.

Logistics and order management quoted short-term planning, local content and BM. The department is mostly active in the short-term planning time frame, using BM, rather than TKL, as a planning basis. As *Logistics and order management* is a department only responsible for CKD-vehicle planning, there is some knowledge on the CKD-vehicle specific practice of local content.

Sales operations quoted SA take-rate, PBK, NST and BM. For each BM, *Sales Operations* plans the SA take-rates for the main markets. Changes resulting from the workings of the PBK project result in a new system available for SA take-rates which is relevant to *Sales Operations*. The new system will have the capability to determine NSTs for applicable markets.

The high number of quotations for SA take-rate can be explained by the relevance of this theme and the ambition of *Demand and capacity planning* to establish SA take-rates for CKD-vehicles. NSTs play a major role in demand planning for CKD-vehicles which explains the high frequency count. Other terms, such as BM or TKL account for a high frequency count due to their relevance throughout the processes. Taken together, it is noticeable that the majority of themes has level of groundedness of above three quotations. An analysis of co-occurrences of codes is presented in Section 6.3.2.2.

6.3.2.2. Analysis of co-occurrence

Co-occurrences happen where two codes are applicable to the same or directly surrounding quotations. As a result, links between two categories can be analysed. It counts as a co-occurrence when one quotation contains the same codes or the previous or subsequent quotation contains the code (Lewis, 2012:11). Co-occurrence and groundedness positively relate to each other – the higher the level of co-occurrence, the higher the groundedness. Based on the co-occurrence, it becomes clear which departments are involved with which activities. A high level of co-occurrence does, however, only indicate that the combination is frequent, it does not yield information on the importance or responsibility of the department. Heat maps show where a high number of co-occurrences appear, using a colour scale from green over yellow to red. Figure 6.14 shows the co-occurrence between activities and responsibilities for volume planning.

		Responsibilities					
		Central sales planning	Local production company	Local sales company	Logistics and order management	Market management	Vehicle documentation and local content
Activities	Central planning car classes	1			1	1	
	Coordination monthly production programme				3		
	Final production programme planning		2	1			2
	Local sales planning	1	3	5			2
	Market analysis	1		1	2	2	
	Planning annual CKD production programme	1		1	7	1	
	Planning annual production programme	3			1		
	Request monthly production programme		1	1		1	
	Type of construction planning					2	2

Figure 6.14: Co-occurrences of responsibilities and activities for volume planning

Logistics and order management indicate a co-occurrence of seven quotations with planning annual CKD-vehicle production programme. The second highest co-occurrence refers to five simultaneous quotations for local sales company and local sales planning. A co-occurrence of three applies to the match of *Logistics and order management* with coordination monthly production programme, local production company with local sales planning and central sales planning with planning annual production programme. A co-occurrence of two happened for *Vehicle documentation and local content* with final production programme planning, local sales planning and type of construction planning, for the local production company with final production programme planning, for *Logistics and order management* with market analysis and for *Market management* with market analysis and type of construction planning. One co-occurrence applies to a total of 14 quotations. *Central sales planning* was simultaneously quoted with central planning car classes, local sales planning, market analysis and planning annual CKD-vehicle production programme. Local production company and request monthly production programme share a common quotation. Local sales company receives four matches with activities, namely with final production programme planning, market analysis, planning annual CKD-vehicle production programme and request monthly production programme. For *Logistics and order management*, the analysis recorded two co-occurrences with central planning car classes and planning annual production programme respectively. Lastly, *Market management* has three matching quotations, with central planning car classes, planning annual CKD-vehicle production programme and request monthly production programme.

Figure 6.15 summarises the co-occurrences between activities and responsibilities relevant for SA-planning. Co-occurrences of level one to level six occured for this process.

		Responsibilities						
		3PL	Central sales planning	Local production company	Local sales company	Logistics and order management	Market management	Vehicle documentation and local content
Activities	Buildibility check			1				5
	Generation of planned orders		5		1			
	Local market analysis		1	2	6		2	1
	Local sales planning		1	3	5			2
	Market analysis		1		1	2	2	
	Planning annual production programme		3			1		
	Planning of equipment							
	Planning of packing	3				2		1
	Plausibilty check of orders		1			3		1
	TBE					5		1
	Type of construction planning						2	2
	Validation of technical feasibility			1				4

Figure 6.15: Co-occurrence responsibilities and activities for SA-planning

A co-occurrence of six emerges for local sales company in combination with local market analysis. There are several instances of a co-occurrence of five, *Central sales planning* adds up to five matching quotations with generation of planned orders, *Vehicle documentation and local content* also achieves a value of five in combination with the activity buildability check. Other instances with a co-occurrence level of five are local sales company with local sales planning and *Logistics and order management* with TBE. The analysis further revealed a co-occurrence of four for vehicle documentation and local content in combination with validation of technical feasibility, followed by four co-occurrences of three. 3PL accounts for a co-occurrence with planning of packing, *Central sales planning* matches three times with planning annual production programme, local production company and local sales planning co-occur three times and *Logistics and order management* attain the same level with plausibility check of orders. The analysis identified eight instances with a co-occurrence of two. *Vehicle documentation and local content* is coded simultaneously twice with local sales planning and type of construction planning, local production company combines twice with local market analysis, *Logistics and order management* accounts for two co-occurrences with market analysis and planning of packing respectively, and market management matches twice with local market analysis, market analysis and type of construction planning respectively. Lastly, there are single co-occurrences for the following instances: *Central sales planning* with local market analysis, local sales planning and market analysis, *Vehicle documentation and local content* with local market analysis, planning of packing, plausibility check of orders and TBE, local production company with buildability check and validation of technical feasibility, local sales company with generation of planned orders and market analysis and *Logistics and order management* with planning annual production programme.

Figure 6.16 illustrates the co-occurrences of responsibilities and activities for the ordering and shipping process. Co-occurrences from level one to level nine occur for the codes relevant to this process.

	Responsibilities								
Activities	3PL	Central sales planning	Local production company	Local sales company	Logistics and order management	Market management	International supplier	Local supplier	Vehicle documentation and local content
Final production programme planning			2	1					2
Local content			2	1		1			9
Manual order input					1				
Material planning									
Order planning					1				
Order processing		1							
Ordering of local content parts							1		
Packing of local content parts							1		
Planning of containerisation and shipping	2								
Planning of containerisation and shipping local content							1		
Pre-assembly of module								1	
TBE					5				1

Figure 6.16: Co-occurrence responsibilities and activities for ordering and shipping

The highest level of co-occurrence of nine can be found for *Vehicle documentation and local content* in combination with local content, followed by five co-occurrences for *logistics and order management* with TBE. There are three instances with codes reaching two co-occurrences, namely 3PL with planning and containerisation and shipping, local production company with final production programme planning local content, as well as *Vehicle documentation and local content* with final production programme planning. Lastly, a total of 11 co-occurrences with a count of one are documented: *Central sales planning* with order processing, local sales company with final production programme planning and local content, *Logistics and order management* with manual order input and order planning, *Market management* with local content, international supplier with ordering of local content parts, packing of local content parts and planning and containerisation and shipping local content, local supplier with pre-assembly of modules, and *Vehicle documentation and local* content with TBE.

Some codes reach a relatively high level of co-occurrence in comparison to the majority of co-occurrences. The high level of co-occurrence results from high frequency of these codes used, stressing the significance of these departments and activities for the process of volume planning. Certain activities and responsibilities are linked to each other but only co-occur once or twice due to low frequency in quotations. The key components of the process can however be defined by looking at high levels of groundedness and co-occurrences in combination with the context of the interviews, observations and additional supporting documents from MBC. The chapter is summarised in Section 6.4.

6.4. Concluding remarks

The qualitative analysis presented in this chapter consists of two components, the SWOT analyses with a focus on secondary data and the content analysis with a focus on primary data. The SWOT analyses provide further background information, while the content analysis examines information relevant to process mapping and evaluation.

Three SWOT analyses on Daimler AG, SCM at MBC, and the CKD-vehicle business summarise external and internal positive and negative factors to provide a balanced overview. The SWOT analyses evaluate the background of the study to show the significance of process and performance metrics. The secondary data used in these analyses was sourced from Daimler AG directly, mostly in the form of internal documents.

The content analysis focuses on the qualitative analysis of the interviews conducted during data collection. The major categories analysed were activities, complications, perceptions, responsibilities and other relevant themes. As part of the content analysis, frequency counts and co-occurrence tables were established.

The frequency count determines the level of groundedness of a code. A high frequency, especially with quotations by different departments, indicates higher credibility of a quotation. The frequency tables also show which department quoted which codes, indicating knowledge and therefore involvement in particular activities or themes. In addition to the hard facts provided in interviews, this analysis also looked at the sentiments interviewees show towards the CKD-vehicle business.

Based on frequency, the most significant activities identified are planning annual CKD-vehicle production programme, generation of planned orders, planning of packing, TBE and local content. The most prevalent complications occurring are forecasting inaccuracy, lead time and manual edit of data. The majority of departments has a negative perception of the CKD-vehicle business, while many actors directly involved in CKD-vehicle planning perceive the CKD-vehicle business in a positive way.

Further, the frequency analysis provides insight into the departments in charge of CKD-vehicle planning. The key departments responsible are *Logistics and order management*, *Local content and vehicle documentation* and *Market management*. The three main supporting technologies identified are Code-SA list, JPP and GOP. Other relevant themes to CKD-vehicle demand and capacity planning are SA take-rate, NST and BM.

The co-occurrence tables further support the involvement of specific departments and activities. These findings are used to confirm mapped processes. High co-occurrences indicate direct involvement. Co-occurrences also indicate the flow of the process and knowledgeable participants.

High co-occurrences can be observed between the *Logistics and order management* department and the activity planning annual CKD-vehicle production programme with regard to the planning of JPP. Furthermore, *Vehicle documentation and local content* reaches a high co-occurrence with the activities buildability check and validation of technical feasibility which are preparation processes for the Code-SA list. Another outstanding co-occurrence exists between *Vehicle documentation and local content* and the activity local content.

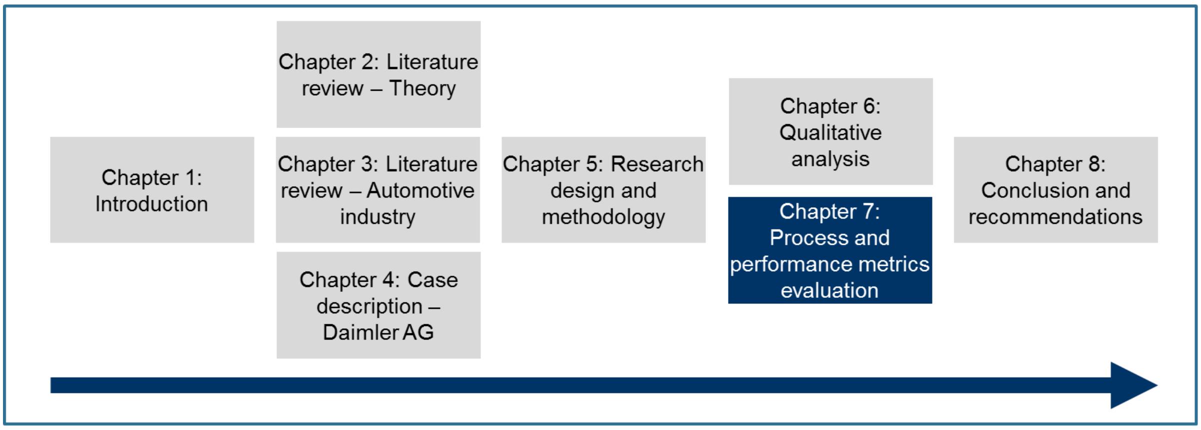
The analyses in this chapter provides a basis for a more informed process identification, mapping and evaluation of the three selected demand and capacity planning processes for CKD-vehicles. The summary of background information, the identification of key actors, as well as key activities supports the observations and secondary data findings. In addition to the results of the content analysis, the actual content of the interviews further guides the mapping and evaluation of the processes further. Based on the analyses in this chapter, Chapter 7 maps and evaluates the selected processes for demand and capacity management, concluding with recommendations of suitable improvements for processes and performance metrics.

Chapter 7. Process and performance metrics evaluation

"Everything should be made as simple as possible,

but not simpler."

(Albert Einstein)



7.1. Introduction

The focus of this chapter is on the process mapping of demand and capacity processes at Mercedes-Benz Cars (MBC). Based on the analyses conducted in Chapter 6, this chapter maps and evaluates the processes for completely-knocked-down (CKD) vehicle planning and evaluates the performance measurement of these processes. Currently, the demand and capacity planning processes for CKD-vehicles differ from the planning processes for completely-built-up (CBU) vehicles. Certain differences are necessary due to particularities regarding CKD-vehicle planning. Other processes and approaches differ for no specific reason. In alignment with the research questions, this chapter describes the current existing demand and capacity planning processes for CKD-vehicles. In a second step in Section 7.2.3, this chapter describes and analyses the existing planning processes for CBU-vehicles in order to identify potential areas for improvement. Considering existing theories and MBC business practices, Section 7.3 identifies successful aspects of CKD-vehicle planning processes currently in place. In contrast, Section 7.4 applies business practices and existing theories in order to identify complications and potential improvements for CKD-vehicle planning processes. The evaluation of processes is followed by an introduction of performance metrics currently in place to measure planning processes at MBC for CKD- and CBU-vehicle planning. This chapter concludes with a recommendation of appropriate performance metrics for CKD-vehicle planning processes based on existing theories and business practices in Section 7.5.

7.2. Assessment of demand planning processes

In order to fully understand the existing processes for demand and capacity planning, this section maps the processes and describes all relevant activities. Section 7.2.1 introduces the symbols used for process mapping, while Section 7.2.2 introduces the current demand and capacity planning processes for CKD-vehicles, and Section 7.2.3 introduces the equivalent for CBU-vehicles.

7.2.1. Introduction to process mapping

This section introduces the researcher’s approach to process mapping, providing background information for the processes described in this chapter. A swimlane diagram illustrates each process and the departments responsible for each step of the process. The focus is only on process steps relevant to the study. To reduce complexity, irrelevant process steps were omitted. Figure 7.1 explains the icons and colours used for mapping the processes.

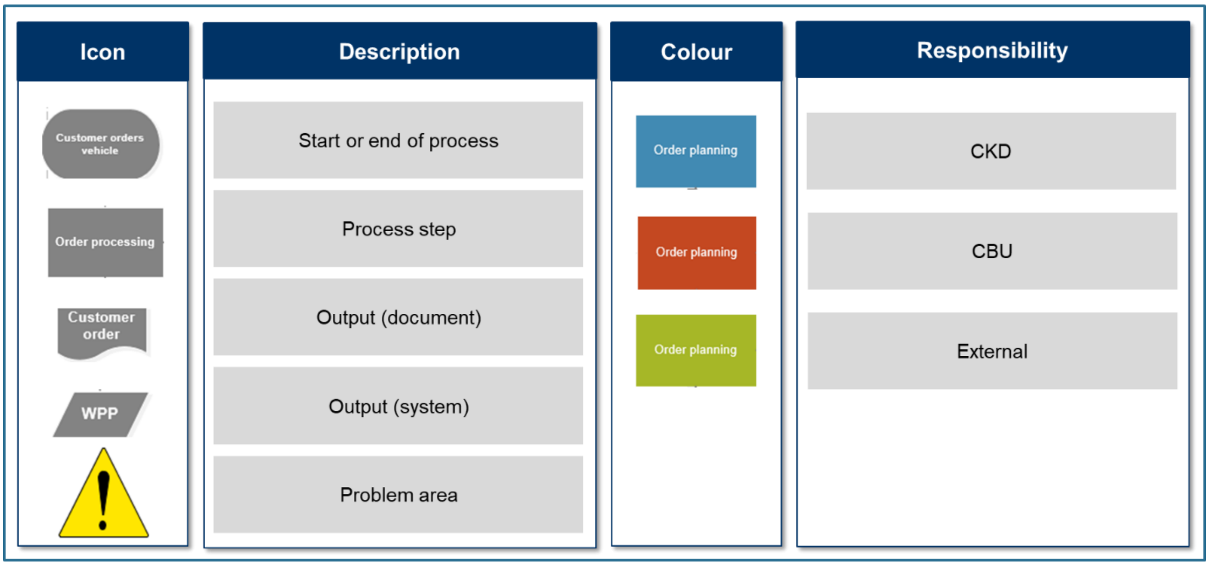


Figure 7.1: Explanation of process shapes and colours

Oval shapes describe the start or end of a process. Rectangular shapes describe a process step, usually an activity. Slightly smaller in size, a rectangular shape with a wavy bottom or a rhombus describe the output of an activity, in the form of a document or in a system, respectively.

The colour red symbolises that the process is a planning process for CBU-vehicles. It is, however, possible that the planning of CKD-vehicles is a parameter of this process as well. In general, red process steps describe the main planning activities of MBC. Green process steps describe activities managed by external parties involved, such as suppliers or local subsidiaries of Daimler Aktiengesellschaft (AG). Process steps in blue describe activities specifically designed for the planning of CKD-vehicles. The blue process steps usually indicate the main process path as the focus is on CKD-vehicles.

7.2.2. Current demand and capacity planning processes for CKD-vehicles

The three processes selected are the planning process for production volumes for CKD-vehicles, the planning process for special equipment (SA) for CKD-vehicles, as well as the planning process for ordering and shipping process for CKD-vehicles. The mapping of processes is required to further evaluate these processes. This section maps and describes all three processes with the assistance of the SIPOC framework and swimlane diagrams.

7.2.2.1. Planning process for production volumes of CKD-vehicles

Planning production volumes takes place based on type of construction (BM). The BM contains information about the car model, engine type and steering mode, which indicates whether the car is a right-hand or left-hand driven vehicle. Figure 7.2 shows a SIPOC diagram for the planning process for production volumes, explaining suppliers, input, process steps, output and customers of the process. Due to the complexity of the process, Figure 7.3 illustrates the process for planning of production volumes.

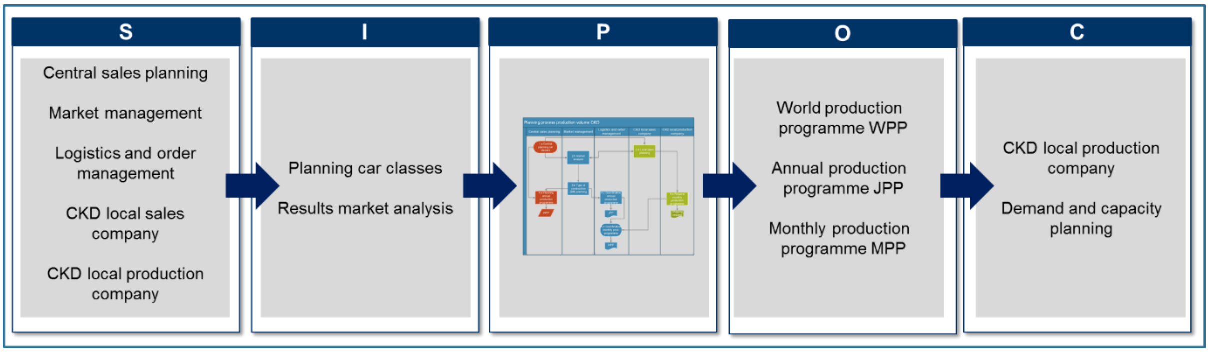


Figure 7.2: SIPOC diagram for the planning process of production volumes

There are six different parties involved in the planning process, namely *Central sales planning*, *Market management*, *Logistics and order management*, the local sales company in the country of destination and the local production company managing the CKD-vehicle assembly. For each CKD-vehicle market, a local sales company manages the sales and market management. Usually, Daimler AG partially owns these local companies together with a local enterprise. These parties all act as suppliers of information.

The main input required is the planning of car classes and the results of the market analysis. Output of the process is the world production programme (WPP), the annual production programme for CKD-vehicles, which is called JPP, and MPP, the monthly production programme for CKD-vehicles. The WPP refers to a data set containing the production volumes for all class types for each month, shown for each plant separately. Although WPP summarises the production volume for CKD-vehicles under one plant, it does not indicate the production volumes for each CKD-vehicle market. The JPP shows a breakdown of each BM for each CKD-vehicle plant. Section 4.7.1.2 describes the JPP in more detail and Addendum B contains an example of an JPP. *Logistics and order management* updates the JPP once a month. The MPP shows the daily packing planning per month. Section 4.7.1.2 describes the MPP in more detail and Addendum C contains an example of an MPP.

Demand and capacity planning as well as the local production company for CKD-vehicles are the customers of this process. *Demand and capacity planning* requires information from the WPP, JPP and MPP for bottleneck management. *Logistics and order management forwards* the MPP to the local production company for CKD-vehicles. Additionally, *Central sales planning* has access to the MPP. There is also possible interaction between *Central sales planning* and *Logistics and order management*. The main purpose of the MPP is, however, production planning. Based on the MPP, the local production company can plan and coordinate a production programme for CKD-vehicles. MBC is not involved in this process. It is solely the responsibility of the local company to run and plan the assembly of CKD-vehicles.

The planning process for production volumes of CKD-vehicles describes the planning procedure for a period of approximately two years before ramp-up. Figure 7.3 shows the mapping of the planning process for types of construction.

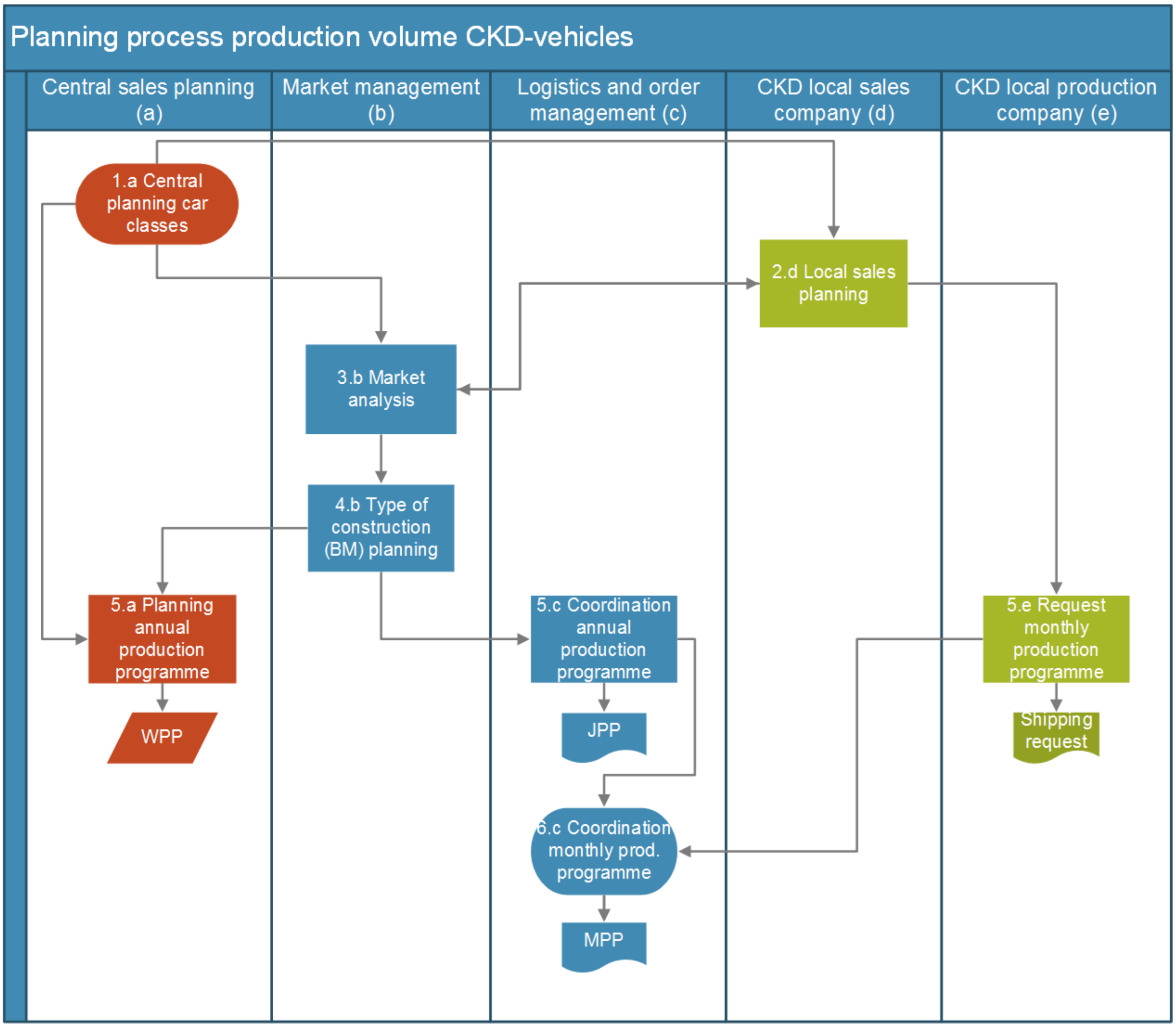


Figure 7.3: Planning process for production volume of CKD-vehicles

Planning relevant to the short-term planning period starts about two years before ramp-up in the department C*entral sales planning* where the planning of car classes takes place as shown in process step 1.a. The exact date of planning commencement depends on the plants that produce the vehicle and on the model itself. *Central sales planning* conducts a feasibility check regarding internal production capacities and supplier capacities for all vehicles, both CBU- and CKD-vehicles. At this stage, *Central sales planning* also combines individual equipment to packages and excludes specific combinations of equipment. Section 7.2.3.2 contains further information on the planning process of SA. *Central sales planning* uses a system called ISP4D, which is only available to departments in the sales division in contact with this process. *Demand and capacity planning* does not have access to ISP4D.

Central sales planning forwards the information on car classes to the local sales company in the foreign country. The local sales company performs a matching activity with their own market analysis and the possible class types and equipment as shown in process step 2.d. The local sales company needs to follow the predetermined SA-packages as well as the suggested volumes. Each CKD-vehicle market has its own local sales company, ensuring that the local sales planning is market specific.

The local sales company also forwards the planning of car classes to the department in charge of market management where a market analysis takes place as displayed in process step 3.b. *Market management* conducts the market analysis in exchange with the local sales company specifically for CKD-vehicles. In this step 4.b, *Market management* further specifies the details of car classes. A division in BM states the engine type and steering mode. *Market management* further defines the national sales types (NST), a division of BM, into three different versions. Output is a breakdown of all equipment in a vehicle for each NST and CKD-vehicle market. *Market management* forwards the volume planning for each BM and CKD-vehicle market to *Central sales planning* and to *Logistics and order management*. *Market management* does not forward the breakdown of BM into NSTs.

The planning for CKD- and CBU-vehicles merges in process step 5.a. *Central sales planning* receives a detailed production volume planning for CKD-vehicles from *Market management* in order to plan the annual production programme for MBC. The output of the planning is the WPP. *Central sales planning* uses the data for further planning regarding SA. There are, however, other more detailed planning processes taking place at the department *Logistics and order management* specifically for CKD-vehicle planning.

Logistics and order management also receives the BM-planning from *Market management*. The planning and coordination of the annual production programme takes place at *Logistics* *and order management* in process step 5.c. This annual production planning is specifically designed for CKD-vehicles. The output is the yearly programme planning JPP.

At approximately the same time as the JPP coordination takes place, the local production company develops a request of the monthly production programme as shown in process step 5.e. Every month, the local production company fills out a shipping request form where it indicates the preferred date of arrival of parts. The date of arrival in the foreign country determines the production programme for the CKD-vehicle plant. The local production company can divide the shipping volume between three to four dates, depending on the length of the month and the production capacities in the mother plant. Each local production company forwards the shipping request form to *Logistics and order management* for CKD-vehicles.

Upon receipt of all shipping request forms from the local production companies, *Logistics and order management* coordinates the monthly packing programme, MPP, as shown in process step 6.c. With the JPP as a basis, a programme planner breaks down the monthly production capacities and assigns a feasible production volume to each day. Criteria for the assignment involve production capacity of the mother plant, the capacity of the logistics service provider 3PL in charge of packaging, and the departure of ships. The programme planner considers the shipping request forms as much as possible. It is however likely that adjustments need to be made. Ultimately, MBC has the deciding power,and the local production company is obliged to accept the MPP. The coordination of both JPP and MPP takes place in Microsoft Excel, There is no additional system used for calculations or planning. The programmer does, however, enter the results of JPP and MPP into the system Global Ordering (GO). This process step marks the end of the planning process for CKD-vehicle production volumes.

While this process focuses on the vehicle as a whole, another process is required to plan demand and capacities for SA for CKD-vehicles. Section 7.2.2.2 introduces the process specific to the planning of SA.

7.2.2.2. Planning process for special equipment (SA) for CKD-vehicles

Different choices of configuration for each vehicle allow customers flexibility in their choices. It does, however, increase planning complexity. *Demand and capacity planning* strongly depends on the planning for SA and requires accurate planning and forecasting. Figure 7.4 illustrates a SIPOC diagram for the CKD-vehicle planning process for SA. Figure 7.5 displays the process itself.

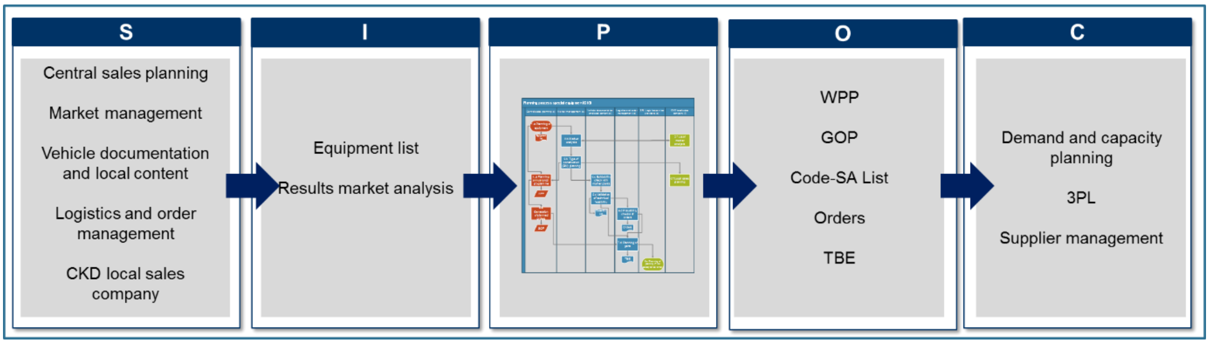


Figure 7.4: SIPOC diagram for the planning process of SA

Suppliers to the process are MBC's internal departments of *Central sales planning*, *Market management*, *Vehicle documentation and local content*, *Logistics and order management* as well as the local sales company. Input required for the process is the equipment list of possible equipment for vehicles, as well as the results from the market analysis. The process provides a number of outputs, namely WPP, sales data used for material forecast (GOP), Code-SA list, orders and material forecast (TBE). WPP and GOP are forecasts combining both CBU- and CKD-vehicles. Only the segment concerned with CKD-vehicles counts as an output of this process. While WPP forecasts production volumes, GOP projects planned orders based on real orders and empirical values. The Code-SA list contains all approved codes for each CKD-vehicle market, further divided into BM and NST. Addendum D shows an extract of the Code-SA list. Orders stand for real and verified customer orders of CKD-vehicles. Lastly, the TBE contains a breakdown from secondary to primary demand, showing all required parts to produce a vehicle. The customers of the process are *Demand and capacity planning*, 3PLs and *Supplier management*. Figure 7.5 illustrates the planning process of SA for CKD-vehicles.

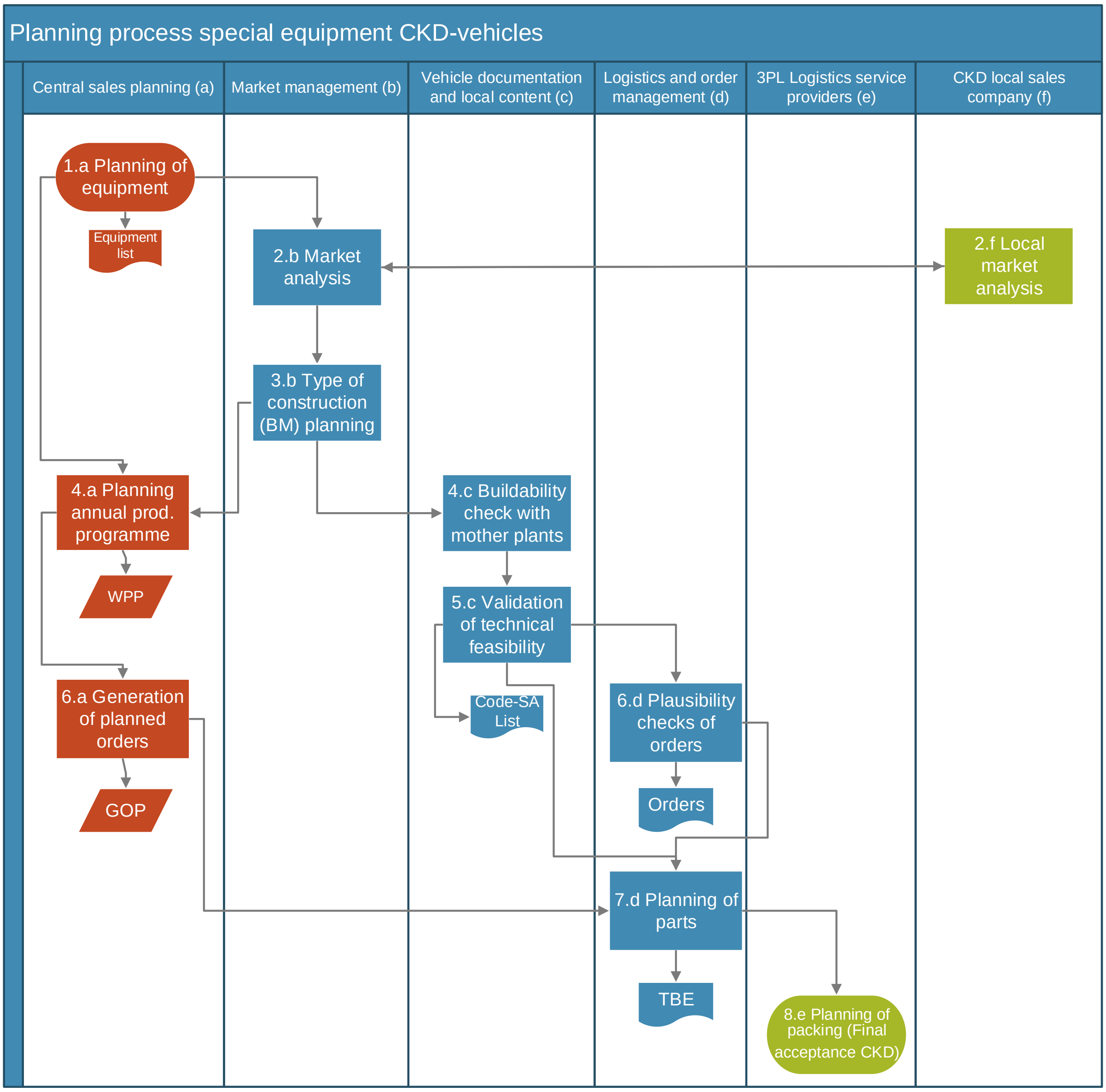


Figure 7.5: Planning process for SA of CKD-vehicles

For the period of short-term planning, the planning process for SA has the same starting point as volume planning. *Central sales planning* conducts an analysis on possible combinations of equipment and necessary restrictions in the system Integrated Sales Planning for Daimler (ISP4D), as shown in step 1.a. The output is a document containing all possible equipment, namely the equipment list.

The equipment list forms the foundation for the next actions of *Market management* and the local sales company in charge of the CKD-vehicle market. In step 2.b, *Market management* conducts a market analysis based on the possibilities deriving from the equipment list. In addition, the local sales company delivers market research on customer needs in the CKD-vehicle market as shown in process step 2.f. An interaction between the local sales company and *Market management* takes place during the analysis.

In the next step, step 3.b, *Market management* decides on suitable equipment packages and allocates them to BM and NST. Usually, there is one basic NST, one sports NST and one luxurious NST. Once *Market management* completes the market analysis, the department forwards the results to *Central sales planning* and *Vehicle documentation and local content*.

Central sales planning receives the BM planning from *Market management*. A consolidation of all CBU- and CKD-models takes place in step 4.a, resulting in the annual production programme WPP. Based on the WPP, *Central sales planning* generates planned orders. These planned orders are currently only generated for CBU-vehicles. The CKD-vehicle planning therefore depends on the planned orders of CBU-vehicles. Forecasts of CBU-vehicles are copied and used for CKD-vehicles. Twice a year, *Central sales planning* publishes a material forecast based on sales data, called the GOP. In addition to the BM, the planned orders document a breakdown in equipment packages and codes. Due to the information on parts demand, this forecast lays the foundation for the planning of parts.

Market management also forwards the BM planning to the department for *Vehicle documentation and local content*, who verifies the buildability of all equipment packages in step 4.c. The buildability check consists of a verification with possible equipment combinations in main plants. MBC requires a CKD-vehicle to consist of equipment that can be built in the main plant as well. No car exists specifically as a CKD-vehicle, but all CKD-vehicles also exist as CBU-vehicles.

Based on a previously conducted buildability check, *Vehicle documentation and local content* validates the technical feasibility of assembly within the CKD-vehicle plant in step 5.c. The assembly at CKD-vehicle plants is not as advanced and well-equipped as the assembly line in MBC's main plants. *Vehicle documentation and local content* verifies the skills of staff and technical capability in terms of production equipment. For new parts requested by *Market management*, *Vehicle documentation and local content* analyses whether an investment in new equipment and training is profitable. The decision depends on demand for the part, the costs involved and the life-cycle of the vehicles that feature the part. Depending on the outcome of the validation, a code is either approved immediately if technically feasible, approved from a certain date onwards if investments are necessary and take time to put in place, or declined if investments are uneconomic. The Code-SA list is the result of this activity.

Vehicle documentation and local content forwards the Code-SA list to the department in charge of *Logistics and order management* where a plausibility check of orders takes place as shown in process step 6.d. The local sales company manually forwards orders *to Logistics and order management*. Section 7.2.3.3 explains the ordering process in detail. The plausibility check ensures that orders only consist of equipment available according to the Code-SA list. This verification takes place in a manual manner using Microsoft Excel. The output result is verified, real orders for CKD-vehicles. *Logistics and order management* enters these orders into the sales programme, GO.

Logistics and order management uses the MPP for planning of parts. Once real orders are verified and available in GO, the planning of parts also refers to real orders. Until then, the Code-SA list serves as an orientation for parts demand. GOP poses the third source of input for this step, despite the lack of planned orders generated for CKD-vehicles specifically. As shown in step 7.d, a breakdown from secondary to primary demand takes place in a material forecast, namely TBE. Following the CBU-vehicle approach, the breakdown applies data from the system DIALOG. The production figures from volume planning are broken down into demand for individual parts. This includes a breakdown of all parts behind a code or equipment package. Supplier management employs the result, TBE, to safeguard supplier capacities and to place final orders. Moreover, TBE contains relevant information for the 3PL in charge of packing.

The 3PL receives a copy of the TBE every month. Based on TBE and MPP, the 3PL can plan a packing programme which equals the production programme for CBU-vehicles as shown in step 8.e. MPP manages the packing programme and TBE provides the required information regarding which parts need to be packed. The planning of packing symbolises the end of the planning process for SA since MBC considers the packing as the final acceptance for CKD-vehicles.

The processes for volume planning and SA focus solely on the planning of information flow for CKD-vehicles. The goods flow, however, also needs to be planned. Section 7.2.2.3 introduces the planning process for ordering and shipping for CKD-vehicles.

7.2.2.3. Planning process for ordering and shipping of CKD-vehicles

The planning process for ordering and packing for CKD-vehicles describes the information flow from the order placement in the CKD-vehicle market to the final assembly in the CKD-vehicle market. Figure 7.6 summarises relevant information about the planning process for ordering and packing in a SIPOC diagram.

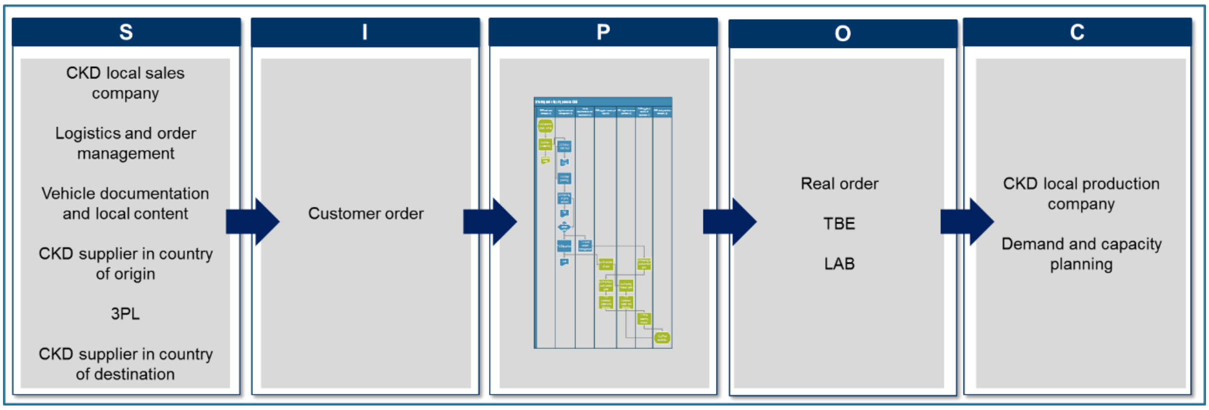


Figure 7.6: SIPOC diagram for the ordering and shipping process for CKD-vehicles

Suppliers involved are the CKD-vehicle local sales company, *Logistics and order management*, *Vehicle documentation and local content*, CKD-vehicle supplier in country of origin, 3PL logistics service providers, and CKD-vehicle supplier in country of destination. An order placed by a customer in a CKD-vehicle market represents the required input to start the process. Due to its complexity, Figure 7.7 illustrates the process with its individual process steps in more detail. Process output are real orders, TBE, and delivery call-off (LAB). Customers of the process are the CKD-vehicle local production company, and *Demand and capacity planning*.

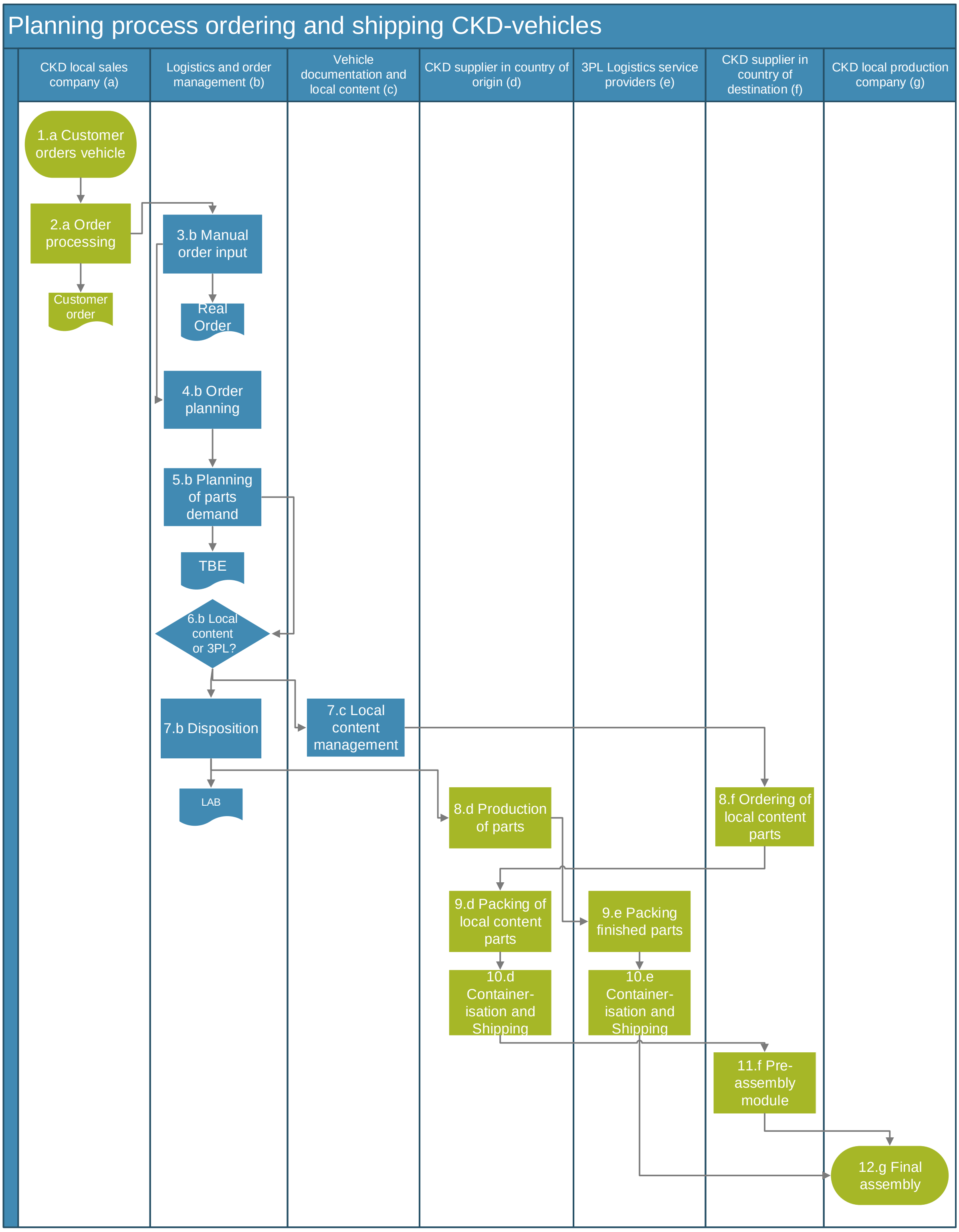


Figure 7.7: Ordering and shipping process for CKD-vehicles

The process starts with the customer in the CKD-vehicle market placing an order for a vehicle at the dealership as shown in process step 1.a. In step 2.a, the local sales team then processes the order to convert it into electronic format. Each local subsidiary uses different systems and procedures, ranging from Enterprise Resource Planning (ERP) systems to manual faxes. At the end of this step, the customer order is finalised.

The local sales company forwards the orders to *Logistics and order management* where the validation and manual order input takes place in step 3.b. Once the real orders are validated and entered into the system GO, MBC's order planning can start. In step 4.b, order management adds a number of administrative parameters to each order, such as the vehicle identification number. At this stage, order management also determines the final acceptance date for packing.

The next step, 5.b, describes the planning of parts demand, more precisely the breakdown from BM into parts. The output is the TBE. The process for SA planning for CKD-vehicles describes this step in more detail in Section 7.2.2.2.

Based on the TBE, *Logistics and order management* decides in step 6.b whether MBC orders the part through a common supplier or through a local supplier. *Logistics and order management* steers the disposition for common suppliers that supply parts for CBU-vehicles as well. Due to the requirement for local content, MBC is obliged to procure certain percentages of parts through a local supplier. Section 3.3.2 introduces this practice, namely local content, and elaborates on its reasons and benefits. A trigger in the TBE puts all local content parts on a list for *Vehicle documentation and local content* to manage.

Logistics and order management is in charge of material planning and procures all parts that come from common suppliers for CBU- and CKD-vehicles in step 7.b. The main task of material planning is to schedule orders and define the lot size of orders. Output is a delivery call-off, namely LAB, which *Logistics and order management* forwards to suppliers in the country of origin.

The supplier in the country of origin receives the LAB from *Logistics and order management*. The majority of suppliers are located in proximity to an MBC production facility, but not all of them necessarily are located in the same country as the production plant. All of these suppliers produce and assemble parts for CBU-vehicles. The ordering and shipping process differs in a few aspects. *Logistics and order management* sends out a separate LAB due to the different delivery locations, the supplier delivers the parts to a consolidation centre (CC) run by a 3PL close to the production plants.

These suppliers then deliver parts or modules to the 3PL for packing in accordance with the LAB as represented in step 8.d. Based on the LAB, the supplier plans its production programme and delivery schedule. Since the part is the same for CKD- and CBU-vehicles, the supplier plans production and possible storage together. The delivery, however, depends on the production type due to the different delivery point.

The 3PL receives the delivery schedule of suppliers to coordinate the packing programme as illustrated in step 9.e. The 3PL packs all parts in kits, which consist of a lot size of six parts and all parts need to be the same. The packaging is mostly designed for single-use, using material such a plastic, cardboard and wood. In addition to the vehicle parts, the 3PL adds documentation required to the kit. The documentation contains an assembly manual, including information on the vehicle this part belongs to and assembly instructions. After the packing of parts, the 3PL organises containerisation and shipping as shown in step 10.d. Containerisation takes place at the CC. Transport via truck delivers the containers to the port in Bremen. From there, shipping to the different CKD-vehicle markets takes place. For MBC, the final acceptance takes place when the part is packed. The international commerce term (Incoterm) applicable is Free on Board (FOB), which means that the actual transfer of ownership takes place when the parts are loaded on the ship. MBC's involvement ends here, and the local production company for CKD-vehicles is comparable to a client purchasing from MBC. The 3PL acts on behalf of MBC. Shipment to the CKD-vehicle markets takes up to 12 weeks depending on the destination.

The process steps for local content parts involve different actors but are similar in content. *Vehicle documentation and local content* management has the administrative responsibility for local content. The department allocates local content to suppliers with suitable facilities in the foreign countries. Similar to material planning at *Logistics and order management*, *Vehicle documentation and local content* forwards orders to local suppliers in the foreign countries. *Vehicle documentation and local content* order parts directly from suppliers in the CKD-countries. In order to qualify as local content, the supplier is required to be located in the same country as the CKD-vehicle plant.

CKD-vehicle suppliers in the country of assembly function as an intermediary in this phase of the process. The local subsidiary of the supplier places an order for the required car parts with the supplier's subsidiary that procures the same parts for CBU-vehicles as shown in process step 8.f. Besides this administrative component, the local supplier is involved again at a later stage for assembly of parts.

The supplier in the country of origin receives the order from the local supplier. In step 9.d, the supplier plans the production of this order. Even if the supplier procures the same part or module for CBU-vehicles, the planning process takes place separately. The supplier does not fully assemble local content parts. Instead, the supplier packs individual components in kits, similar to the packing procedures at the 3PL CC. After production, the supplier packs the local content parts in kits, similar to the packing process at the CC of the 3PL, as shown in process step 9.e. After packing, the supplier containerises and ships the kits to the local supplier in the foreign country where assembly takes place, which is represented by step 10.e.

In order to qualify as local content, value creation needs to take place in the foreign country. As a result, a local subsidiary of the supplier orders local content on behalf of MBC and pre-assembles individual components in parts or modules. Step 11.f illustrates this activity. Lastly, the local production company plans the final assembly production programme as shown in step 12.g. A programme planner merges the planning of both local content parts and common supplier parts. Depending on the assembly date of the vehicle, the local production company also plans storage of parts. The final assembly programme planning marks the concluding step in this process.

The processes described in Sections 7.2.2.1 to 7.2.2.3 map and describe the three selected processes for CKD-vehicle demand and capacity planning. The following Section 7.2.3 introduces the equivalent processes for CBU-vehicle planning in a similar manner.

7.2.3. Processes for CBU-vehicle demand and capacity planning

The planning processes for CBU-vehicles yield a foundation to suggest improvements for the processes for CKD-vehicle planning. CBU-vehicles are the core business of MBC. Therefore, the company invests more resources to the maintenance of CBU-vehicle processes and it can be assumed that these processes are generally functioning well. This section describes the CBU-vehicle planning processes for production volume, SA and ordering.

7.2.3.1. Planning process for production volumes of CBU-vehicles

At MBC, the task of production volume planning for CBU-vehicles is divided among four departments, namely *Central sales planning*, *Market management*, *Programme planning* and *Production planning*. The description omits other actors to reduce complexity. Figure 7.8 illustrates the planning process for CBU-vehicle production volumes.

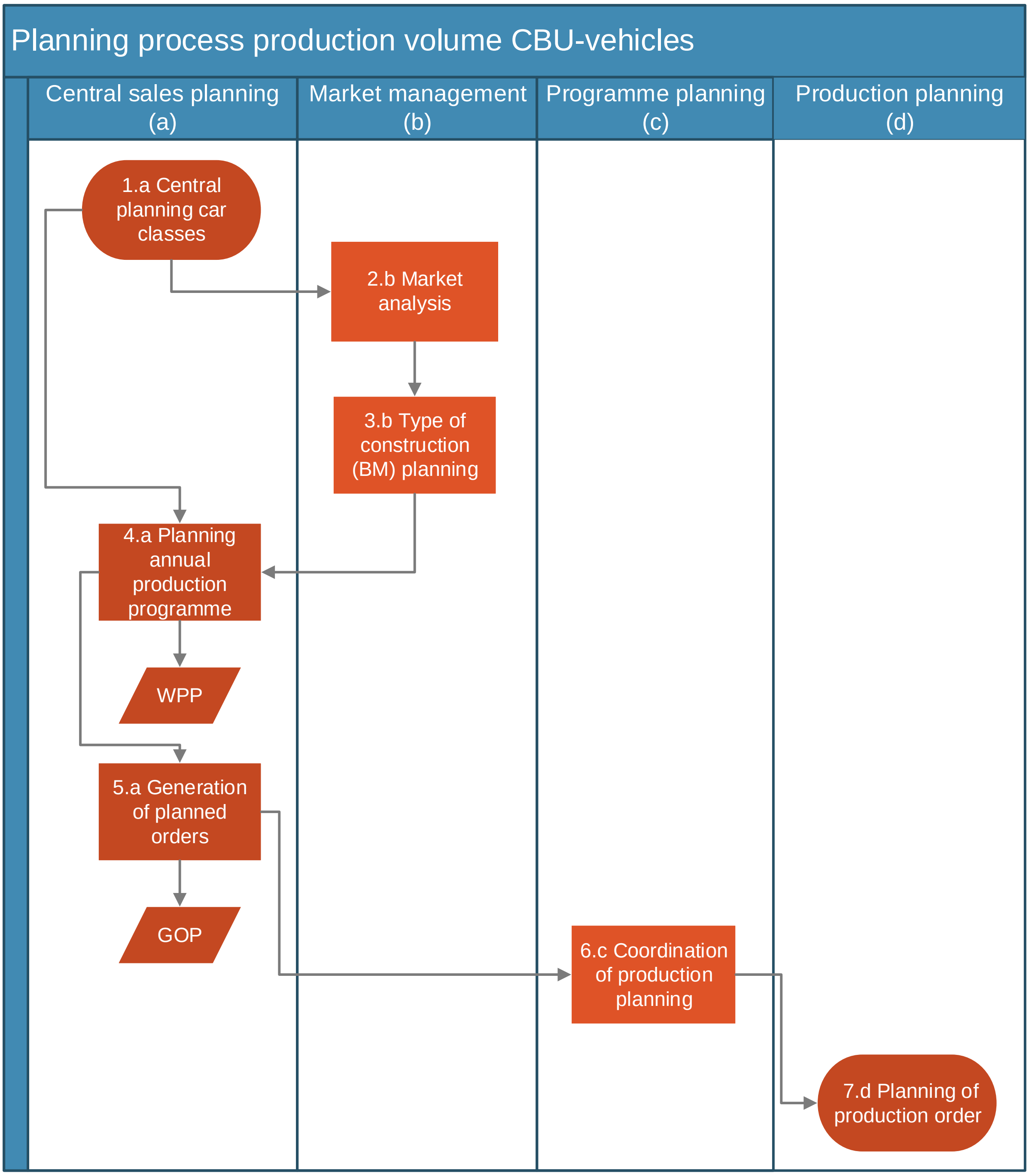


Figure 7.8: Planning process for production volume of CBU-vehicles

In accordance with the planning process for CKD-vehicles, this study uses the central planning of car classes as a starting point. *Central sales planning* assigns different car classes to each model in step 1.a. *Market management* conducts an analysis to investigate the needs of a market as shown in process step 2.b. Based on the market analysis, the same department divides all car classes during the process step 3.b. *Market management* also allocates potential SA to the BM-planning.

The planning of the annual production programme requires input from two sources, namely the central planning of car classes and the type of construction planning. The planning of the annual production programme, which also contains information on production volumes for CKD-vehicles, develops the WPP by consolidating the results of the market analysis from each market. The planning of the annual production programme is shown in step 4.a. WPP shows the production volumes for each BM on a monthly basis, divided into production figures for all plants.

In step 5.a, the generation of planned orders takes place based on the annual production programme. A forecasting model uses existing and forecasted orders based on historic values and demand estimates to develop planned orders in the GOP. A validation of planned orders takes place before publishing the GOP. The validation includes buildability checks to ensure that the material forecast incorporates all restrictions.

The *Programme planning* department uses the GOP to allocate production volumes to each day of production, as illustrated in step 6.c. The department sends the finalised production programme to *Production planning*. In this final step 7.d, *Production planning* allocates a specific vehicle, including a vehicle identification number, to a specific day. Production planning also manages the sequencing of vehicles for production.

The process for production volume planning includes more detailed information about SA in the steps closer to ramp-up. Section 7.2.3.2 describes the planning process for SA for CBU-vehicles in more detail.

7.2.3.2. Planning process for special equipment CBU-vehicles

Central sales planning, *Market management* and *Sales operations* are the main actors involved in the planning process for SA. The description omits other actors to reduce complexity. Figure 7.9 illustrates the planning process for CBU-vehicle SA.

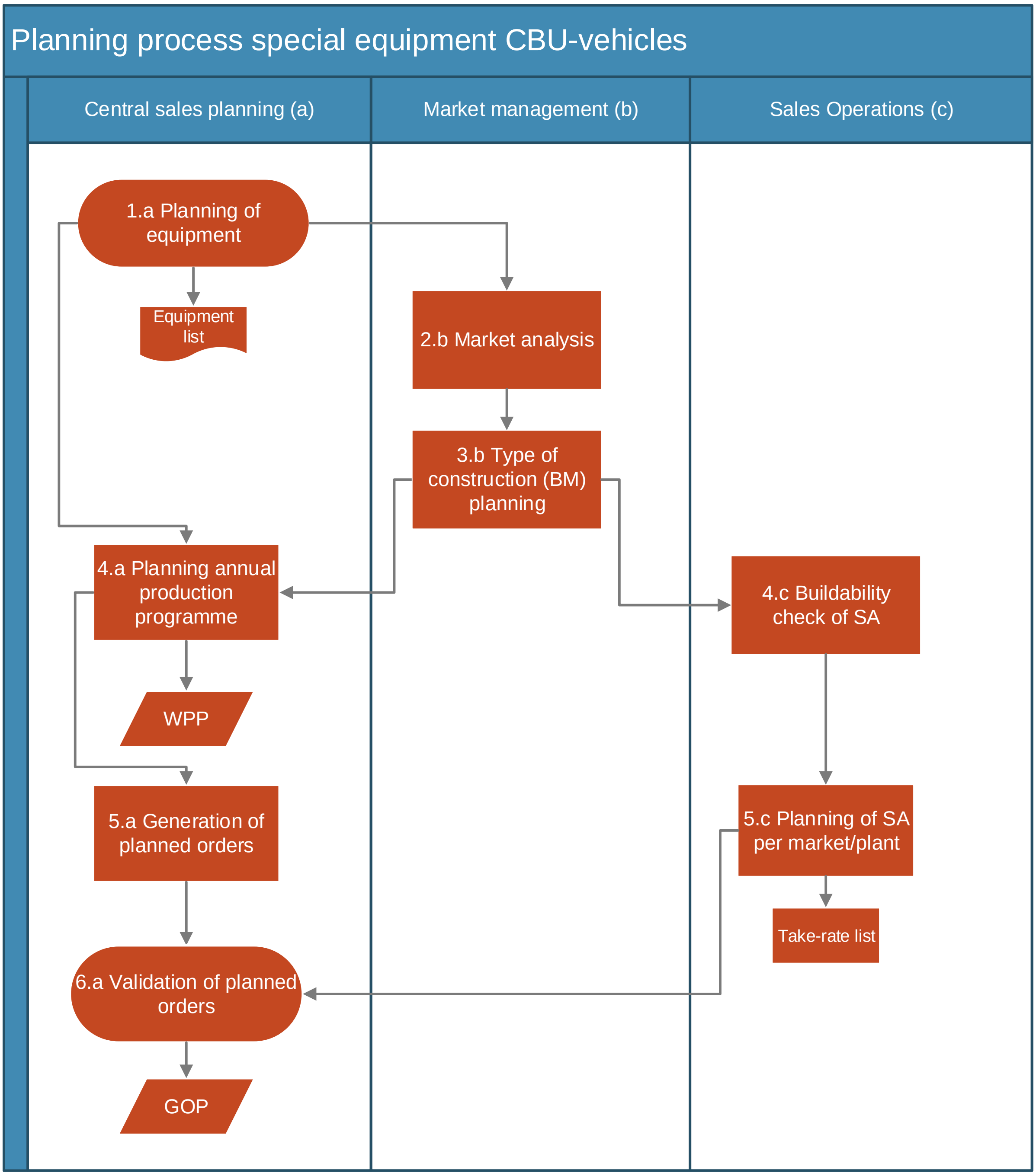


Figure 7.9: Planning process for SA for CBU-vehicles

The process starts with *Central sales planning* and the planning of SA in process step 1.a. The output of this activity is a list of all equipment possible for a specific car class. *Central sales planning* forwards the equipment list to *Market management*. In step 2.b, a market analysis takes place and *Market management* defines the BM with the associated equipment in step 3.b. The task of *Market management* is similar to the activity described for CKD-vehicles in Section 7.2.2.1, with a focus on equipment rather than BM only. *Market management* forwards the results of the market analysis to *Central sales planning* and *Sales operations*.

In step 4.c, *Sales operations* conducts a buildability check for SA suggested by *Market management*. The department takes possible production restrictions and market limitations into account. Based on this validation, *Sales operations* consolidates the applicable SA with the associated take-rates as shown in step 5.c. The output is a Microsoft Excel document, called a take-rate list.

In combination with the results of the analysis of all markets and the car class planning, *Central sales planning* develops the annual production programme in step 4.a as described in Section 7.2.2.1. The result is the WPP. In step 6.a, *Central sales planning* then generates planned orders and validates these orders. Another input factor for validation of planned orders is the take-rate list developed by *Sales operations*. Such a verification does not exist for CKD-vehicle planned orders. The final output of this process is the material forecast GOP.

7.2.3.3. Planning process for ordering of CBU-vehicles

The planning process for ordering of CBU-vehicles describes the origin of real orders. As opposed to the planning process of ordering and shipping for CKD-vehicles described in Section 7.2.2.3, the ordering process for CBU-vehicles is limited to ordering since packing and local content is not a relevant component for CBU-vehicles. Local sales companies of all markets, *Order management*, *Demand planning* and suppliers are the main actors in this process. Figure 7.10 illustrates the planning process for ordering of CBU-vehicles.

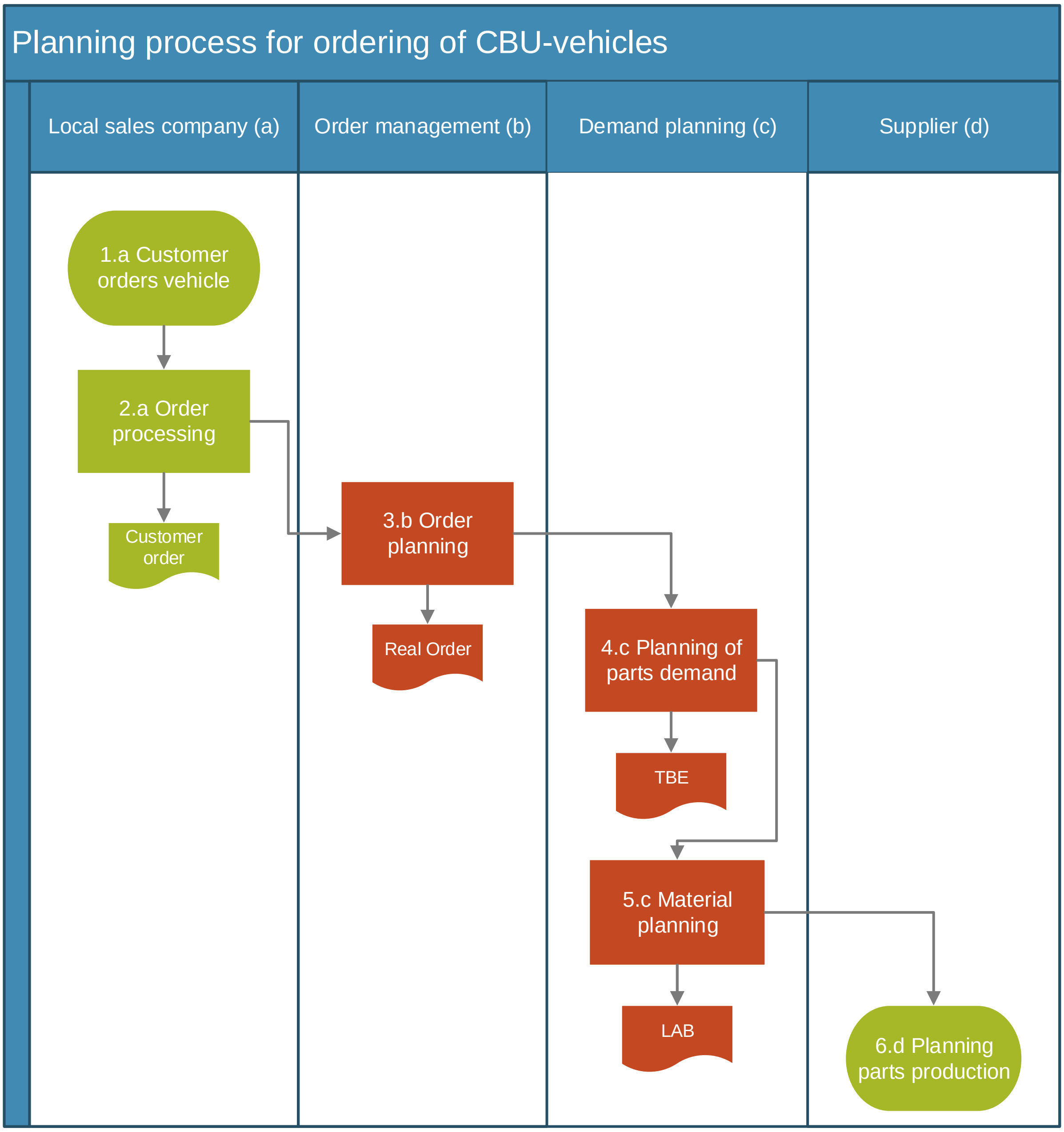


Figure 7.10: Planning process for ordering of CBU-vehicles

The process starts with a customer placing an order with a local dealership as shown in process step 1.a. In step 2.a, the local sales company then processes the order, using the system Cesar, with the output of a customer order. The system Cesar is integrated into GO. *Order management* validates the orders in GO and adds additional parameters such as the vehicle identification number in process step 3.b. Output is real orders. The processing, forwarding and planning of orders is completely automated in the systems Cesar and GO. No manual forwarding, validation or editing is required.

Once *Order management* has created real orders, *Demand planning* starts with the planning of demand for parts as shown in process step 4.c. This activity breaks down real orders into secondary demand. Output is a material forecast, namely TBE. Based on the material forecast, *Demand planning* starts material planning in step 5.c, leading to the delivery call-off LAB. Demand planning then sends LABs to all suppliers delivering a part. Based on the LAB, suppliers plan their production of parts in the final step 6.d.

A general understanding of CKD- and CBU-vehicle planning processes enables an evaluation of CKD-vehicle planning processes for demand and capacity planning. The evaluation starts with the positive aspects of CKD-vehicle planning processes in Section 7.3.

7.3. Positive aspects of processes for CKD

The current planning processes for CKD-vehicle demand and capacity planning as introduced in Section 7.2.2 include a number of positive aspects. Some aspects are linked to process models and design, other factors indicate a successful sales and operations planning (S&OP) planning process. This section combines existing theories from literature as well as best practices from MBC as a guideline for the evaluation.

To fulfil requirements for the CKD-vehicle business specifically, MBC designed and adjusted the processes in place. When it comes to process management and process models, it is recommended to work with different styles to ensure that the process represents the activities as well as input and output (van der Aalst, 2012; vom Brocke *et al*., 2014:534). MBC integrated special departments for CKD-vehicle planning to ensure an adequate management of planning activities. Furthermore, MBC accommodates specific activities or characteristics such as local content management or the 3PL for packing in the process.

In the addition to the adjustments to fulfil requirements for the CKD-vehicle business, MBC involves the customer’s needs in planning. Cecere (2016b) stresses the importance of customer orientation for S&OP processes in order to achieve high performance results. For CKD-vehicles, the local sales company counts as the customer. MBC involves both the local sales company as well as the local production company in the production volume planning process, *Market management* actively communicates with the local sales company. For the monthly programme planning, *Logistics and order management* receive information from the local production company and aim at accommodating all requests. The local sales company is in direct contact with the end consumer. MBC does not include the whole supply chain into their planning processes. However, the integration of the direct customer indicates a direct step towards end-to-end responsibility.

Another advantage of the CKD-vehicle business at MBC is the expertise of employees. The majority of employees involved in CKD-vehicle planning account for great expertise in their field. According to Bryan (2008) the staff component of the 7-S model, the category that covers human resources and talent of employees, is one of the critical factors for a business' success. The employees of the CKD-divisions know their business as well as their individual duties well, and many of them have been working for MBC for several years. As an example, the programme planner in charge of monthly production planning has acquired knowledge about all factories, including capacities, demand distribution and shipping procedures, resulting in the ability to manually coordinate the CKD-vehicle packing programme.

The process structure in terms of responsibilities for activities and communication channels is clearly structured. As part of the 7-S model, Bryan (2008) stresses the importance of structures in place by referring to, amongst others, reporting structures. With the involvement of several entities, these clear communication channels and structures are crucial success factors for a process. Seven departments are directly involved in the ordering and shipping process. The communication process is strictly structured by only involving required departments, allowing for a clear flow of information. Unstructured communication channels and unclear responsibilities potentially lead to inefficiencies in terms of extra work and resources.

The number of actors involved in the planning processes are distributed over several departments. Cross-functional planning positively affects business performance as it allows for a more holistic view, especially in large companies (Ball, 2015a:4). MBC's processes for demand and capacity planning involve, amongst others, the functions of *Central sales planning*, *Market management,* as well as the local sales and production company. Therefore, MBC benefits from insight from other departments which potentially increases process performance.

With regard to the product forecasts, MBC has forecasts for each product group. Ball (2015a:7) indicates that segmentation of demand forecasting increases the effectiveness of S&OP. MBC has developed a product portfolio with a variety of different vehicles. These vehicles are characterised by different demand and supply requirements. MBC plans demand based on BM, which indicates a breakdown of all products into segments. In addition to a categorisation based on products, MBC further divides the world into different markets. There are a number of *Market management* departments, conducting the market analysis for the countries or regions.

The processes for demand planning include several monthly reviews. For successful S&OP, monthly reviews, for example of demand and supply planning, are strongly recommended

(Tinker, 2010:6; Logility, 2017a). In the process for production volume planning for CKD-vehicles, the planning of JPP and MPP is linked to a monthly review of demand and internal production capacities. The planning process for SA for CKD-vehicles reviews the Code-SA list on a monthly basis.

In addition to the monthly reviews incorporated, the process output undergoes a monthly management review. Monthly management reviews are also linked to a more successful S&OP process (Tinker, 2010:6; Logility, 2017a). On a monthly basis, management reviews the forecasted and planned production figures, including CKD-vehicles sent for packing. If forecasted and real orders significantly differ, adjustments are possible. Figure 7.11 summarises all positive aspects of CKD-vehicle processes for demand and capacity planning.

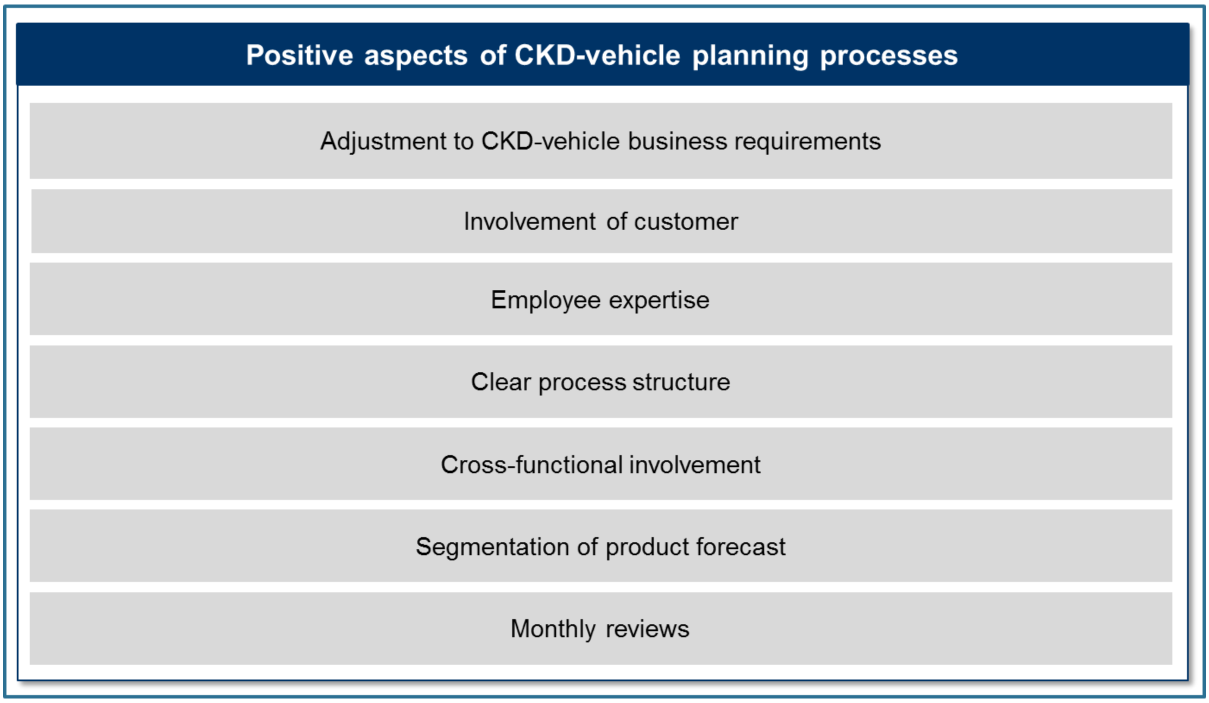


Figure 7.11: Summary of positive aspects of CKD-vehicle planning processes

On the one hand, MBC shows versatility and structure when it comes to demand planning. Clear structures and well-trained employees enable reliable demand and capacity management. Moreover, MBC applies several principles characteristic of successful S&OP. On the other hand, demand and capacity planning processes at MBC involves a number of complications. Section 7.4 elaborates on the complications discovered and introduces specific improvements to reduce the effect of these problem areas.

7.4. Complications and potential improvements for CKD-vehicle planning

This study has identified a number of complications occurring in the processes for CKD-volume planning, planning for CKD-vehicle SA and in the ordering and shipping process for CKD-vehicles. Section 7.4.1 to 7.4.3 introduce the complications identified and provide suitable solutions to improve process performance.

7.4.1. Planning process for production volumes for CKD-vehicles

Section 7.2.2.1 introduces the reader to the planning process for CKD-vehicle production volumes. Figure 7.12 illustrates the problem areas in the process for volume planning.

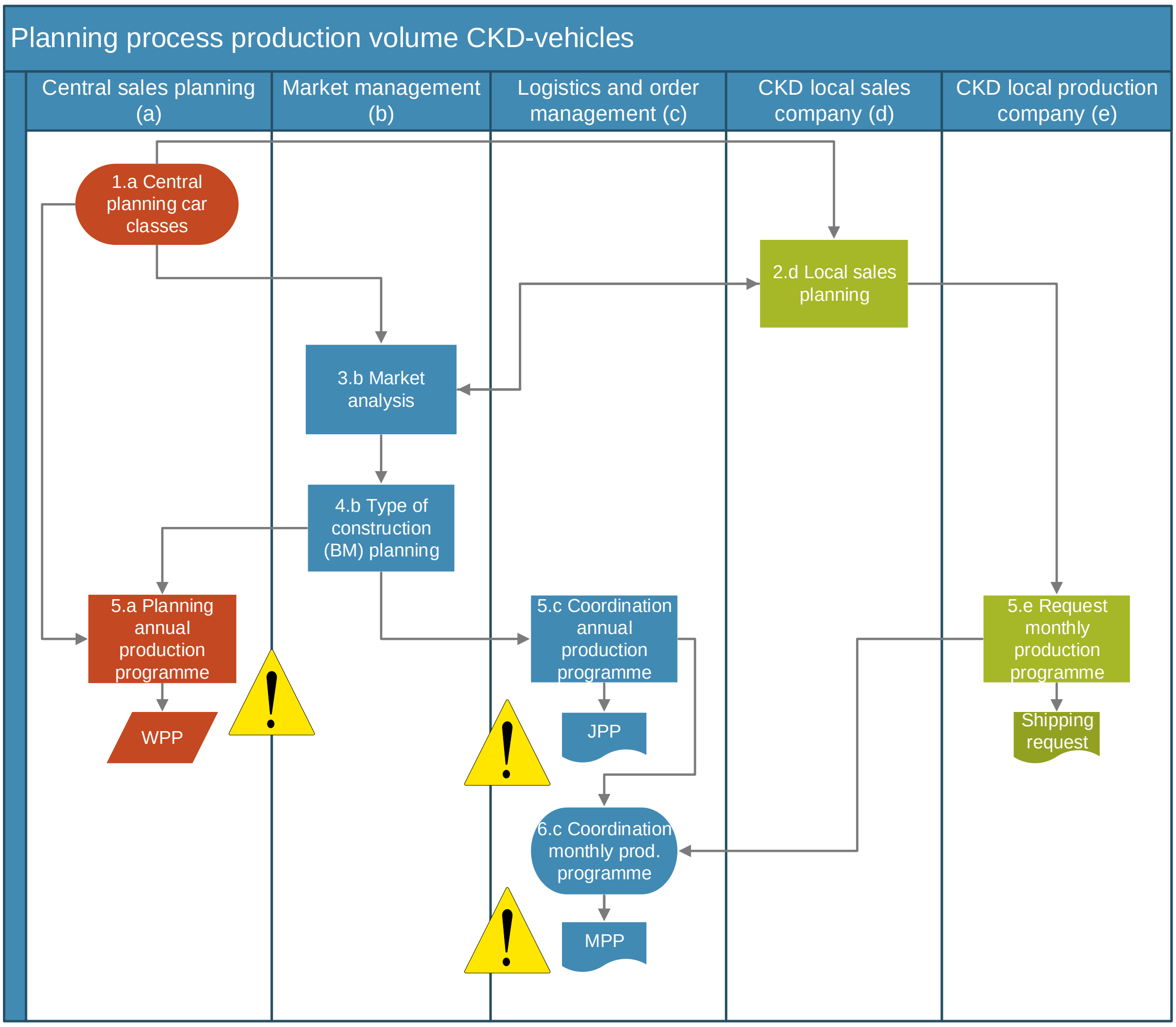


Figure 7.12: Problem areas volume planning process CKD-vehicles

Mapping and analysing the process for production volume planning for CKD-vehicles identified several potential areas of improvement. The yellow warning signs in Figure 7.12 highlight potential problem areas in the production volume planning process for CKD-vehicles. Loss of information and manual data handling are the main problems.

7.4.1.1. Loss of information in the world production programme (WPP)

The loss of information in the planning of the annual production programme for CBU- and CKD-vehicles combined poses a potential problem. The WPP sees all CKD-vehicle markets as one entity. Ball (2015a:7) highlights that the segmentation of demand planning is a key element of successful S&OP. While CKD-vehicle planning divides vehicle planning according to different products and markets, *Central sales planning* only uses the segmentation based on car models.

The aggregation of all CKD-vehicles is the result of packing as final acceptance instead of production. MBC's involvement with the CKD-vehicle business only extends until packing of CKD-vehicle kits. The packing of a CKD-vehicle kit equals to the final production of a CBU-vehicle. A different subsidiary of Daimler AG manages the assembly-plant for CKD-vehicles. The users of WPP do not require information on the country of destination of the CKD-vehicle in their daily business. It is, however, relevant, which main production plant is associated with the packing of CKD-vehicle kits. With MBC's growing network of plants, 3PLs in several locations pack kits for CKD-vehicles. These 3PLs are located in proximity to the plant where MBC produces CBU-vehicles, and WPP does not contain any information on 3PLs or packing locations. This further stresses the loss of information in WPP. Figure 7.13 summarises the problem of loss of information in WPP as well as a potential solution and benefit.

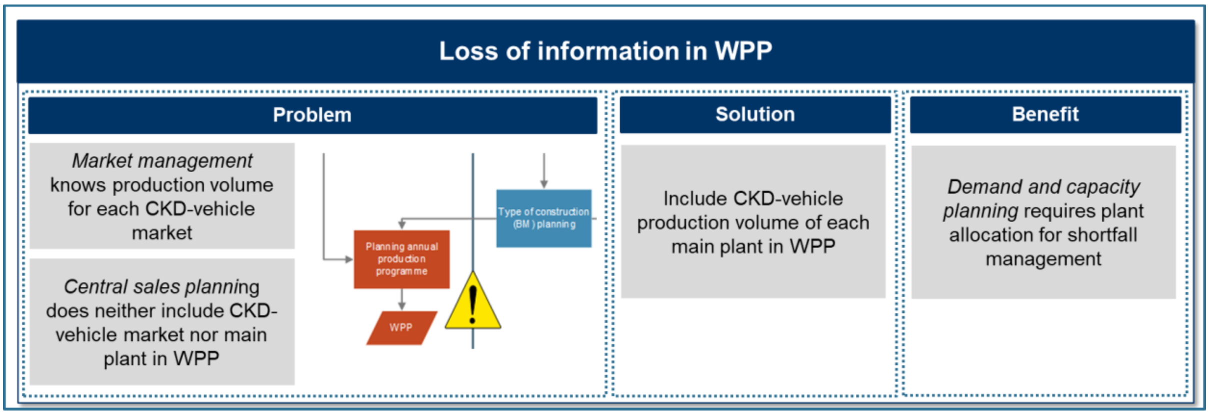


Figure 7.13: Summary of loss of information in WPP

The main plant of a CKD-vehicle is relevant for demand and capacity management. *Demand and capacity planning* has access to the CKD-volumes allocated to each main plant in the strategic planning phase. For short-term planning, *Demand and capacity planning* could benefit from available information about CKD-vehicles and main plant allocation with regard to shortfall management as the main plant is the point of delivery for the supplier. The delivery destination of a supplier is relevant information in case of a shortfall. Currently, *Demand and capacity planning* deducts demand of parts for CKD-vehicles before shortfall management is implemented. Shortfall management for CKD-vehicles can only function if demand for CKD-vehicles is allocated to the respective main plant or 3PL in charge of packing. It is therefore recommended to divide the current category for CKD-vehicles into subcategories representing the main plants of the models. Besides the available information for *Demand and capacity planning*, the whole supply chain could potentially benefit from increased availability of data.

7.4.1.2. Manual data handling of programme planning

Another area for potential improvement is the handling of crucial planning steps in Microsoft Excel. According to Cecere (2016a:182), appropriate technology increases the likelihood to increase performance. Further, the usage of Microsoft Excel for large data sets is known to be prone to errors and time-consuming (Lash, 2017; Logility, 2017b).

Logistics and order management plans both JPP and MPP manually in complex Microsoft Excel sheets. There are functioning formulas ensuring the feasibility of the programme. The manual input however, does not ensure an optimal volume distribution. This especially accounts for the MPP where a programme planner manually decides on a feasible packing programme for CKD-vehicles. The programme planner relies on experience and develops the production programme based on trial and error until finding a feasible solution. Figure 7.14 aggregates the problems deriving from the manual data handling of JPP and MPP, as well as a potential solution and benefits.

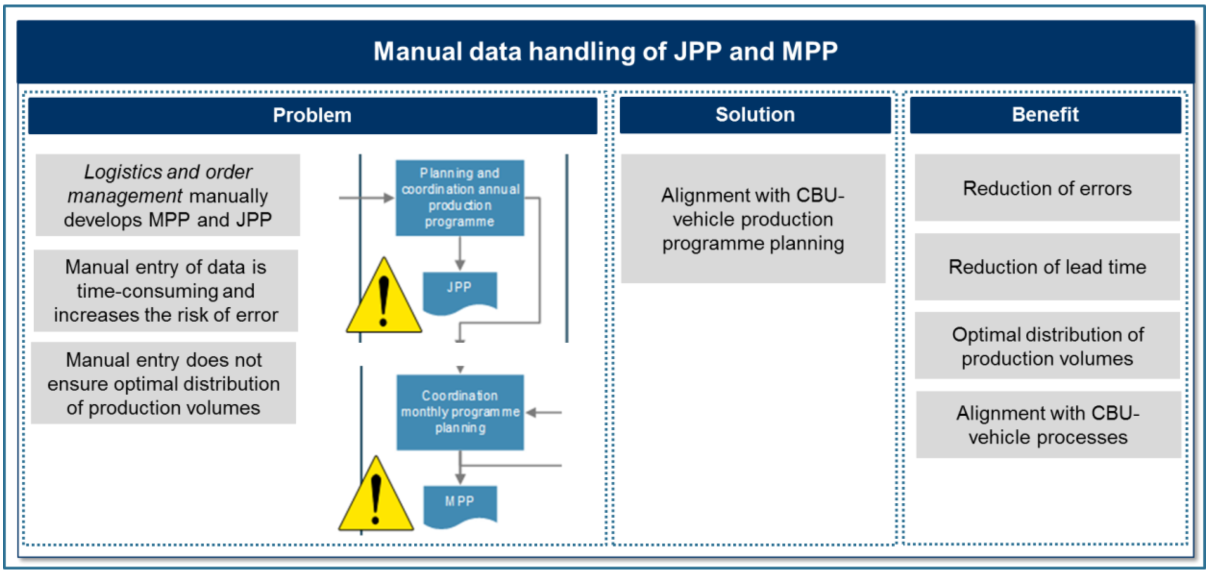


Figure 7.14: Summary data handling of JPP and MPP

An alignment with the system used to plan the production programme for CBU-vehicles allows for a more optimal programme planning process. The system in place for CBU-vehicle programme planning develops a production programme without manual configuration. This change allows for a reduction of errors, a shorter lead time and an alignment of CBU- and CKD-vehicle processes.

Concluding, the process for CKD-vehicle volume planning strongly depends on manual data handling. Additionally, loss of information regarding CKD-vehicle allocation to main plants inhibits the incorporation of CKD-vehicles in shortfall management. Possible solutions comprise the alignment with systems and procedures in use for CBU-vehicle volume planning.

7.4.2. Planning process for special equipment of CKD-vehicles

Mapping and analysing the planning process for SA for CKD-vehicles identifies several potential areas of improvement. Loss of information, inaccurate forecasts and manual data handling are the main problems. Figure 7.15 highlights the problem areas in the planning process for SA for CKD-vehicles.

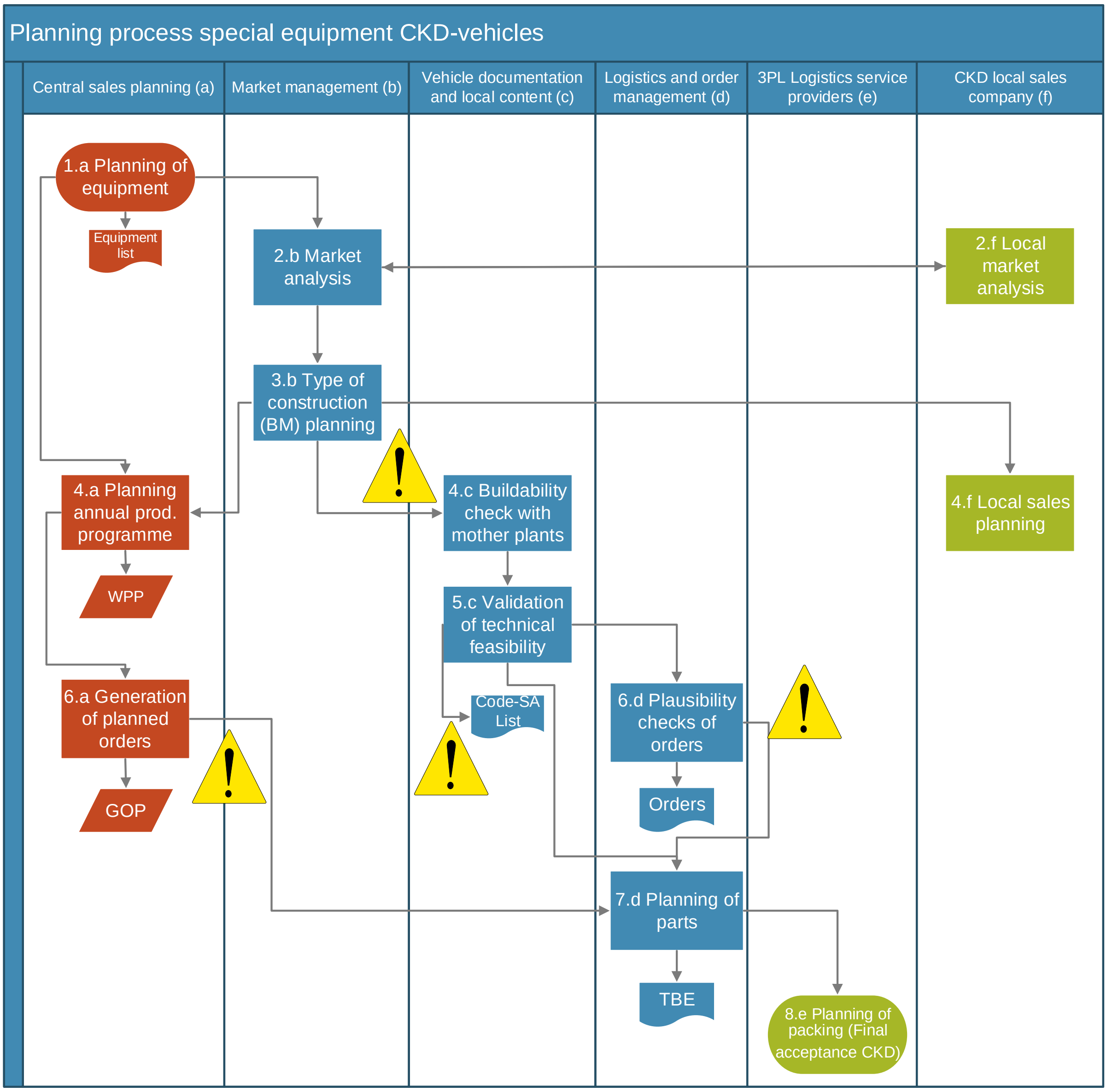


Figure 7.15: Problem areas planning process for SA for CKD-vehicles

The yellow warning signs point out that the communication between *Market management* and *Vehicle documentation and local content*, the generation of planned orders for GOP, the Code-SA list, as well as the plausibility check of orders offer potential for improvement. The Sections 7.4.2.1 to 7.4.2.4 further discuss these problem areas as well as potential solutions and benefits.

7.4.2.1. Loss of information

Potential loss of information occurs between *Market management* and *Logistics and order management*. The loss of information due to a broader segmentation structure can be linked to inhibiting performance (Ball, 2015a:7). *Market managemen*t works with the distribution of

NSTs for each BM. *Logistics and order management* does not require this information for volume planning. From this point onwards, the proportional distribution of NSTs is unknown. *Logistics and order management* reports the distribution only at a later point when real orders are processed. NSTs, however, carry value for other departments. The current process does not allow MBC to calculate take-rates and there is no interaction between *Sales operations*, the sales department in charge of take-rates, and *Demand and capacity management* regarding CKD-vehicles specifically. The take-rates enable *Demand and capacity planning* as well as *Supplier management* to safeguard capacities more accurately. Figure 7.16 illustrates the problem of loss of information from NST to BM, the results thereof, as well as a solution and potential benefits.

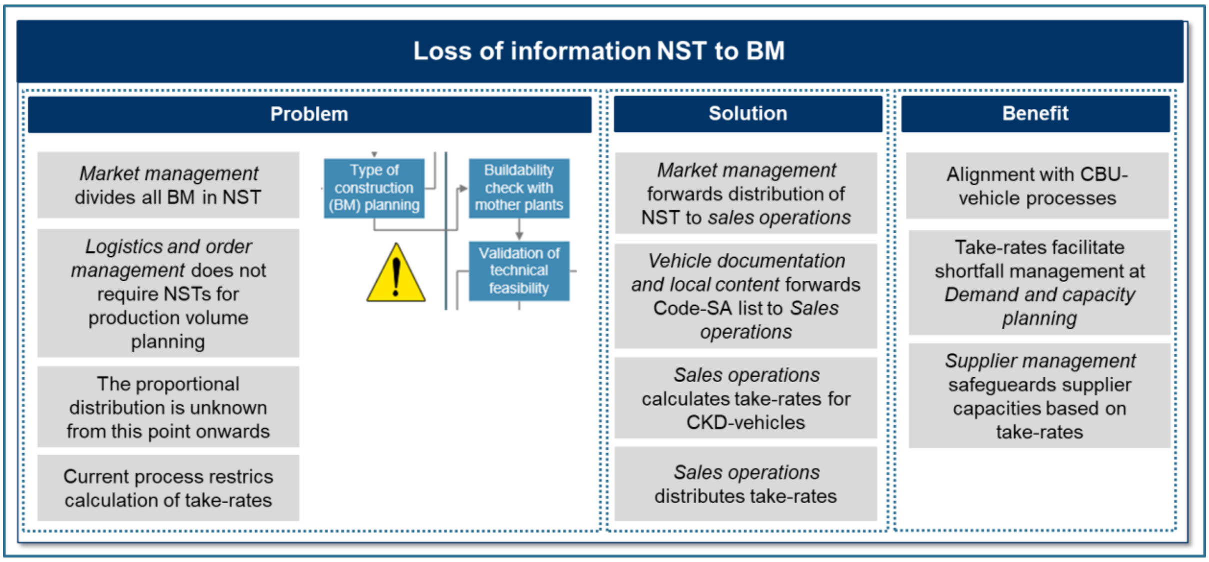


Figure 7.16: Summary of loss of information from NST to BM

A potential solution to generate and distribute take-rates can be observed with take-rates for CBU-vehicles, which can be applied to the planning process for CKD-vehicles. *Sales operations* requires two additional types of input in order to calculate take-rates: the distribution of NSTs and the Code-SA list. *Market management* is required to forward the proportional distribution of NST and *Vehicle documentation and local content* is required to forward the Code-SA list to *Sales operations*. In combination with the forecast of production volumes for CKD-vehicles, which is already accessible for *Sales operations*, the department is able to calculate take-rates for CKD-vehicles specifically. It is recommended that *Sales operations* calculates the take-rates for each CKD-vehicle market individually due to a variation of NST's depending on the market. In order for *Supplier management* and *Demand and capacity planning* to have access to the take-rates, *Sales operations* is required to publish the take-rates on the same platform as used for CBU-vehicles.

7.4.2.2. Manual data handling of the Code-SA list

Similar to the process for production volume planning, manual handling of data poses a risk to the quality of planning and, as a result thereof, process performance (Cecere, 2016b; Lash, 2017; Logility, 2017b). *Vehicle documentation and local content* consolidates all codes for SA manually in a Microsoft Excel sheet that is sent out via email to other departments that rely on the list. A manual process is time-consuming and requires more human resources than an automated approach. Moreover, manual handling of data without an electronic verification process increases the risk of faulty information being forwarded. Additionally, the Code-SA list is not linked to any system which limits the effective use of the information in the document. Subsequently, the validation of orders is also designed as a manual process. The local sales company starts with local sales planning before vehicle documentation and local content publishes the Code-SA list. The long lead time results in additional work at the local sales company due to rectifications to match the requirements of the Code-SA list. Figure 7.17 summarises the issue of manual data handing of the Code-SA list.

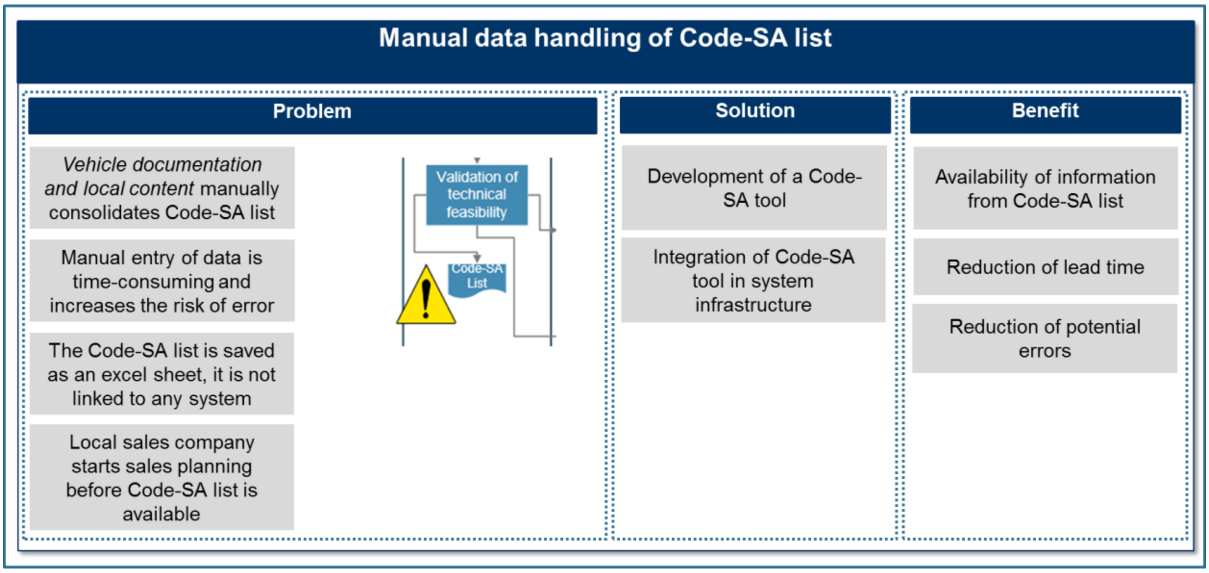


Figure 7.17: Summary of manual data handling of the Code-SA list

As described in Section 4.8, MBC is currently redesigning the Code-SA list into an automated system-based tool. This development will allow for better integration in the system infrastructure of MBC. The Code-SA list contains valuable information that forms the foundation to improve subsequent process steps. The integration of the Code-SA tool in the system infrastructure of MBC allows for an improved availability of information. Regarding the handling of data, an automated tool reduces lead time and the likelihood of errors. Similar to the manual handling of the Code-SA list, the manual handling of plausibility checks is introduced in Section 7.4.2.3.

7.4.2.3. Manual plausibility check

Logistics and order management validates real orders upon receipt from the local sales company. Besides the fact that technology improvements are linked to increasing profitability, the relatively long time required due to manual work potentially causes backlogs and increases lead time (Cecere, 2016b; Lash, 2017; Logility, 2017b). The plausibility check takes place based on the real order and the Code-SA list. The staff uses templates to validate the real order in alignment with the Code-SA list. The results are manually entered into the GO system. Although the templates reduce the risk of errors, an automated system could reduce this risk even further. Due to the time-consuming manual handling of plausibility checks and order conversion, real orders are available in the system at a relatively late stage in comparison with CBU-vehicle orders and there is no flow of information between *Logistics and order management* and *Central sales planning* regarding real orders. Figure 7.18 summarises the complications of manual data handling of plausibility checks.

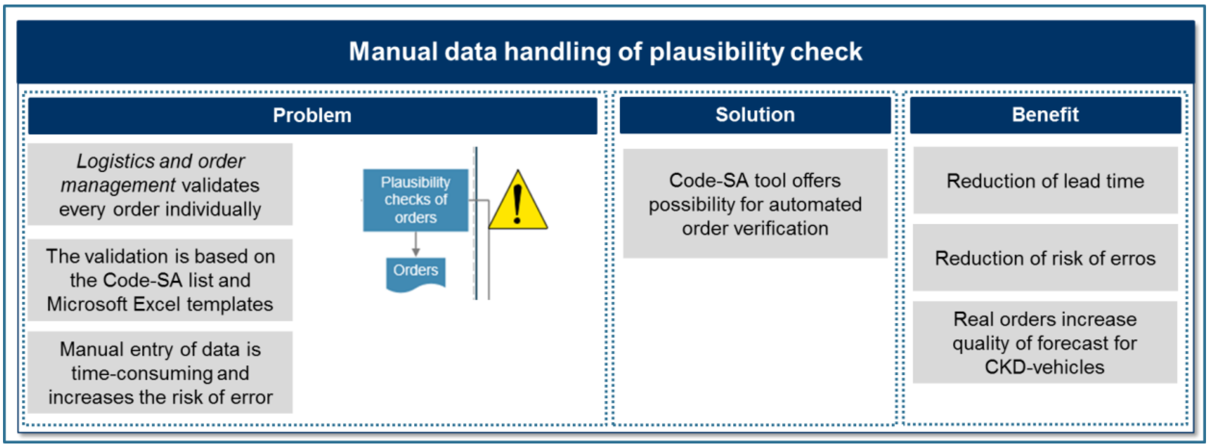


Figure 7.18: Summary of manual data handling of plausibility check

The development and integration of the Code-SA tool offers the possibility for an automated plausibility check. The system integration links the Code-SA tool directly with GO, the system for order management. This automated plausibility check reduces lead time as no manual order verification is required anymore. Moreover, the development eliminates the risk of human error. Besides these benefits in terms of application, the shorter lead time allows for central sales planning to verify the forecast for CKD-vehicles with real orders, potentially resulting in an improved forecast. Section 7.4.2.4 further discusses the issue of forecast inaccuracy for CKD-vehicles.

7.4.2.4. Forecast inaccuracy

A third problem arises from the inaccuracy of forecasts in the GOP. Ball (2015b:3) stresses the importance of forecasting accuracy and the measurement thereof. Currently, the GOP relies on CBU-vehicle orders to develop a forecast for CKD-vehicles. As a result, the planned orders differ significantly from the real orders once available. Once real orders replace planned orders, the forecast starts to differ significantly in comparison to CBU-vehicles. As a result, *Demand and capacity planning* cannot rely on the forecast for CKD-vehicle production volumes. Due to the time-consuming manual handling of the Code-SA list, *Central sales planning* currently is unable to validate CKD-vehicle orders as *Vehicle documentation and local content* forwards the Code-SA list only shortly before the GOP needs to be published. Figure 7.19 summarises the problem of the inaccurate forecast, introducing a potential solution and benefits.

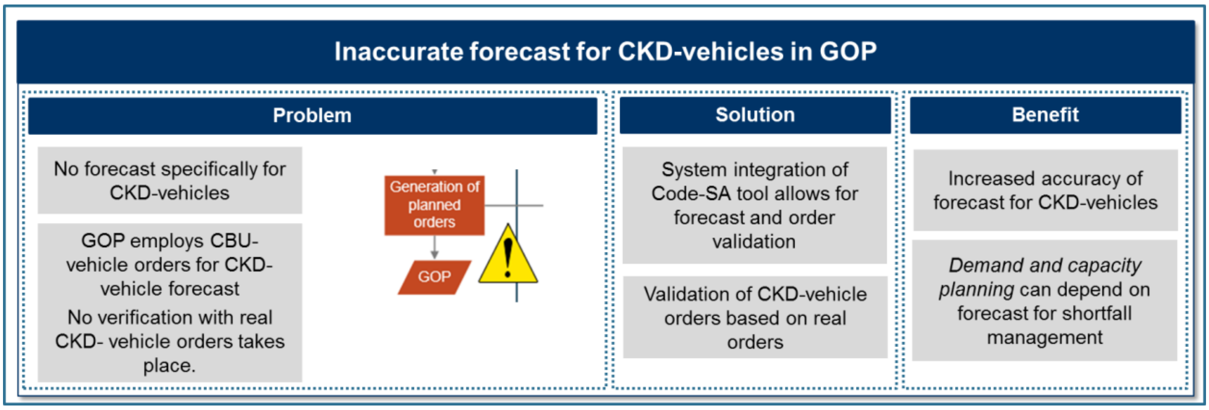


Figure 7.19: Summary inaccurate forecast for CKD-vehicles in GOP

The system integration described in Section 7.4.2.2 forms the basis to improve the CKD-vehicle forecast in GOP. With an integrated Code-SA tool, it could be possible to forecast and validate CKD-vehicle orders. The order forecast could utilise current and historic orders of CKD-vehicles. In addition to the forecast, a validation of planned orders with real orders could take place as part of the forecasting method. Both the improved forecasting method and validation of orders increases the accuracy of the forecast for CKD-vehicles. As a result, *Demand and capacity planning* can depend on the forecast for CKD-vehicles for shortfall management. Other departments, such as *Supplier management*, could also benefit from the increased accuracy as it could allow for a more precise safeguarding of supplier capacities in the short-term time horizon.

In summary, the current state of the Code-SA list creates several complications which can be solved through the development of a Code-SA tool in combination with a comprehensive system integration. An improvement of the planning process for SA for CKD-vehicles positively affects the ordering and shipping process. Section 7.4.3 describes the planning process for ordering and shipping of CKD-vehicles in more detail.

7.4.3. Planning of ordering and shipping for CKD

Describing and analysing the process for ordering and shipping for CKD-vehicles identifies several potential areas of improvement. Loss of information, inaccurate forecasts and manual data handling are the main problems. Figure 7.20 illustrates the problem areas.

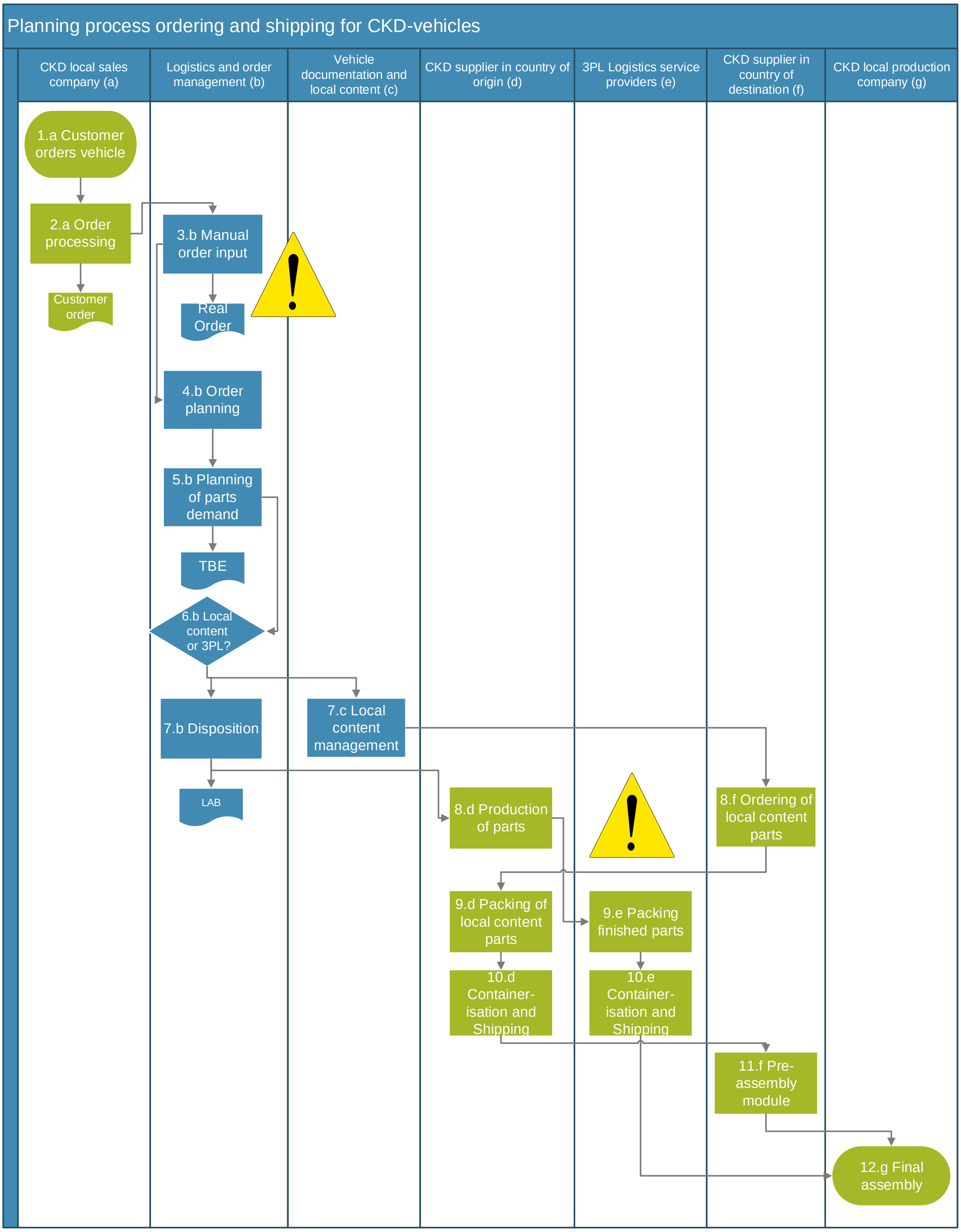


Figure 7.20: Problem areas planning process ordering and shipping for CKD-vehicles

The yellow warning signs further highlight process steps that offer potential for improvement. In the planning process for ordering and shipping for CKD-vehicles, manual order input and the practices of local content require further clarification.

7.4.3.1. Manual data handling of orders

Logistics and order management handles orders placed by the local sales companies manually. Manual data handling instead of the application of appropriate technologies inhibits performance (Cecere, 2016b). There is no standardised order management for CKD-vehicles. Each entity places orders differently, for example via email or fax. The manual handling of data is extremely time-consuming and increases the likelihood of mistakes. The time consumed to forward, validate and enter the orders significantly postpones the availability of real orders in the system for *Central sales planning* and *Demand and capacity planning*. Figure 7.21 summarises the situation of manual data handling for orders.

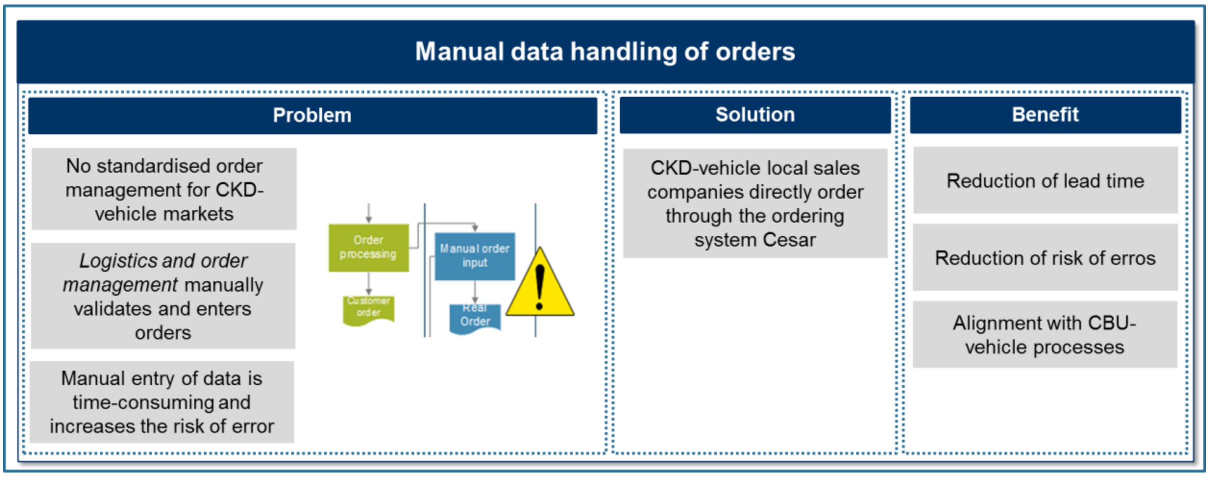


Figure 7.21: Summary of manual data handling of orders

A solution can be derived from the order handling of CBU-vehicle orders. In CBU-vehicle markets, dealerships directly place their orders in a system called Cesar. The system automatically transmits the orders to MBC who has access to the orders immediately through the system GO. Section 4.8 introduced the project GO Redesign, a project managing the system integration of the new CKD-vehicle plant in Russia. It is recommend to align all CKD-vehicle local sales companies through the introduction of the system Cesar for an automated, homogeneous handling of orders. The introduction of a uniform computer system allows for a significant reduction of lead times. In addition, a computer system drastically reduces the risk of errors, both for the CKD-vehicle local sales company as well as for *Logistics and order management*. Additionally, a common system represents a further alignment of CKD- and CBU-vehicle processes. Other specifications of CKD-vehicle processes cannot be aligned as they are unique to the CKD-vehicle business. The strategy of local content is such a specification and the problem regarding unclear procedures related to local content are explained in Section 7.4.3.2.

7.4.3.2. Unclear procedures for local content

A second problem area in the planning process for ordering and shipping for CKD-vehicles the unclear procedures around local content. As pointed out by vom Brocke *et al.*, (2014:536), it is crucial for successful process management that employees understand the processes in place. The only party actively involved with local content is *Vehicle documentation and local content*. Other departments directly or indirectly involved with supplier management lack understanding of these procedures. It is unclear whether a single supplier delivers both regular and local content parts or if there are differences in suppliers. In the case of a shortfall, *Demand and capacity planning* is not aware of local content parts. Currently, *Demand and capacity planning* does not differentiate between local content, common parts for CKD-vehicles, and parts for CBU-vehicles. The department is generally not aware of local content parts. Figure 7.22 summarises the unclear procedures for local content.

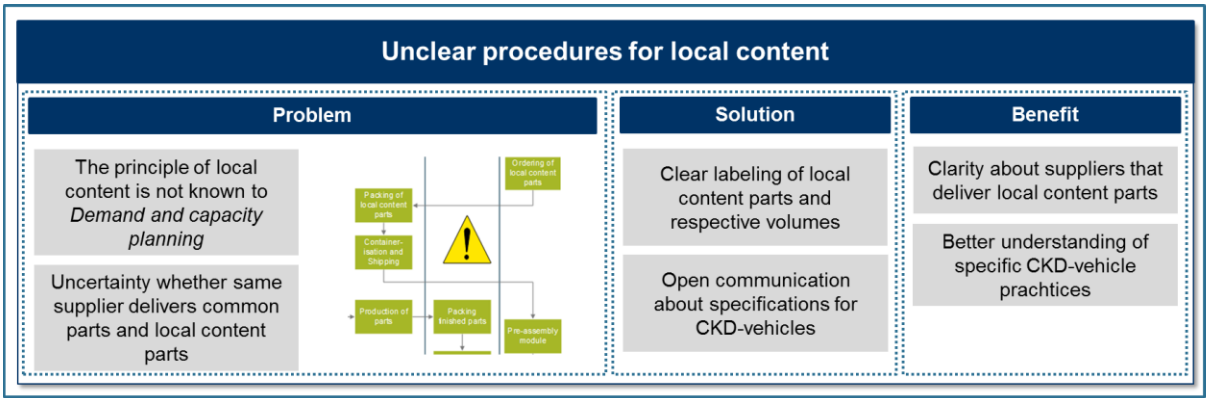


Figure 7.22: Summary of unclear procedures for local content

Firstly, it is recommended that *Vehicle document and local content* clearly labels the suppliers and allocated volumes of local content parts in DIALOG and other systems involved. Secondly, an open communication of local content procedures to other departments involved with suppliers, such as *Demand and capacity planning* as well as *Supplier management*, strengthens the understanding and allows for an appropriate handling of local content in these departments. Thirdly, a process database, which contains all processes at MBC, or at least the processes relevant to *Supply chain management (SC)* sector, could be implemented. In order for the database to function, further process mapping of all processes is required. With a better understanding of local content, other departments can adjust processes where required, to accommodate local content specifications.

Common complications such as manual data handling, forecasting accuracy or loss of information can be allocated to specific process steps. There are, however, further general complications that refer to the process as a whole. Section 7.4.4 elaborates on general complications and potential improvements for CKD-vehicle planning processes.

7.4.4. General complications and potential improvements

Based on a review of existing theory and business practices, further complications and potential improvements have been identified through the analysis. These areas for improvement mostly refer to the alignment with strategy, vision and mission, process implementation and organisational management structures.

As introduced in Section 4.6, MBC and *SC* both encompass a customised strategy, vision and mission. The vision of MBC is aligned with the sector *SC*'s vision, and both statements focus on high standard products. While there is a clear alignment of vision, mission and strategy of the entity, the guiding statements differ in detail. According to Snowdon (2008:3-4), a clear strategy, vision and mission guide successful process management, especially in the implementation phase. This includes an alignment of a department's statements with the corporate statements (Chopra & Meindl, 2007:22).

The strategy *Mercedes-Benz 2020* aims to achieve growth by strengthening the core business, growing globally, leading in technology and pushing digitalisation. On the contrary, *SC* follows a strategy around cost, quality, reliability, end-to-end responsibility and a strengthening of the production programme. An alignment of both strategies is unclear. Further, the mission of MBC focuses on safety and sustainability, while *SC* focuses on a timely production to strengthen sales capabilities. Additionally, it is noticeable that a strategic focus on cost, quality and reliability is broad and can be contradictive, especially when considering the mission, which adds the factor of time. Regarding CKD-vehicle planning, the strategy of the department does not provide sufficiently clear guidance. Firstly, an alignment of mission and strategy with MBC's corporate identity potentially provides clearer guidance. Secondly, a strategy that focusses rather on one or two attributes further increases the potential for successful guidance.

In terms of guidance, employees further require information on their activities and responsibilities in order to efficiently perform their duties. One aspect of the 7-S Model, the factor of systems, entails practices and processes that support how work is done (Bryan, 2008). Processes potentially lead to higher employee efficiency, assuming that the employees are aware of and familiar with the processes in place (vom Brocke *et al.*, 2014:536; Matthews & Dixon, 2016:3). In *SC* and for vehicle-planning processes specifically, MBC lacks clear process documentation. As a result, many employees are uncertain about exact process steps in place. In many instances, employees fulfil their duties based on a personalised approach. It is difficult for other employees, especially from other departments, to fully understand processes in place. The lack of understanding of the CKD-vehicle business is an example of the lack of process documentation and clarity. A database for mapped processes, ideally cross-functional, has the potential to provide guidance for existing and new employees.

Another complication arises from the organisation of employees. As a large business unit, MBC is managed in high hierarchies with a variety of different departments and management levels as introduced in Section 4.5. The 7-S Model also considers organisational structures, pointing out that high hierarchies potentially reduce efficiency. In addition, high hierarchies complicate reporting structures and make process ownership unclear (Bryan, 2008). MBC's high hierarchies result in slow decision-making processes. Furthermore, the distribution of demand and capacity management for CKD-vehicles is spread over different sectors and it is often unclear why the responsibility for an activity lies with a department. A flatter hierarchy with a functional approach as introduced by Bowersox *et al.*, (2007:527) can potentially improve process performance and efficiency. Further restructuration should, however, be well planned. Matthews & Dixon (2016:3) highlight that restructuration of organisational structures leads to uncertainty and confusion with employees. MBC is under constant restructuration. It is advisable to reduce changes in organisational structure to a minimum and rather aim towards a flatter hierarchy than introducing additional management levels.

The lack of process ownership is another complication linked to organisational structures that can be observed throughout all processes. Several approaches stress the significance of process ownership for successful processes (Hayler & Nichols, 2005:41-51; Bolstorff & Rosenbaum, 2011; Berardinelli, 2012). Process ownership should be allocated at executive level (Ball, 2015b:14; Matthews & Dixon, 2016:4). The department with the most involvement in a process should take accountability of the process ownership, with the executive of the department as the process owner. It is suggested that *Logistics and order management* takes process ownership of all processes as the majority of activities are under management of the department. Alternatively, *Vehicle documentation and local content* could take on process ownership for the planning process for SA for CKD-vehicles or the ordering and shipping planning process. Both *Logistics and order management* as well as *Vehicle documentation and local content* are departments specifically designed for CKD-vehicle operations. *Logistics and order management* is in charge of the major activities in the three identified processes, therefore presenting a suitable process owner. *Vehicle documentation and local content* is a suitable alternative for process ownership for planning of SA and ordering and shipping as the department's involvement in these processes is also significant.

Overall, the level of supply chain maturity of MBC can be identified between level two and three (Rüth, 2014; Payne & Salley, 2017:6-7). MBC is in control of functional processes within departments and further aims at the improvement of cross-functional processes. Generally, MBC shows cross-functional alignment and co-operation but there is still room for improvement in the form of cross-functional collaboration rather than pursuing each department's own best interests. Regarding the focus of the supply chain, *SC* stresses the focus on costs in their strategy but also includes smaller aspects of customer focus. It is recommended for MBC to further develop the level of supply chain maturity to reach level four. The recommendations suggested in this chapter can assist in increasing the level of supply chain maturity. Figure 7.23 summarises all general complications and recommended improvements.

Complication	Improvement
Misalignment of strategy, vision and mission	Clear focus and alignment
Lack of process understanding	Clear communication or process database
High hierarchies	Consider reduction for next restructuring
Lack of process ownership	Define ownership for each process

Figure 7.23: Summary of general complications and improvements

The positive and negative aspects of CKD-vehicle planning processes have been derived from qualitative data analysis. An assessment of performance further indicates the level of process performance. Such an assessment, however, requires performance measurement and suitable metrics. Section 7.5 evaluates performance management of planning processes at MBC.

7.5. Evaluation of performance measurement

The measurement of the supply chain performance is of great importance to a company, as discussed in the literature review. Section 2.6 elaborates on the theoretical aspects of supply chain performance and suitable metrics. MBC follows the principle of key performance indicators (KPIs) to measure performance. As with the majority of business activities, *SC* measures and monitors CKD- and CBU-vehicle businesses separately with different KPIs. Considering the research questions, Section 7.5.1 introduces the metrics used to measure CKD-vehicle business performance, Section 7.5.2 describes metrics in place for CBU-vehicle business performance, and Section 7.5.3 suggests potentially suitable, new performance metrics for CKD-vehicle planning processes specifically.

7.5.1. Metrics for CKD-vehicle planning

MBC designed a number of KPIs specifically for the company's CKD-vehicle business. On the one hand, different KPIs are more adjusted to the business specifications. On the other hand, differences impede the comparability of the measured values. Davis & Novack (2012:12) recommend an alignment of KPIs throughout individual business units for a better understanding of the metrics applied where possible. A possible alignment strongly depends on the nature of the activities to be measured, and a full alignment is not always possible. *Demand and capacity planning* works with two KPIs that measure supply chain performance for CKD-vehicles, namely packing fulfilment and quote special packing requests. Similar to the KPIs measuring programme fulfilment, these KPIs measure the degree to which MBC could fulfil the packing programme as planned. The same principle applies to special requests fulfilled as planned, which is measured by the KPI quote special packing requests for CKD-vehicles. The target for both KPIs is 100%. Table 7-1 shows the information on SCM KPIs for CKD-vehicles.

Table 7-1: SCM KPIs for CKD-vehicles

Metric	Description	Target
Packing fulfilment CKD-vehicles	Packing programme fulfilled as planned	100%
Quote special packing requests CKD-vehicles	Special requests fulfilled as planned	100%

As the majority of planning for CKD-vehicle S&OP takes place separately from the CBU-vehicle business, performance management also takes place separately. *Demand and capacity planning* does not have access to additional KPIs for CKD-vehicles despite their potential relevance.

These additional KPIs do, however, exist. The *Network and performance CKD* department manages a number of metrics specifically designed for the CKD-environment. The folowing logistics KPIs are in place to measure CKD-vehicle planning:

- **Average complete cars:** Completed Cars contain all relevant parts when receiving/opening delivery kits including wrong, damaged and missing parts included (MO/PCPN, 2016:4).
- **Average perfect cars:** Perfect Cars contain all relevant parts at the moment of receiving/opening delivery. The difference to a complete car is that perfect cars exclude wrong, damaged or missing parts (MO/PCPN, 2016:8).
- **Logistics costs:** This KPI measures three different cost types: All costs from order of vehicle to FOB (excluding admin cost), all costs from FOB to plant, and all costs for claims, orders and subsequent deliveries (MO/PCPN, 2016:9).
- **Stock in Process:** Stock is shown for the intervals from order to FOB, from FOB to plant, and for sales. Time wise, stock is measured for each month, and an accumulated year-to-date figure is given (MO/PCPN, 2016:10).
- **Lead time for series delivery:** For each country and model, this KPI measures lead times for the intervals from order to FOB, from FOB to country, from country to plant, from plant to end of production and from end of production to sales (MO/PCPN, 2016:12).

Table 7-2 summarises the KPIs explained above. In addition, a short description and a target gives the reader further information on each KPI. The KPIs measuring average complete cars and perfect cars aim for a target of 100%. There is no defined target for logistics costs and stock in progress. MBC sets the target for total lead time to 150 days for all models.

Table 7-2: Logistics KPIs for CKD-vehicle business

Metric	Description	Target
Average completed cars	Complete cars received	100%
Average perfect cars	Perfect cars received	100%
Logistics costs	All costs	No target defined
Stock in process	Stock from order to sales	No target defined
Lead time for series delivery	Lead time from order to sales	150 days

Both *Demand and capacity planning* as well as *Network and performance CKD* work with performance metrics that do not measure actual process performance of demand and capacity planning processes, but rather the quality of the output of the processes. The metric to measure packing fulfilment of CKD-vehicles indicates an orientation towards forecasting accuracy. Further, the KPI measuring lead time includes the impact of planning processes as these processes account for a significant component of lead time.

In addition to the KPIs in place for CKD-vehicle demand and capacity planning specifically, *SC* manages a number of metrics for the CBU-vehicle business. These performance metrics will be discussed further in Section 7.5.2.

7.5.2. Metrics for CBU-vehicle planning

Demand and capacity planning administers and utilises a number of KPIs for CBU-vehicles. The KPIs are divided into administrative measures and measures specific to the technical operations of the sector. The following KPIs are relevant to this study:

- **Programme fulfilment**: This KPI measures the level to which the programme has been fulfilled. The value is measured as a percentage. Both fewer cars produced, as well as more cars produced have an impact on the fulfilment rate.
- **Quote special programme requests**: This measure expresses to what extent special programme requests are fulfilled. The KPI only applies to requests that MBC accepted before. Similar to programme fulfilment, this KPI is a percentage that can be influenced by both under- and overfulfilment.
- **Costs of airfreight**: This KPI includes all costs for airfreight that MBC is liable for. In case of a shortfall, MBC requires air transport to ensure smooth production activities. Depending on the cause of the shortfall, MBC or the supplier is liable for the cost of air transport. MBC does not include costs covered by suppliers or third parties into this KPI.
- **Amount of airfreight**: The amount of airfreight measures the number of parts flown. This KPI includes all parts flown, irrespective of which party is liable for the costs of airfreight.
- **Code restrictions (CoRe)**: This KPI measures how many CoRe MBC currently manages. The KPI is divided into subcategories. Firstly, MBC distinguishes between CoRe created by suppliers or created internally. Secondly, it is relevant whether MBC addresses the case in a committee or not. The different categories utilise different targets. MBC only measures CoRe with an influence on at least 95% of the production programme.
- **Programme scheduling guideline (EPV):** This KPI counts all restrictions regarding the production programme schedule.

Table 7-3 summarises the KPIs applicable to CBU-vehicle demand and capacity planning. A short description indicates what the KPI measures.

Table 7-3: SCM KPIs for CBU-vehicles

Metric	Description	Target
Programme fulfilment	Programme fulfilled as planned	100%
Quote special programme requests	Special requests fulfilled as planned	100%
Costs of airfreight	Total of all costs for air freight for MBC	0
Amount of airfreight	Number of parts flown	0
CoRe	Restrictions of more than 95%	0

All KPIs work towards specifically designed targets. For the KPIs regarding programme fulfilment, MBC sets a target of 100%. All other KPIs, which measure total numbers, aim to be as low as possible towards a target of zero.

Similar to the metrics defined for CKD-vehicle business specifically, the metrics for CBU-vehicle demand and capacity planning focus on planning process output rather than on performance of the actual process. The metric of programme fulfilment takes planning into account by comparing the planned production programme to the actual programme.

The metrics currently in place to measure performance of demand and capacity planning processes do not sufficiently measure process performance. Therefore, Section 7.5.3 suggests potential performance metrics for CKD-vehicle demand and capacity planning processes.

7.5.3. Potential performance metrics for CKD-vehicle planning processes

The planning process improvements suggested in Section 7.4 could potentially improve the performance of supply chain processes. Suitable metrics need to be identified in order to measure the success of these improvements. This section suggests a set of metrics based on relevant literature identified in Chapter 2 in combination with the currently existing metrics identified in the previous Sections 7.5.1 and 7.5.2.

Underlying theories found in published literature serve as source of information in order to identify suitable metrics to measure process performance. Davis & Novack (2012:15) identified that a number of approximately seven metrics per department as most suitable. Further, it is of great importance that both employees and management understand the metrics in place to increase acceptance and awareness (Davis & Novack, 2012:15). To define a target for each metric, the practice of benchmarking should identify values after the metric is implemented. The target should be defined based on past values, incorporating a factor of continuous improvement into the target (Christopher, 2011:237).

Based on metrics of the SCOR model as developed by the Supply Chain Council (2012), and the metrics identified as best-in-practice by Ball (2015b:2), this study identified seven metrics, namely *forecasting accuracy, percentage of planned packing, end-to-end order-to-delivery lead times, number of assumptions/decisions, perfect order fulfilment, planning costs and inventory days of supply*. These metrics, summarised in Table 7-4, have been identified as most suitable to measure process performance of demand and capacity planning processes.

Table 7-4: Potential performance metrics

Attribute	Description	Metric
Demand/supply match	The ability to accurately forecast demand	Forecasting accuracy
Supply performance	The ability to accurately plan packing	Percentage of planned packing
Customer satisfaction	The time required from order to delivery	End-to-end order-to-delivery lead time
S&OP process management	Plan of record of process improvements	Number of assumptions/decisions
Reliability	The ability to perform an order as expected	Perfect order fulfilment
Costs	The cost of operating supply chain processes	Planning costs
Inventory	Amount of inventory in the supply chain	Inventory days of supply

These seven metrics together form a balanced and comprehensive way to measure process performance as well as the increase in performance based on the improvements recommended. The metric *forecasting accuracy* describes the ability to accurately forecast demand. Forecasting inaccuracy for CKD-vehicles is one of the complications identified in this study that can be improved. The metric measures the accuracy of the forecast per product group. The segmentation should take place on the level of class type (TKL). Potentially, further tracking of forecasting accuracy could take place on the basis of BM. The metric has an impact on demand and supply balances as forecasting accuracy positively influences the match of demand and supply.

The second metric, *percentage of planned packing*, measures the percentage of CKD-vehicles packed, indicating the ability to accurately plan vehicle packing. This metric is influenced by the existing metrics in place to measure performance of the CKD-vehicle business. It is the metric's target to measure supply performance by monitoring how many vehicles can be packed as scheduled. The metric is linked to forecasting accuracy with a focus on the planning of packing by measuring the accuracy of the planning. Negative as well as positive deviations from planning reduce the percentage of vehicles packed as planned. Late packing, early packing, additional short-notice requests to add vehicles or reduce the number of vehicles, are measured in this category. The metric should be tracked for the CKD-vehicle business as a whole, and a segmentation in TKL to identify problem areas in different product groups.

The third metric, *end-to-end order-to-delivery lead time*, measures the time required from order to delivery. This metric is a means to measure the impact of demand and capacity planning on customer performance. Complications identified in this study are long handling times and manual data handling. Implementing the recommended improvements can be measured through the monitoring of lead times throughout the supply chain. A measurement of the total lead time as well as the lead time of individual section of the supply chain should be taken. Subsections included should be ordering time, order processing time, time to develop MPP and JPP, and shipping time. Currently, MBC already measures lead time for CKD-vehicles and this practice should be continued.

The fourth metric*, number of assumptions/decisions*, measures S&OP process management and the improvement thereof. The metric keeps a record of process improvements. By monitoring decisions, assumptions and changes made to planning processes, it can be measured whether the changes implemented based on these decisions and assumptions have a positive or negative influence on the performance of the processes. Frequent, periodic reviewing of the track record could guide potential additional improvements or indicate which assumptions and decisions might not lead to improvements.

The fifth metric, *perfect order fulfilment*, measures the reliability of a planning process. The metric monitors the ability to perform an order as expected by taking all incomplete or faulty orders into consideration. The improved planning processes should have an impact on the percentage of perfect orders through overall improvement of the planning quality. This metric measures the effect of the process improvements recommended in this study. Similar to other metrics, a breakdown into TKL is recommended in addition to measuring perfect order fulfilment for all CKD-vehicles combined.

The sixth metric focuses on the factor of cost. The metric called *planning costs* tracks the operating costs of supply chain planning processes. A clear definition of costs measured, is required to know what to measure and to compare within the metric. Costs included should be management and labour costs directly associated with the process, as well as the costs for materials used, such as costs associated with computer systems or licences. Planning costs should be monitored per planning process and across the supply chain.

The seventh metric, *inventory days of supply*, measures the amount of inventory in the supply chain. This metric monitors individual parts, packed parts en route to CKD-vehicle assembly plants, as well as finished goods in the foreign country. With successful implementation of process improvements, the inventory is likely to be reduced as process deficiencies affect lead times and, as a result thereof, inventory levels. Measuring inventory levels provides an overview of the impact of process management of demand and capacity planning.

The seven recommended performance metrics aim to measure the recommended improvements in this study as well as the overall performance of process management at MBC. The metrics suggested are therefore linked to the complications and improvements discussed in this chapter. Further, the metrics take into account strategy, vision and mission of *SC*. Section 7.6 concludes this chapter by further summarising the findings regarding the evaluation of demand and capacity planning processes, possible improvements and the measurement thereof.

7.6. Concluding remarks

This chapter maps and evaluates the processes for demand and capacity planning for CKD-vehicles at MBC and recommends performance metrics to measure the performance of these processes and the effectiveness of the improvements recommended. The findings in this chapter are based on existing theories in literature as well as insights acquired from primary and secondary data.

The mapping of the three planning processes for volume planning, SA-planning, and ordering and shipping for CKD-vehicles illustrates and describes the processes in detail. The processes, illustrated in swimlane diagrams, provide information on responsible departments, activities, input and output as well as process flow. Furthermore, the same three processes for CBU-vehicles provide background information on current best practices at MBC.

The identification of the current state of processes is the foundation to evaluate the processes. The evaluation identifies positive and negative aspects of the processes. Firstly, positive aspects of the three planning processes for CKD-vehicles emphasise the functioning components of the process. Key points are the cross-functional collaboration of departments, monthly reviews of demand and supply planning and the expertise of employees in the CKD-vehicle business at MBC. The positive aspects highlighted indicate practices that should be continued and further developed.

Secondly, negative aspects of the three processes for CKD-vehicle planning indicate problem areas that can potentially cause complications. These complications should be reduced by improving the processes currently in place. Key factors that require improvement are manual handling of data, forecasting accuracy and loss of information. General complications not connected to a particular process include the lack of alignment of vision, mission and strategy as guiding principles, high hierarchies, and the lack of process ownership.

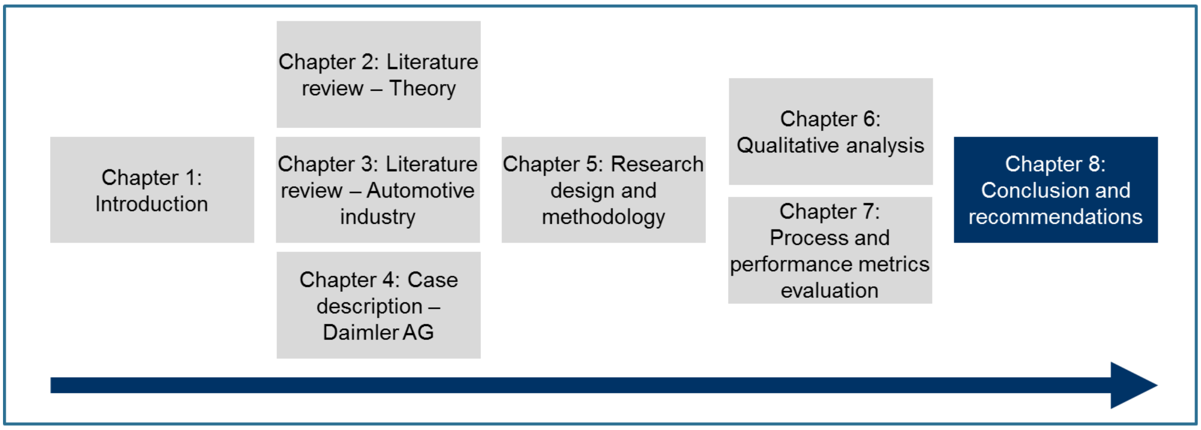
Existing complications offer the opportunity for improvements. Recommended improvements include cross-functional sharing of information, integration of systems and tools, and a forecasting system using real orders as verification. Generally, the study recommends a flattening of hierarchies, the nomination of process ownership and an alignment of strategy, vision and mission.

In order to see the success of implemented changes and improvements with regard to performance, it is necessary to measure the performance. Performance measurement require metrics that monitor relevant information only. Performance metrics should therefore measure process performance as well as the effectiveness of improvements made. Seven balanced metrics measuring different aspects of the processes itself and the output of the processes are recommended to MBC to measure the suggested changes.

Chapter 8. Conclusion and recommendations

"What is now proved was once only imagined."

(William Blake)



8.1. Introduction

The final chapter of this thesis summarises the results and concludes the findings of the study in the form of a review of the research questions in Section 8.3. Based on the findings, Section 8.4 provides recommendation for implementation of the findings, followed by additional observations made in Section 8.5. As this study was subject to limitations, recommendations for future research are made in Sections 8.5 and 8.6.

8.2. Review of research

The research design and methodology described in Chapter 5 provided a guideline for the research conducted in this study. As a starting point, a literature review provided sufficient background information on existing theories relating to sales and operations planning (S&OP) as well as process and performance management. Additional background information on the automotive industry and purchasing and delivery configurations relevant to this study offered a holistic view of the topic of this study.

The application of an exploratory case study design guided the researcher to focus specifically on completely-knocked-down (CKD) vehicle demand and capacity planning at Mercedes-Benz Cars (MBC). Data collection consisted of secondary data and primary data from MBC. Primary data collected through interviews and focus groups provided the majority of the information for this thesis. Secondary data was required to fill the gaps and verify specific statements and assumptions. Mapping and evaluation of processes significantly depended on primary data, while secondary data was required to gather information on performance measurement at MBC. The collection of primary data regarding performance metrics was inhibited by data protection regulations accompanied by a lack of interest of employees at MBC. From the perspective of the business, the main interest was in research on process clarification and improvements. As a result, the qualitative analysis mostly provided results beneficial for process mapping and evaluation. The content analysis served developed quantifiable backup for the relevant statements in the interviews.

The study's research quality benefited from several factors, leading to a high level of research validity and reliability. A key informant from MBC at *Demand and capacity planning* frequently reviewed the progress and results of the project. The repetitive involvement of expert interviewees in the stage of data collection and analysis further supports validity. In addition to validity, reliability defines the research quality of the study. Adherence to the research design and methodology facilitates a high level of reliability.

Research was done in order to solve the problem statement and to answer the research questions. A review of the research questions will be done in Section 8.3.

8.3. Review of research questions

The research questions as introduced in Section 1.4 provided guidance to the research of the study. The answers to the research questions aim at solving the research problem. A review of the following five research questions provides a conclusion to the findings of this research.

8.3.1. Current processes for CKD-vehicle demand and capacity planning

The first research question focuses on the identification of current processes for CKD-vehicle demand and capacity planning. In alignment with the scope of this study, research identified three main processes relevant to demand and capacity planning of CKD-vehicles. Interviews and the qualitative analysis thereof, observations, personal communication and secondary information made available at MBC provided sufficient background information to map the processes. The analyses are discussed in Chapter 6 and the results are presented in Section 7.2.2. The three main processes are the planning process for production volumes for CKD-vehicles, the planning process for special equipment (SA) for CKD-vehicles, and planning process for ordering and shipping for CKD-vehicles. Figure 8.1 illustrates the answer to the first research question.

Research question 1:
What are the current processes for CKD-vehicle demand and capacity planning?

Planning process for production volumes for CKD-vehicles

Planning process for special equipment for CKD-vehicles

Planning process for ordering and shipping for CKD-vehicles

Figure 8.1: Summary of results of research question 1

The planning process for production volumes describes the activities from the results of the market analysis and the planning of car classes to the production and packing programmes world production programme (WPP) for CKD-vehicles and completely-built-up (CBU) vehicles combined as well as annual programme planning (JPP) and monthly programme planning

(MPP) for CKD-vehicles specifically. This process forms the foundation for the local production company to plan CKD-vehicle assembly and for *Demand and capacity planning* to manage shortfalls and implement constraints. The process involves the co-operation of three departments at MBC, namely *Central sales planning*, *Market management* and *Logistics and order management*. Furthermore, external parties involved are CKD-vehicle local sales companies and CKD-vehicle local production companies. The activities take place as part of short-term planning within a two-year time horizon.

There are similarities between the planning process for production volumes and the planning process for SA, since the equipment of a vehicle partly depends on the planned volumes. The planning process for SA consists of activities from the results of the market analysis and equipment list, to the development of the vehicle forecasts WPP and sales data used for material forecast (GOP) as well as the material forecast (TBE), the Code-SA list and real orders. This cross-functional process involves the MBC departments *Central sales planning*, *Market management*, *Vehicle documentation and local content* as well as *Logistics and order management*. External parties involved are logistics service providers (3PLs) and CKD-vehicle local sales companies. The process generates output for *Demand and capacity planning*, *Supplier management* and the 3PL. This process takes place in the short-term planning horizon within two years prior to packing of the vehicle.

The third process describes the planning process for ordering and shipping. While the processes for production volumes and SA describe the planning of information flow, this process entails the planning of physical goods flow. Activities taking place in this process range from the customer placing an order in the local dealership, to the planning of the final assembly in the local CKD-vehicle plant. As opposed to the previously introduced processes, the majority of activities here are carried out by external parties. Internal MBC departments involved include *Logistics and order management*, and *Vehicle documentation and local content*. External entities involved are CKD-vehicle local sales companies, CKD-vehicle suppliers in the country of origin, 3PLs, CKD-vehicle suppliers in country of destination and the CKD-vehicle local production companies. Besides the TBE and the delivery call-off (LAB), the main process output is real orders for CKD-vehicles. The process also takes place in the short-term horizon within a year to approximately two months prior to packing of the CKD-vehicle.

In addition, the study identified the equivalent of these three main processes for CBU-vehicles. The planning processes for CBU-vehicles provide a reference point for further process improvements since the CBU-vehicle business is the main business component of MBC.

The three key processes identified describe the planning processes for production volumes, SA as well as ordering and shipping as they are currently in practice. The processes are characterised by positive and negative aspects. Section 8.3.2 answers the second research question focusing on the positive aspects of the processes.

8.3.2. Positive aspects of current demand and capacity planning processes

The study has identified a number of positive aspects of the processes currently in place for demand and capacity planning. The evaluation of processes took place based on processes and practices in place for CBU-vehicles and theories identified from the literature, listed in Chapter 2. Based on the analysis in Chapter 6, Section 7.3 fully identified the positive aspects of the processes. Figure 8.2 summarises the results relating to the second research question.

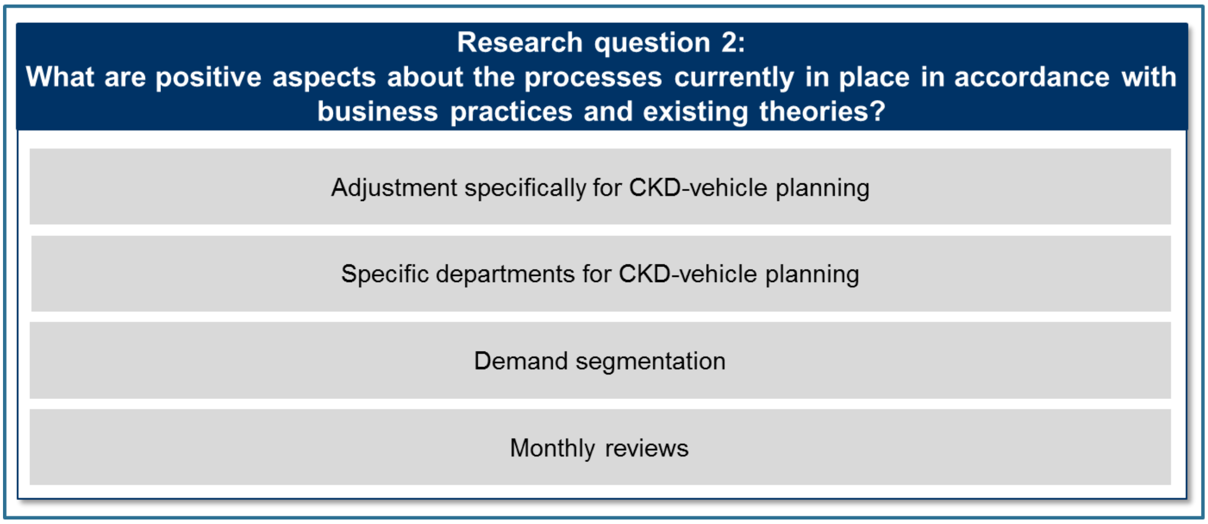


Figure 8.2: Summary of results of research question 2

MBC implemented processes for CKD-vehicle demand and capacity planning which significantly differs from the equivalent processes for CBU-vehicles. The variance in process design does, however, not necessarily pose an obstacle. The specifications of the CKD-vehicle business require customised activities and processes to a certain extent.

In addition to the department involved in demand and capacity planning for all vehicles, MBC implemented a specific department for CKD-vehicle planning which plays a crucial role in the planning processes. As the final acceptance for CKD-vehicles takes place at packing, this step also marks the end of the direct involvement and responsibility of MBC. Furthermore, MBC involves the clients, namely the local subsidiaries, directly in the planning processes. The cross-functional co-operation in combination with the integration of external entities indicates a step towards end-to-end planning and customer orientation.

Considering the planning content, MBC follows the principle of demand segmentation. Information on forecasts per car class is generated and MBC differentiates between the different models and markets. The segmentation is, however, more detailed for CBU-vehicles than for CKD-vehicles.

Additionally, MBC has incorporated monthly review meetings for demand and capacity planning. These meetings include reviews of supply and demand planning output with a focus on the production and packing programmes. Part of the review is a comparison of the previously forecasted figures with the current forecast and real orders. Such monthly reviews play a crucial role in successful S&OP.

The positive aspects identified in this study indicate that MBC is conscious of process management and S&OP in particular. In addition to the well-functioning aspects of the demand and capacity planning processes, several complications pose a threat to the supply chain performance of MBC. Section 7.4 concludes the key aspects of complications and potential improvements of CKD-vehicle planning processes for demand and capacity planning.

8.3.3. Complications resulting from current processes

In accordance with the results of the qualitative analysis, secondary data from MBC and the literature presented in Chapter 2, this section concludes the complications occurring as a result of the current processes for demand and capacity planning. Section 7.4 elaborates on the complications specifically for each process based on the analysis from Chapter 6. The complications identified are in alignment with the problem statement as described in Section 1.3. Figure 8.3 summarises the results for the third research question.

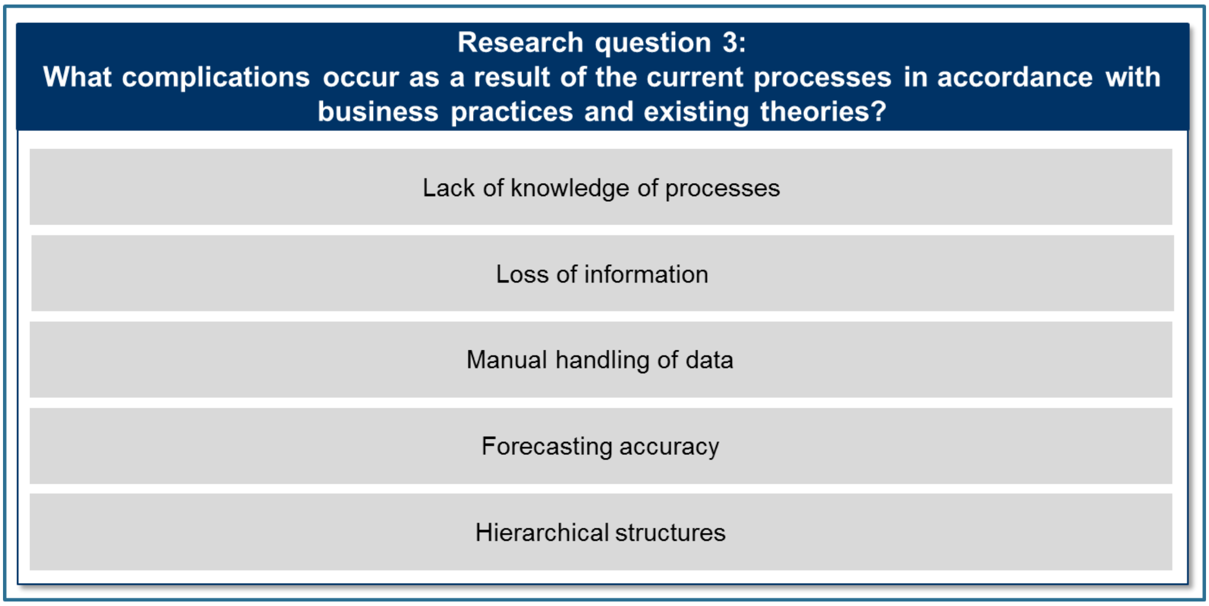


Figure 8.3: Summary of results of research question 3

One of the main reasons for MBC to promote research in the area of CKD-vehicle planning can be derived from the lack of knowledge of CKD-vehicle processes in departments not directly involved with these processes. Departments such as *Demand and capacity planning* and *Supplier management* depend on the output of demand and capacity planning for CKD-vehicles as the operations of these departments include the management of both CBU- and CKD-vehicles. Unclear processes, structures and procedures in place can potentially lead to complications. Responsibilities for activities and outputs are unclear. Therefore, it is unclear whom to contact in cases where clarifications or additional information is required.

The information that *Demand and capacity planning* receives about CKD-vehicles is limited compared to CBU-vehicles. Within the planning process, information is not forwarded due to the fact that this information is not required for the next process step. There is, however, value in forwarding the information as other departments using the output of the process can potentially benefit from it. In most cases, the loss of information refers to the planning granularity of vehicles or car parts. Despite planning taking place at a more detailed level, an aggregation takes place to compile the information.

The reduction of data complexity might be linked to the manual handling of data. The programme planner at *Logistics and order management*, for example, manually handles large amounts of data in Microsoft Excel. Another example of manual data handling in Microsoft Excel is the Code-SA list for SA for CKD-vehicles. The lack of technology leads to a number of complications. The manual handling of data is error-prone and time-consuming. Even more aggravating, working in Microsoft Excel limits the possibilities of system integration. As a result, manual distribution of information instead of automated system integration is takes place. The availability of data is therefore limited, which further inhibits the work of departments such as *Demand and capacity planning*.

In addition to the previously mentioned complications, the planning processes for CKD-vehicles suffer from forecasting inaccuracy, especially in the forecasted production programme, GOP. The forecasts for production volumes and SA for CKD-vehicles show significant changes as soon as real orders are included in the planning processes. The inaccuracy results from the lack of forecasting procedures for CBU-vehicles and SA. *Central sales planning* applies the CBU-vehicle forecast to CKD-vehicles. For CKD-vehicles, a validation with real orders is not applied. As a result, *Demand and capacity planning* cannot rely on the forecasted CKD-vehicle figures and SA.

Overall, the success of demand and capacity planning processes seems to be inhibited by corporate obstacles. High hierarchical organisational structures pose one obstacle to the successful performance of processes. Also, a partial misalignment between strategy, vision and mission potentially leads to conflicting interests rather than focus on corporate goals.

The complications occurring due to the current processes in place negatively influence the operations of involved parties as well as departments depending on process output of demand and capacity planning processes. The complications identified provide opportunities to improve the planning processes. Section 8.3.4 suggest possible improvements for demand and capacity planning processes for CKD-vehicles.

8.3.4. Recommended improvements

The complications identified through research require improvements in order to increase supply chain performance. These improvements are based on the qualitative data analysis, secondary information from MBC and existing theories discussed in Chapter 2. In alignment with the analysis in Chapter 6, Section 7.4.4 suggest possible improvements to increase process performance. The fourth research question is summarised in Figure 8.4.

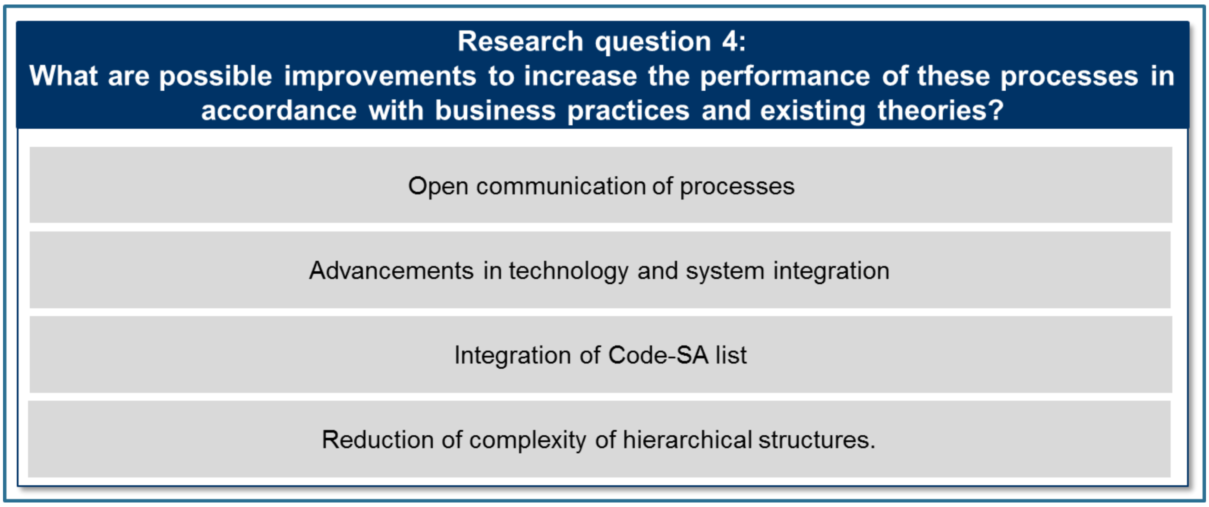


Figure 8.4: Summary of results of research question 4

In order to provide a knowledge base for processes, open communication regarding the of processes is required. Besides team and departmental presentations informing employees about tasks and responsibilities, a corporate process database has the potential to provide adequate information on each process. A database for all processes relevant to demand and capacity planning with limited access to *SC* could be an alternative. At MBC, it is required that processes are mapped and signed off before these processes can be internally published.

Advancements in technology and system integration are required to reduce the manual handling of data. The CKD-vehicle local sales company places orders for the new CKD-vehicle plant in Russia through the same system that CBU-vehicle markets use. The system integration should also be expanded to other CKD-vehicle plants to reduce and potentially eliminate the manual handling of orders. A reduction of errors and lead time are other possible improvements of system integration. Further, MBC is currently integrating a system to replace the Code-SA list. The tool is integrated into the system landscape of MBC, allowing better availability of information regarding SA.

The integration of the Code-SA list further facilitates the increased availability of information. For SA for CBU-vehicles, MBC operates with take-rates, indicating a percentage of total cars that are equipped with a certain piece of SA. *Sales operations* calculates these take-rates for all CBU-vehicles. Based on the information in the Code-SA list in combination with the class type distribution developed by *Market management*, *Sales operations* has sufficient information to calculate take-rates for CKD-vehicles. In alignment with the CBU-vehicle take-rates, this information can be made available to other departments such as *Demand and capacity planning* and *Supplier management*. This improvement requires the co-operation and willingness of *Market management* and *Sales operations* to forward information.

The inaccuracy of forecasts also creates significant complications. The integration of the Code-SA list results in earlier availability of information on SA for *Central sales planning*. In combination with the potential availability of real orders through a system integration of CKD-vehicle plants for order management, the Code-SA tool enables *Central sales planning* to forecast orders for CKD-vehicles and validate these orders with real orders. This validation process can potentially increase the accuracy of forecasts for CKD-vehicles.

In general, Daimler Aktiengesellschaft (AG) could include a reduction of complexity in terms of hierarchical structures as a goal for future restructuration. Regarding the development of strategy, vision and mission, a corporate alignment of these guiding statements is advised to facilitate corporate identity and goals.

These improvements related to process knowledge, availability of information, manual data handling and forecast accuracy potentially lead to an increase in supply chain performance. Section 8.3.5 reviews the last research question regarding potential metrics to measure performance.

8.3.5. Recommended performance metrics

The identification of metrics to measure the performance of the three processes for demand and capacity planning for CKD-vehicles is a logical step to follow after the development of potential improvements. In order to identify successful improvements, performance of each process needs to be measured. Increased performance can be linked to the improvements made. This study identified seven metrics based on best-practice at MBC and existing theories in literature as described in Section 7.5. Figure 8.5 summarises the result relevant to the fifth research question.

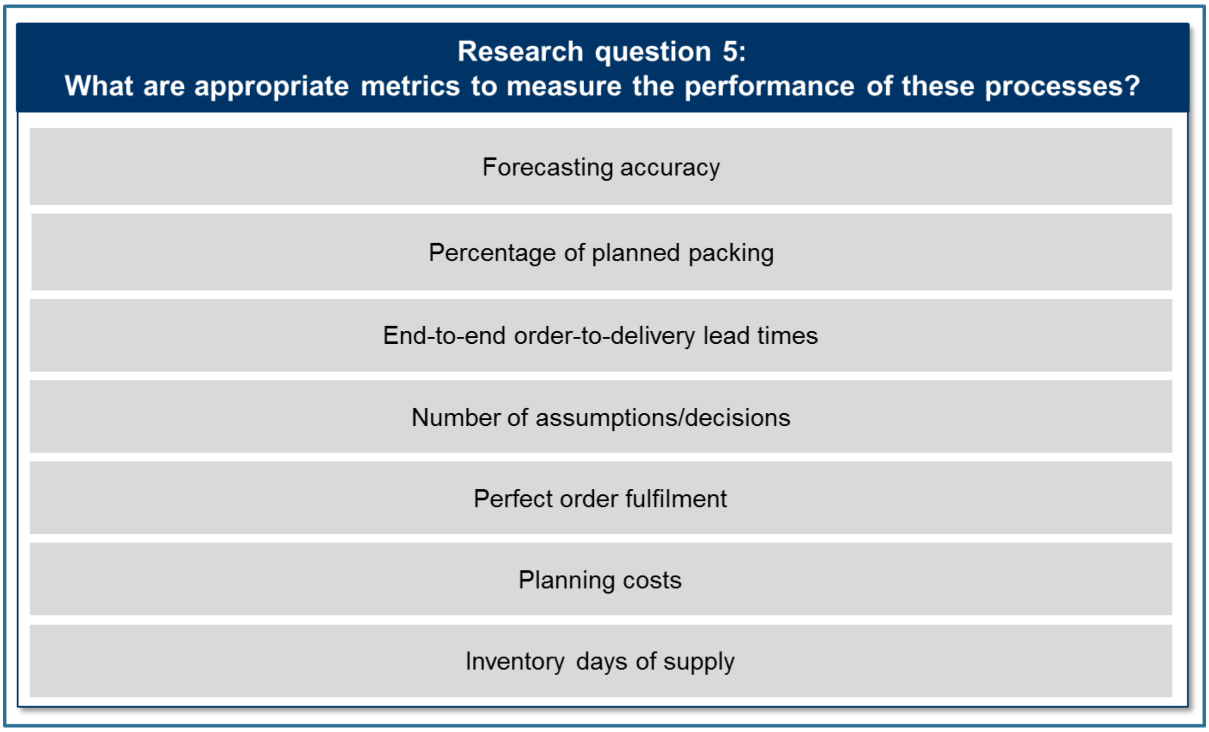


Figure 8.5: Summary of results of research question 5

All seven metrics provide a balanced approach that measures both improvements to demand and capacity planning processes, as well as the actual performance of the processes. It is recommended for targets to be defined after monitoring the performance for three months with further adjustments of targets every three months. In detail, the metrics are:

- **Forecasting accuracy:** As forecasting inaccuracy is one of the complications evident from the current state of the processes, the measurement of forecasting accuracy indicates whether the improvements have brought about positive impact, as intended. The metric should be implemented for each class type (TKL) specifically for CKD-vehicles.
- **Percentage of planned packing:** The monitoring of packing fulfilment measures the overall performance of the planning processes. The packing programme is one of the major outputs of demand and capacity planning for CKD-vehicles. Additional and fewer vehicles packed count as a deviation from the originally planned packing programme.
- **End-to-end order-to-delivery lead times:** Another complication results from the manual handling of data, leading to a significant increase of lead times within the planning processes. By measuring the lead times of individual sections of the planning processes as well as the overall lead time of the supply chain, MBC can identify the effect of the automatisation of manual data handling.
- **Number of assumptions/decisions:** Part of the measuring of process improvement includes measuring which decisions and assumptions have led to successful changes. This metric monitors the number of assumptions or decisions made in relation to process

changes and improvements. The track record provides information on successful and less successful changes.

- **Perfect order fulfilment:** In alignment with the packing programme, a metric is required to measure the quality of demand and capacity planning processes. This metric measures the vehicles completely packed without faulty or missing parts which could result in late deliveries.
- **Planning costs:** In order to be balanced, the factor costs needs to be considered in the measurement of planning process performance. Planning costs include all costs directly associated with the processes for demand and capacity planning, such as labour and system costs. The costs are tracked per process to determine whether the recommended improvements have an impact on cost, as there was no direct recommendation to improve costs.
- **Inventory days of supply:** Inventory levels are an indication for successful planning processes. High inventory levels can often be associated with deficiencies of demand and capacity planning. This metric looks at the result of the planning processes rather than at the process itself.

As the results presented in this study provide recommendations on how to improve process performance and measure these improvements, it is in MBC's control to implement the changes that are out of the scope of the study. Section 8.4 contains recommendations for the implementation of the results of this study.

8.4. Recommendations for implementation

Research has provided valuable insight on demand and capacity planning processes for CKD-vehicles at MBC. Part of the research consisted of the identification of suitable improvements for processes and performance metrics. This section provides recommendations for implementation of these suggested improvements.

The decision of which recommendations to implement solely lies with MBC. Limiting factors are budget restrictions, lack of co-operation of other departments or management approval. In alignment with the scope of the study, research did not consider the overall effect of these limiting factors.
Figure 8.6 summarises all recommendations for implementation.

Recommendations for implementation

- Continue successful practices
- Implement changes for CBU-vehicle planning for CKD-vehicles
- Full technology integration of new CKD-plants
- Assimilation of CKD-vehicle planning with CBU-vehicle planning
- Develop implementation plan
- Implement metrics immediately to measure changes

Figure 8.6: Summary of recommendations for implementation

Firstly, it is advised that MBC continues successful processes steps, practices and approaches. Where possible, development of such successful aspects should be facilitated. Proven successful processes can be used as inspiration for further development in alignment with the theory of benchmarking.

Secondly, the development of CBU-vehicle planning processes should be in alignment with CKD-vehicle planning processes. The implementation of changes and improvements for CBU-vehicles should also be considered for CKD-vehicles where possible. This alignment promotes a further assimilation of processes and avoids that the CKD-vehicle business is left behind with regard to development.

Thirdly, it is recommended to fully integrate new CKD-vehicle plants with regard to technology and systems. In addition to technology, other practices common for CBU-vehicles can also be considered to be implemented for new plants. The integration of new plants ensures that latest technology standards are fulfilled and further facilitates a slow assimilation of all CKD-vehicle processes where possible.

Fourthly, processes and handling of current CKD-vehicle plants should be assimilated to CKD-vehicle processes and handling within the course of the next 10 years. The consequences of complications might currently be limited due to the low production volumes of CKD-vehicles. The planned increase of CKD-vehicle production volumes, however, will increase the impact of these consequences and improvements significantly.

Fifthly, it is recommended that MBC develops an implementation plan to manage the changes required. The plan should include all improvements MBC wishes to implement. Factors considered in the implementation plan should include cost, required resources, time lines, objectives and potential difficulties that could be encountered.

Lastly, it is recommended to replace existing key performance indicators (KPIs) or at least implement the recommended metrics as soon as possible. An implementation before the adaption of all recommended process changes enables a performance of the current state of the processes to show the development achieved.

These recommendations discussed above provide guidance to MBC for the implementation of process modifications and performance metrics. In addition to the main findings of the study, other relevant findings have been discovered during the course of this research. Section 8.5 introduces additional observations made.

8.5. Additional observations from research

In addition to the findings within the scope of the study, research provided insight on a variety of topics outside of the scope. This section summarises the main findings not directly related to the scope of the study. These findings are still relevant and can potentially affect supply chain performance. Figure 8.7 summarises the additional observations made from research.

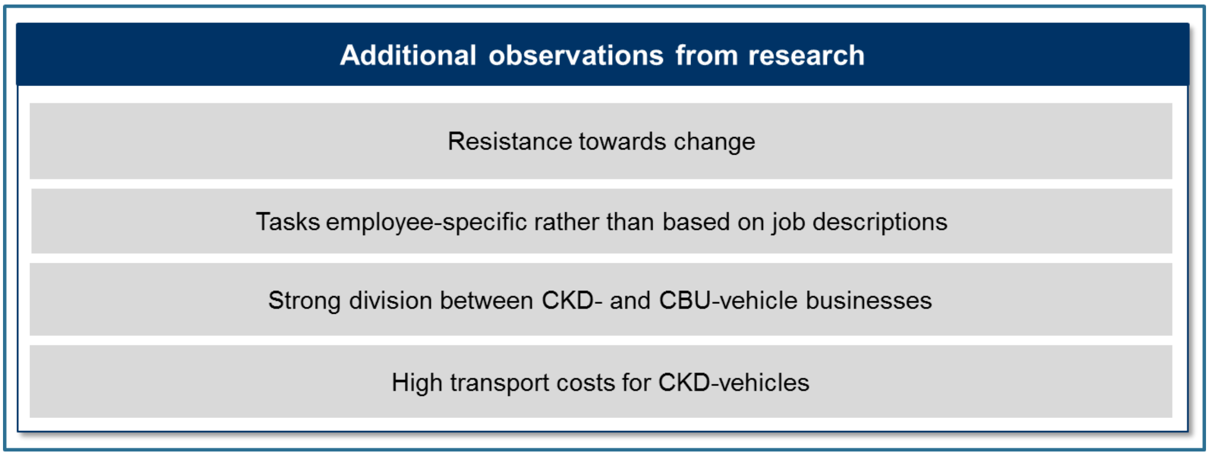


Figure 8.7: Summary of additional observations from research

While several managers and employees showed high interest in research on process and performance management, a strong resistance towards change could be observed in company culture. This resistance includes potential process changes as well as the management of KPIs. High hierarchies that further complicate change support this aspect of company culture.

In terms of job descriptions, it can be observed that the tasks an employee is in charge of strongly depends on the employees themselves rather than on the job description. Based on expertise, employees take on tasks and expand their field of responsibility. On a higher dimension, this phenomenon can even be observed for whole teams or departments, leading to further uncertainty regarding responsibilities of departments.

Further, research showed a strong division between the CKD- and CBU-vehicle businesses. The departments that deal with both CKD- and CBU-vehicles tend to see the CKD-vehicle business as a separate entity, leading to a lack of understanding why process improvement of CKD-vehicle planning processes is of relevance to such departments. On the contrary, departments specifically designed for the CKD-vehicle business do not see the connection to the CBU-vehicle business.

Specifically for CKD-vehicles at MBC, it was observed that there are high transport costs for parts, especially in case of bottlenecks. Delivery of individual, missing parts via air transport, is common practice. An improvement of the planning process of ordering and shipping for CKD-vehicles that facilitates a reduction of lead time which potentially decreases the number of parts that need to be delivered in this way.

The observations described in Section 8.3 to 8.5 lead to opportunities for further studies. Section 8.6 suggests recommendations for further research.

8.6. Recommendations for further research

This research identified a number of potential topics for further research. Some of these opportunities are derived from data collection, while others are based on the findings of the study. Section 8.6.1 introduces the main recommendations for further research directly linked to the study, while Section 8.6.2 suggests further research topics identified during the research process.

8.6.1. Further research based on the study results

Research focused on three specific demand and capacity planning processes for CKD-vehicles at MBC. Within the context of MBC, other processes relevant to the CKD-vehicle business can be investigated, such as the commercial processes currently in place for CKD-vehicles. Moreover, an evaluation of the processes for CBU-vehicle planning is an option. This could also include the integration of CKD-vehicles into shortfall management at *Demand and capacity planning*.

The topic of process and performance management is strongly linked to supply chain maturity. Taking into consideration other factors such as technology and supplier integration as well as customer orientation, an extensive study of supply chain maturity and the development thereof is recommended. Such a study could include the supply chain for CKD-vehicles, for CBU-vehicles or a combination of both.

This study was limited to a recommendation of improvements for process management. In a further study, the implementation of changes could be investigated, measuring the impact on process performance. With regard to performance metrics, a more detailed study of performance metrics at MBC for demand and capacity planning is recommended to monitor the effectiveness of improvements suggested.

In order to facilitate further generalisation of the study, the same study could be repeated at other original equipment manufacturers (OEMs). The study could be taken further to include suppliers and other relevant actors to investigate the process performance of end-to-end supply chain processes. Process performance studies are not limited to the automotive industry. An expansion and application to other industries is also possible. Figure 8.8 summarises all recommendations for further research.

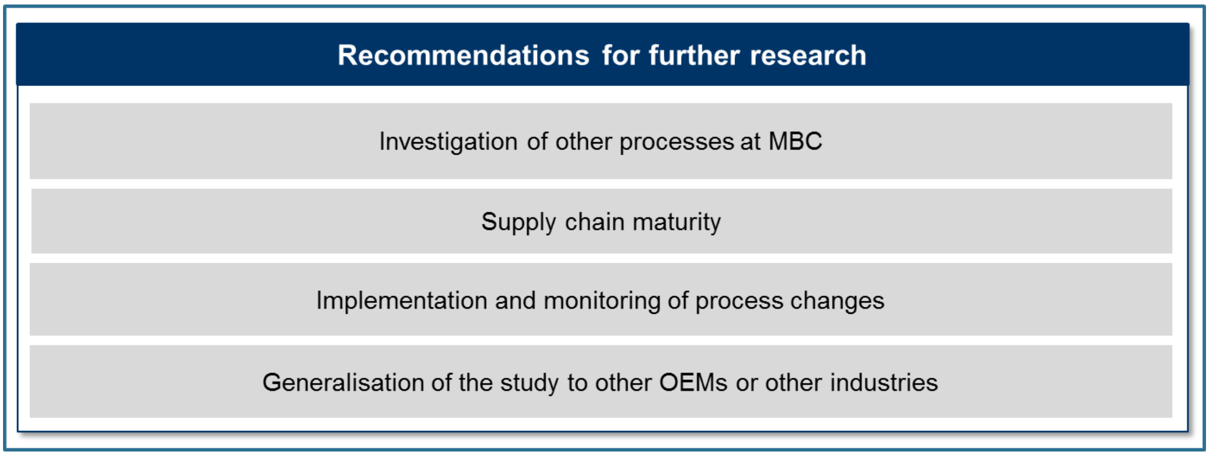


Figure 8.8: Summary of recommendations for further research

In addition to the recommendations for further research directly related to the scope of this study, opportunities for further research loosely related to the topic have also been identified. Section 8.6.2 summarises the key opportunities for future research.

8.6.2. Future research related to the topic

The field of CKD-vehicle business provides many opportunities for future research. Local content practices is one such potential area. Supplier selection, exact practices, as well as governmental regulations leading to local content could be further studied. Specifically to CKD-vehicles at MBC, the usage of single-use packaging versus reusable containers for CKD-vehicle shipping as well as the reduction of flight costs for CKD-vehicle part deliveries are further areas of interest.

This study indicated a significant need for technology in the field of supply chain processes and performance. A potential follow-up study could be conducted on the implementation of technology for further processes, potentially identifying a suitable level of technology integration.

With regard to performance metrics, this study focuses on metrics measuring process performance. In the course of research, performance management has been identified as an area of little interest for the majority of employees involved in the study. An additional study could investigate supply chain performance management at MBC. Such a study would be beneficial to the company, as performance management suffers from negligence.

A last opportunity for further research is the impact on company culture upon change. A large company such as MBC develops a strong, individual company culture. Possible research could investigate how company culture is linked to change, to process or performance management, or any other business area. Figure 8.9 summarises all research opportunities.

Figure 8.9: Summary of other research opportunities

The study has identified a number of areas for potential research, further highlighting the importance of the topic of the study. Section 8.7 concludes the study with final closing remarks.

8.7. Final concluding remarks

The overall purpose of the study was the clarification of processes for demand and capacity planning for CKD-vehicles at MBC, followed by the identification of positive and negative aspects, leading to potential improvements and metrics to measure the performance of these processes and improvements. Current uncertainties about the processes in place and the impact of inaccurate forecasts for CKD-vehicles were the two motivating factors stipulating this research. The cause of these issues arises from the relatively low production numbers for CKD-vehicles and the perception of CKD-vehicles as a minor side business.

During the course of this research, three main processes for demand and capacity planning have been identified and mapped. Further, positive and negative aspects of the currently existing processes have been identified based on a qualitative data analysis, best-practices at MBC, and existing literature. Taking the negative and positive attributes of the processes into account, again under the consideration of best practice at MBC and existing literature, potential recommendations to improve the performance of the processes in question have been developed. Finally, the identification of suitable performance metrics to measure the performance of the processes and the improvement thereof, took place.

The study concludes that the processes currently in place are characterised by a number of positive aspects, such as sufficient process structures in place. There are, however, a variety of opportunities for performance improvement. The majority of the recommended improvements relates to supporting factors such as technology, lead times and forecasting inaccuracy. In order to measure the success of the improvements implemented, MBC requires performance metrics that measure these improvements as well as the overall performance of the processes. These recommendations form the foundation for subsequent process improvements, such as the development of take-rates and shortfall management for CKD-vehicles. The study suggests a number of potential metrics specifically designed for demand and capacity planning for CKD-vehicles at MBC.

In conclusion, it is recommended that MBC implements significant changes and further assimilates demand and capacity planning of CKD-vehicles to CBU-vehicles to achieve a more uniform way of planning processes. Increasing production volumes of CKD-vehicles increase the need for process improvements. The metrics recommended will measure the success of the implementation of improvements as well as the general performance of planning processes for demand and capacity management for CKD-vehicles.

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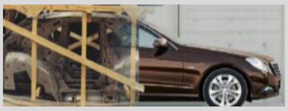
Addenda

Addendum A: Meta-analysis of the automotive industry

	Organisations							Top 3 OEMs			Analysis
External influences	McKinsey&Company, 2016	Verband deutscher Automobilindustrie, 2016	Deloitte, 2014b	KPMG International, 2017	Deloitte, 2015	PricewaterhouseCoopers, 2014b	KPMG, 2014	Daimler AG, 2016	BMW Group, 2016	Audi AG, 2016	Count
Globalisation & shift to (emerging) markets	X			X	X	X	X	X	X	X	8
Rise of new technologies	X		X		X	X	X	X	X	X	8
Digitalisation	X	X		X		X	X	X	X	X	8
Sustainability	X				X	X	X		X	X	6
Changing consumer expectation & mobility behavior	X			X		X	X	X		X	6
Demographic & city development				X			X			X	3
Big Data				X			X	X			3
Geopolitical & economic instability				X					X		2

Internal trends	McKinsey&Company, 2016	Verband deutscher Automobilindustrie, 2016	Deloitte, 2014b	KPMG International, 2017	Deloitte, 2015	PricewaterhouseCoopers, 2014b	KPMG, 2014	Daimler AG, 2016	BMW Group, 2016	Audi AG, 2016	Count
Autonomous driving	X		X	X			X	X	X	X	7
New competitions and cooperations	X	X		X	X			X	X	X	7
Electrification and alternative powertrain	X		X	X				X	X	X	6
Connectivity	X					X	X	X	X	X	6
New business models & diversification	X	X			X		X	X		X	6
Diverse mobility (ride,carsharing etc.)	X	X	X	X			X	X			6
Platform strategy, standardisation, modularity				X	X			X	X	X	5
Shift in production to emerging markets				X		X		X	X	X	5
Corruption and loss of credibility		X			X			X		X	4
Growing and more international supplier base		X				X			X		3
Safety			X					X			2
Smart logistics										X	1

Addendum B: Yearly Programme Planning JPP for CKD



Yearly Program Planning CKD-Packaging 2017

Kufri 04-2017

Summary

Country	Comment		Typ-class	OP Kufri 07-2015	OP ⇳ Kufri 04-2017	Last Program Kufri 03-2017	Kufri 03-2017 ⇳ Kufri 04-2017	Current Program Kufri 04-2017
Brazil	W205	Change model type	W205	6.024	- 1.060	5.020	- 56	4.964
	X156	**Change 48 units SKD to CKD**	X156	5.131	- 1.032	3.888	212	4.100
				11.155	**- 2.092**	**8.208**	**856**	9.064
China/BAIC			X166	3.193	- 1.813	1.188	192	1.380
				3.193	**- 1.813**	**1.188**	**192**	1.380
India			V222	774	- 167	522	85	607
			X222	105		90	15	105
			V213	3.793	251	3.480	564	4.044
			W205	3.514	- 669	2.592	253	2.845
			X253	3.263	- 781	2.400	82	2.482
			X156	2.092	- 223	1.704	164	1.868
			C117	2.426	- 112	2.016	299	2.315
			W166	1.973	- 70	1.638	265	1.903
			X166	1.102	258	1.170	190	1.360
				19.040	**- 1.513**	**15.612**	**1.915**	17.527
Indonesia	X253	Increase by 120 units realized.	V222	146	42	162	26	188
	W166	Shift to July not possible.	W213	1.060		888	172	1.060
	X166	Tuscaloosa Plant shutdown.	W205	920		816	104	920
			X253	195	112	144	163	307
			W166	404	49	390	63	453
			X166	91	21	96	16	112
				2.817	**223**	**2.496**	**544**	3.040
Malaysia			V222	425	- 119	312	- 5	307
			W213	3.932	- 1.255	2.496	181	2.677
			W205	3.765	446	3.576	635	4.211
			X253	3.151	- 446	2.328	377	2.705
				11.274	**- 1.373**	**8.712**	**1.188**	9.900
Thailand	X253	Increase accepted by Valmet.	V222	690	- 258	372	60	432
			W213	3.319	195	2.976	538	3.514
			C205	976	28	792	212	1.004
			W205	3.598	- 641	2.520	436	2.956
			C253	502	56	504	54	558
			X253	1.311	474	1.368	417	1.785
			X156	1.617	- 195	1.224	198	1.422
			C117	2.064	- 446	1.416	201	1.617
			W166	697	- 272	396	29	425
				14.774	**- 1.060**	**11.568**	**2.146**	13.714
Vietnam			V222	690	56	642	104	746
			W213	1.143	112	1.080	175	1.255
			W205	1.980	- 390	1.368	222	1.590
			X253	2.175	418	2.232	362	2.594
				5.989	**195**	**5.322**	**862**	6.184
All markets	V222	April - 2 weeks shutdown period	V222	2.346	- 384	2.010	- 48	1.962
	V222	June - 2 weeks 1 shift group production	X222	90		90		90
	W213	June - 2 weeks 1 shift group production	W213	8.136	- 816	7.440	- 120	7.320
	W166	June/July - 1 week shutdown period	V213	3.264	216	3.480		3.480
	W213	July - 1 week one shift group production	C205	840	24	792	72	864
	W213	August - 3 weeks shutdown period	W205	17.040	- 1.992	15.192	- 144	15.048
	W213	August - 1 week one shift group production	C253	432	48	504	- 24	480
	W213	Okt/Nov - 1 week shutdown period	X253	8.688	- 192	8.472	24	8.496
			X156	7.608	- 1.248	6.816	- 456	6.360
	all	seasonal adjustments	C117	3.864	- 480	3.432	- 48	3.384
			W166	2.646	- 252	2.424	- 30	2.394
			X166	3.774	- 1.320	2.454		2.454
				58.728	**- 6.396**	**53.106**	**- 774**	**52.332**

Yearly Program Planning CKD-Packaging
2017
Kufri 04-2017
- Division after BM -

Baureihe	Land	CKD/SKD	Bezeichnung	Baumuster		Jan	Feb	Mär	Apr	Mai	Jun	Jul	Aug	Sep	Okt	Nov	Dez	Gesamt
				Arbeitstage		15	20	23	18	20	19	21	23	21	20	21	11	232
E-Class long	Indien	CKD	E 220 L d	213.104 6	R		56		28		28	28						139
	Indien	CKD	E 350 L d	213.131 6	R	56	112	112	56	84	28	84	56	112	139	112	112	1060
	Indien	CKD	E 200 L	213.142 6	R	56	223	363	418	390	363	390	251	446	446	418	279	4044
	Indien		V 213			112	390	474	502	474	418	502	307	558	586	530	390	5243
Total V213	W050					112	390	474	502	474	418	502	307	558	586	530	390	5243
E-Class	Indonesien	SKD	E 200	213.042 6	R						28				28			56
	Indonesien	SKD	E 250	213.045 6	R		84	84		28				28	28	56		307
	Indonesien	SKD	E 300	213.048 6	R	28	84	112	112	139				84	28	56	28	669
	Indonesien		W 213			28	167	195	112	167	28			112	84	112	28	1032
	Malaysia	CKD	E 200	213.042 6	R			84			112	139	84	195	195	251	84	1143
	Malaysia	CKD	E 250	213.045 6	R													
	Malaysia	CKD	E 300	213.048 6	R													
	Malaysia	CKD	E 350 e	213.050 6	R	112	112	167	195	167	167	139	56	167	139	195		1617
	Malaysia	CKD	E 350 e	213.053 6	R												139	139
	Malaysia		W 213			112	112	251	195	167	279	279	139	363	335	446	223	2900
	Thailand	CKD	E 350 e	213.050 6	R	195	139	279	335	335	335	363	223	335	363	390		3291
	Thailand	CKD	E 350 e	213.053 6	R												167	167
	Thailand		W 213			195	139	279	335	335	335	363	223	335	363	390	167	3458
	Vietnam	CKD	E 200	213.042 5	L		56	56	56	56	112				28	28	28	418
	Vietnam	CKD	E 250	213.045 5	L	84	28	84	84	84	84				28	28		502
	Vietnam	CKD	E 300	213.048 5	L	56	28	56	56	56					28	28	28	335
	Vietnam		W 213			139	112	195	195	195	195				84	84	56	1255
Total W213	W050					474	530	920	837	865	837	641	363	809	865	1032	474	8645

Yearly Program Planning CKD-Packaging
2017
Capacities

	Plant	Vehicle	Jan	Feb	Mrz	Apr	Mai	Jun	Jul	Aug	Sep	Okt	Nov	Dez	Gesamt
Working Days	W050	E-Klasse	16	18	22	14	20	16	18	7	21	18	19	11	200
	W050	S-Klasse	16	18	20	10	20	16	21	23	21	18	21	11	215
	W067		16	20	23	18	21	20	21	23	21	19	21	11	234
	Valmet						21	21	21	21	26	25	25	11	171
	W054		16	20	23	18	20	19	21	23	21	20	21	11	233
	W371		16	20	22	19	22	21	21	23	21	21	21	11	238
	W138		15	20	23	19	22	17	16	23	20	22	20	11	228

V 213	W050	Capacity Units/Week	Jan	Feb	Mrz	Apr	Mai	Jun	Jul	Aug	Sep	Okt	Nov	Dez	Gesamt
Capacity	CKD	200	744	837	1.023	651	930	744	837	325	976	837	883	511	9.296
Program	CKD		112	390	474	502	474	418	502	307	558	586	530	390	5.243
Available capacity	CKD		632	446	548	149	456	325	335	19	418	251	353	121	4.053

W 213	W050	Capacity Units/Week	Jan	Feb	Mrz	Apr	Mai	Jun	Jul	Aug	Sep	Okt	Nov	Dez	Gesamt
Capacity	CKD	260	967	1.088	1.329	846	1.208	967	1.088	423	1.269	1.088	1.148	665	12.085
Capacity	SKD	40	128	167	205	130	186	149	167	65	195	167	177	102	1.838
Capacity	Total		1.095	1.255	1.534	976	1.394	1.116	1.255	488	1.464	1.255	1.325	767	13.923
Program	CKD		446	363	725	725	697	809	641	363	697	781	920	446	7.613
Program	SKD		28	167	195	112	167	28			112	84	112	28	1.032
Program	Total		474	530	920	837	865	837	641	363	809	865	1.032	474	8.645
Available capacity	CKD		521	725	604	121	511	158	446	60	572	307	228	218	4.471
Available capacity	SKD		100		9	19	19	121	167	65	84	84	65	74	807
Available capacity	Total		621	725	614	139	530	279	614	125	655	390	293	293	5.278

Yearly Program Planning CKD-Packaging
2017
Kufri 04-2017
- Percentage of BM-

Baureihe	Land	CKD/SKD	Bezeichnung	Baumuster	Jan	Feb	Mär	Apr	Mai	Jun	Jul	Aug	Sep	Okt	Nov	Dez	Gesamt
V213 E-Class long	Indien	CKD	E 220 L d	213.104 6 + 708		14 %		6 %		7 %	6 %						3 %
	Indien	CKD	E 350 L d	213.131 6 + 708	50 %	29 %	24 %	11 %	18 %	7 %	17 %	18 %	20 %	24 %	21 %	29 %	20 %
	Indien	CKD	E 200 L	213.142 6 + 708	50 %	57 %	76 %	83 %	82 %	87 %	78 %	82 %	80 %	76 %	79 %	71 %	77 %
	Indien		V 213		100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Total V213					2 %	7 %	9 %	10 %	9 %	8 %	10 %	6 %	11 %	11 %	10 %	7 %	100 %
W213 E-Class	Indonesien	SKD	E 200	213.042 6 + 719						100 %				33 %			5 %
	Indonesien	SKD	E 250	213.045 6 + 719		50 %	43 %		17 %				25 %	33 %	50 %		30 %
	Indonesien	SKD	E 300	213.048 6 + 719	100 %	50 %	57 %	100 %	83 %				75 %	33 %	50 %	100 %	65 %
	Indonesien		W 213		100 %	100 %	100 %	100 %	100 %	100 %			100 %	100 %	100 %	100 %	100 %
	Malaysia	CKD	E 200	213.042 6 + 718			33 %			40 %	50 %	60 %	54 %	58 %	56 %	38 %	39 %
	Malaysia	CKD	E 250	213.045 6 + 718													
	Malaysia	CKD	E 300	213.048 6 + 718													
	Malaysia	CKD	E 350 e	213.050 6 + 718	100 %	100 %	67 %	100 %	100 %	60 %	50 %	40 %	46 %	42 %	44 %		56 %
	Malaysia	CKD	E 350 e	213.053 6 + 718												63 %	5 %
	Malaysia		W 213		100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
	Thailand	CKD	E 350 e	213.050 6 + 701	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %		95 %
	Thailand	CKD	E 350 e	213.053 6 + 701												100 %	5 %
	Thailand		W 213		100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
	Vietnam	CKD	E 200	213.042 5 + 717		50 %	29 %	29 %	29 %	57 %				33 %	33 %	50 %	33 %
	Vietnam	CKD	E 250	213.045 5 + 717	60 %	25 %	43 %	43 %	43 %	43 %				33 %	33 %		40 %
	Vietnam	CKD	E 300	213.048 5 + 717	40 %	25 %	29 %	29 %	29 %					33 %	33 %	50 %	27 %
	Vietnam		W 213		100 %	100 %	100 %	100 %	100 %	100 %				100 %	100 %	100 %	100 %
Total W213					5 %	6 %	11 %	10 %	10 %	10 %	7 %	4 %	9 %	10 %	12 %	5 %	100 %

Yearly Program Planning CKD-Packaging 2017

Kufri 04-2017

- Container estimates per country -

	Working days	15	20	23	18	20	19	21	23	21	20	21	11	232
Land	Baumuster	Jan	Feb	Mär	Apr	Mai	Jun	Jul	Aug	Sep	Okt	Nov	Dez	Gesamt
Brasilien CKD/SKD	W 205	78	202	225	185	156	237	312	353	228	229	183	140	2528
Brasilien SKD	X 156	174	126	209	285	257	129	98	157	219	188	157	101	2100
Brasilien	Summe	252	328	434	470	413	366	410	510	447	417	340	241	4628
China/BAIC CKD	X166					12	24	48	96	144	288	336	240	1188
China/BAIC	Summe					12	24	48	96	144	288	336	240	1188
Indien CKD	V 222	50	37	32	69	105			25	19	56	92	56	541
Indien SKD	X 222	6	6	12		17						28	17	86
Indien CKD	V 213	41	142	171	181	170	152	181	111	200	210	190	141	1890
Indien CKD	W 205	138	168	47	123	153	168	106	122	137	137	138	123	1560
Indien CKD	X 253	161	142	18	196	126	144	36	161	143	161	197	108	1593
Indien SKD	X 156	57	72	88	102	86	116	88	73	57	72	86	74	971
Indien SKD	C 117	72	100	43	114	100	100	71	128	129	128	129	72	1186
Indien SKD	W 166	131	154	90	165	159	103	85	120	159	142	125	120	1553
Indien SKD	X 166	109	109	135	93	135	79	85	87	103	109	97	49	1190

Addendum C: Monthly programme planning MPP for CKD-vehicles

Juli 2017 — Monthly programme planning CKD-packing

Arbeitstage: 21

Land		Typ				MJ	L	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	ges.	Send.
Vietnam	CKD	S	450	222.166	717	808	L			6	6	6	6	6			6	6	6	6	6			6	6	6					6	6	6	6	6				108	18
CKD-Einheiten V222					108					6	6	6	6	6			6	6	6	6	6			6	6	6					6	6	6	6	6				108	18
Indien	CKD	E	220 L d	213.104	708	808	R			24	24	24	24	24			24	24	24	24	24																		240	40
Indien	CKD	E	350 L d	213.131	708	808	R																	24															24	4
Indien	CKD	E	200 L	213.142	708	808	R																		24	24	24												72	12
CKD-Einheiten V213					336					24	24	24	24	24			24	24	24	24	24			24	24	24	24												336	56
Malaysia	CKD	E	200	213.042	718	808	R																		24	24													48	8
Malaysia	CKD	E	350 e	213.050	718	808	R						24	24													24												72	12
Thailand	CKD	E	350 e	213.050	701	808	R			24	24	24					24	24	24	24	24			24				24			24	24							288	48
CKD-Einheiten W213					408					24	24	24	24	24			24	24	24	24	24			24	24	24	24	24			24	24							408	68
Thailand	SKD	C	250	205.345	712	808	R							24			24	24																					72	12
CKD-Einheiten C205					72									24			24	24																					72	12
Indien	CKD	C	220 d	205.002	708	808	R			48	24							24	24							48													168	7
Thailand	CKD	C	350 e	205.047	701	808	R				48	24							24	48						24	48					24							240	10
Vietnam	CKD	C	200	205.042	717	808	L																										24						24	1
Vietnam	CKD	C	300	205.048	717	808	L																										24						24	1
Brasilien	CKD	C	180	205.040	714	808	L							24			72	24			48			48	48			48			72	24		24	72			48	552	23
Indonesien	SKD	C	200	205.042	719	808	R			24																													24	1
Indonesien	SKD	C	300	205.048	719	808	R																	24	24														48	2
Malaysia	CKD	C	350 e	205.047	718	808	R					24	24	24																									72	3
Malaysia	SKD	C	180	205.040	716	808	R					24	48																										72	3
Malaysia	SKD	C	200	205.042	716	808	R											24	24	24	24							24				24	24	24					192	8
CKD-Einheiten W205					1416					72	72	72	72	48			72	72	72	72	72			72	72	72	48	72			72	72	72	48	72			48	1416	59
Thailand	SKD	GLC	250d 4m	253.309	712	808	R																				24												24	4
CKD-Einheiten C253					24																						24												24	4
Indien	CKD	GLC	220d 4m	253.903	708	808	R														24			24															48	2
Vietnam	CKD	GLC	250 4m	253.946	717	808	L						24	24				24							24														96	4
Vietnam	CKD	GLC	300 4m	253.949	717	808	L																				24	24				24		24					96	4
Malaysia	SKD	GLC	200	253.942	716	808	R			24	48						24			24																			120	5
Malaysia	SKD	GLC	250 4m	253.946	716	808	R																								24				24			24	72	3
Thailand	SKD	GLC	250d 4m	253.909	712	808	R					24		24					24		24					24		24					24		24				192	8
CKD-Einheiten X253					624					24	48	24	24	48			24	24	24	24	48			24	24	24	24	48			24	24	24	24	48			24	624	26
Brasilien	CKD	GLA	200	156.943	714	808	L					24																24											48	2
Brasilien	SKD	GLA	200	156.943	713	808	L										24							24	24	24												24	120	5
Indien	SKD	GLA	220d 4m	156.905	709	808	R											24	24																				48	2
Indien	SKD	GLA	200 d	156.908	709	808	R			24	24																				24	24							96	4
Thailand	SKD	GLA	200	156.943	712	808	R																											24	24				48	2
Thailand	SKD	GLA	250	156.944	712	808	R						24	24						24																			72	3
SKD-Einheiten X156					432					24	24	24	24	24			24	24	24	24				24	24	24		24			24	24		24	24			24	432	18
Indien	SKD	CLA	200 d	117.308	709	808	R				24		24													24		24				24							120	5
Thailand	SKD	CLA	200	117.343	712	808	R																											24				24	48	2
Thailand	SKD	CLA	250	117.344	712	808	R										24			24				24															72	3
CKD-Einheiten C117					240						24		24				24			24				24		24		24				24		24				24	240	10
Indien	SKD	GLE	250 d	166.003	709	808	R												24	24	6													12	12			12	90	15
Indonesien	SKD	GLE	250 d	166.003	719	808	R											6																					6	1
Indonesien	SKD	GLE	400	166.056	719	808	R											18																					18	3
Thailand	SKD	GLE	500 e	166.063	712	808	R																					12			12								24	4
CKD-Einheiten W166					138													24	24	24	6							12			12			12	12			12	138	23
BAIC	CKD	GLS	400	166.856	703	808	L														6			6	6	6													24	4
BAIC	CKD	GLS	500	166.871	703	808	L																										6	6	6			6	24	4
Indien	SKD	GLS	350 d	166.823	709	808	R																	6	18	18	18					12	12						84	14
Indonesien	SKD	GLS	400	166.856	719	808	R														18			12															30	5
CKD-Einheiten X166					162																24			24	24	24	18					12	18	6	6			6	162	27
über Deutschland										174	222	174	198	198			222	198	174	198	174			198	174	198	144	192			150	174	102	126	150			120	3660	271
Summe Total										174	222	174	198	198			222	222	198	222	204			222	198	222	162	204			162	186	120	144	168			138	3960	321

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	ges.
SKD-Karossen Sindelfingen																																
SKD-Karossen Bremen			48	48	24	48	24			48	48	24	48	24			24	24		24	24			24	24	24	24	24			24	624
SKD-Karossen Valmet					24		24					24		24					24		24					24		24				192
SKD-Karossen Rastatt			24	24		24	24			24	24	24	24				24	24	24					24	24		24	24			24	384
SKD-Karossen Kecskemét				24		24				24			24				24		24		24				24		24				24	240
SKD-Karossen Tuscaloosa											24	24	24	24			18	18	18	18	12			12	12	12	12	12			12	252
CKD Sindelfingen S-Klasse			6	6	6	6	6			6	6	6	6	6			6	6	6					6	6	6	6	6				108
CKD Sindelfingen W213			24	24	24	24	24			24	24	24	24	24			24	24	24	24	24			24	24							408
CKD Sindelfingen V213			24	24	24	24	24			24	24	24	24	24			24	24	24	24												336
CKD Bremen			48	72	48	48	72			72	72	48	48	72			72	72	72	72	72			72	72	48	48	72			48	1320
CKD Rastatt					24																24											48
CKD Tuscaloosa														6			6	6	6							6	6	6			6	48
			174	222	174	198	198			222	222	198	222	204			222	198	222	162	204			162	186	120	144	168			138	3960

Truck departure bef. Shipping 7 WD ab D / 10 WD ab USA — Shipping dates

	1.	2.	3.	4.	5.	KW 30 Schiff 1 EH	Abfahrt	KW 31 Schiff 2 EH	Abfahrt	KW 32 Schiff 3 EH	Abfahrt	KW 33 Schiff 4 EH	Abfahrt	KW 34 Schiff 5 EH	EH
Vietnam CKD S 450	20.07.		03.08.	10.08.		30	30.07.		06.08.	48	13.08.	30	20.08.		
CKD-Einheiten V222						30				48		30			
Indien CKD E 220 L d	14.07.	21.07.	28.07.			72	25.07.	72	01.08.	96	08.08.		15.08.		22.08.
Indien CKD E 350 L d			28.07.				25.07.		01.08.	24	08.08.		15.08.		22.08.
Indien CKD E 200 L				04.08.			25.07.		01.08.		08.08.	72	15.08.		22.08.
CKD-Einheiten V213						72		72		120		72			
Malaysia CKD E 200				10.08.			30.07.		06.08.		13.08.	48	20.08.		
Malaysia CKD E 350 e		27.07.		10.08.			30.07.	48	06.08.		13.08.	24	20.08.		
Thailand CKD E 350 e	20.07.	27.07.	03.08.	10.08.		72	30.07.	72	06.08.	72	13.08.	72	20.08.		
CKD-Einheiten W213						72		120		72		144			
Thailand SKD C 250	20.07.					72	30.07.		06.08.		13.08.		20.08.		
CKD-Einheiten C205						72									
Indien CKD C 220 d	14.07.	21.07.	28.07.			72	25.07.	48	01.08.	48	08.08.		15.08.		22.08.
Thailand CKD C 350 e	20.07.	27.07.	03.08.	10.08.		72	30.07.	72	06.08.	72	13.08.	24	20.08.		
Vietnam CKD C 200				10.08.			30.07.		06.08.		13.08.	24	20.08.		
Vietnam CKD C 300				10.08.			30.07.		06.08.		13.08.	24	20.08.		
Brasilien CKD C 180		20.07.	27.07.	03.08.	10.08.			120	31.07.	144	07.08.	144	14.08.	144	21.08.
Indonesien SKD C 200	20.07.					24	30.07.		06.08.		13.08.		20.08.		
Indonesien SKD C 300				10.08.			30.07.		06.08.		13.08.	48	20.08.		
Malaysia CKD C 350 e	20.07.					72	30.07.		06.08.		13.08.		20.08.		
Malaysia SKD C 180		27.07.					30.07.	72	06.08.		13.08.		20.08.		
Malaysia SKD C 200			03.08.	10.08.			30.07.		06.08.	96	13.08.	96	20.08.		
CKD-Einheiten W205						240		312		360		360		144	
Thailand SKD GLC 250d 4m				10.08.			30.07.		06.08.		13.08.	24	20.08.		
CKD-Einheiten C253												24			
Indien CKD GLC 220d 4m			28.07.				25.07.		01.08.	48	08.08.		15.08.		22.08.
Vietnam CKD GLC 250 4m		27.07.	03.08.				30.07.	72	06.08.	24	13.08.		20.08.		
Vietnam CKD GLC 300 4m			03.08.	10.08.			30.07.		06.08.	48	13.08.	48	20.08.		
Malaysia SKD GLC 200	20.07.	27.07.				72	30.07.	48	06.08.		13.08.		20.08.		
Malaysia SKD GLC 250 4m			03.08.	10.08.			30.07.		06.08.	24	13.08.	48	20.08.		
Thailand SKD GLC 250d 4m		27.07.	03.08.	10.08.			30.07.	72	06.08.	72	13.08.	48	20.08.		
CKD-Einheiten X253						72		192		216		144			
Brasilien CKD GLA 200		20.07.		03.08.				24	31.07.		07.08.	24	14.08.		21.08.
Brasilien SKD GLA 200		20.07.	27.07.	03.08.	10.08.			24	31.07.	48	07.08.	24	14.08.	24	21.08.
Indien SKD GLA 220d 4m		21.07.					25.07.	48	01.08.		08.08.		15.08.		22.08.
Indien SKD GLA 200 d	14.07.			04.08.		48	25.07.		01.08.		08.08.	48	15.08.		22.08.
Thailand SKD GLA 200				10.08.			30.07.		06.08.		13.08.	48	20.08.		
Thailand SKD GLA 250	20.07.	27.07.				48	30.07.	24	06.08.		13.08.		20.08.		
SKD-Einheiten X156						96		120		48		144		24	
Indien SKD CLA 200 d		21.07.		04.08.			25.07.	48	01.08.		08.08.	72	15.08.		22.08.
Thailand SKD CLA 200				10.08.			30.07.		06.08.		13.08.	48	20.08.		
Thailand SKD CLA 250		27.07.	03.08.				30.07.	24	06.08.	48	13.08.		20.08.		
CKD-Einheiten C117								72		48		120			
Indien SKD GLE 250 d		24.07.		07.08.			~~29.07.~~	54	05.08.		12.08.	36	19.08.		
Indonesien SKD GLE 250 d	14.07.	21.07.				Bodies	28.07.	6	04.08.		11.08.		18.08.		
Indonesien SKD GLE 400	14.07.	21.07.				Bodies	28.07.	18	04.08.		11.08.		18.08.		
Thailand SKD GLE 500 e			31.07.				30.07.		06.08.	24	13.08.		20.08.		
CKD-Einheiten W166								78		24		36			
BAIC CKD GLS 400			27.07.				27.07.		03.08.	24	10.08.		17.08.		24.08.
BAIC CKD GLS 500					10.08.		27.07.		03.08.		10.08.		17.08.	24	24.08.
Indien SKD GLS 350 d			31.07.	07.08.			~~29.07.~~		05.08.	60	12.08.	24	19.08.		
Indonesien SKD GLS 400		21.07.	28.07.				28.07.	Bodies	04.08.	30	11.08.		18.08.		
CKD-Einheiten X166										114		24		24	
						654 Eh		966 Eh		1050 Eh		1098 Eh		192 Eh	

davon	KW 30	KW 31	KW 32	KW 33	KW 34
SKDs ab D	264 Eh	360 Eh	288 Eh	504 Eh	24 Eh
SKDs ab USA		78 Eh	114 Eh	60 Eh	

Addendum D: Extract of SA-Code-list

COUNTRY	THAI (879L)	THAI (879L)	THAI (879L)	Brazil (775L)	Brazil (775L)	Brazil (775L)	Brazil (775L)	Brazil (775L)	Brazil (775L)
VEHICLE SERIES	C-Class FC	C-Class FC	C-Class FC	C-Class FW	C-Class FW	C-Class FW	C-Class FW	C-Class FW	C-Class FW
VEHICLE MODEL / BAUMUSTER	C250 C2053456	C250 C2053456	C250 C2053456	C180 C2050405	C180 C2050405	C200 C2050425	C250 C2050455	C250 C2050455	C300 C2050485
DIALOG DESCRIPTION	M274+M20+M00 8	M274+M20+M00 8	M274+M20+M00 8	M274+M16+M00 8	M274+M16+M00 8	M274+M20+M01 3+M008	M274+M20+M00 8	M274+M20+M00 8	M274+M20+M01 4+M008
STEERING	RL	RL	RL	LL	LL	LL	LL	LL	LL
1´ ST PACKING	06/ 16	06/ 16	06/ 16	06/ 16	06/ 16	06/ 16	06/ 16	12/ 16	12/ 16
RUN-OUT	-	-	-	-	-	11/ 16	11/ 16	-	-
LINES	Baisc	Baisc	AMG	Ava	Exclu	Ava	AMG	Ava	AMG
PACKAGE	-	OPT	-	-	-	-	-	-	-
CODE DESCRIPTION									
CKD- BLACK									
CKD- POLAR WHITE				(X)	(X)	(X)	(X)	(X)	(X)
CKD- MAGNETITBLACK - METALLIC PAINT									
CKD- OBSIDIAN BLACK - METALLIC PAINT				(X)	(X)	(X)	(X)	(X)	(X)
CKD- PERIDOTBROWN METALLIC PAINT									
CKD- DOLOMITBROWN - METALLIC PAINT									
CKD- SPINELLBLUE - METALLIC PAINT									
CKD- IRIDIUM-SILVER - METALLIC PAINT				(X)	(X)	(X)	(X)	(X)	(X)
CKD- CITRINBROWN METALLICPAINT									
CKD- CAVANSITBLAU - METALLIC PAINT									
CKD- RUBINBLACK - METALLIC PAINT									
CKD- DIAMONDSILVER METALLIC PAINT									
CKD- SELENITGREY - METALLIC PAINT				(X)	(X)	(X)	(X)	(X)	(X)
CKD- HYACINTHRED - METALLIC PAINT									
CKD- ANTHRAZITEBLUE - METALLIC PAINT									
FABRIC - BLACK / ANTHRACITE									
FABRIC - GRAY									
LEATHERETTE - BLACK / ANTHRACITE	(X)			(X)	(X)				
LEATHERETTE - BEIGE	(X)				(X)				
LEATHERETTE - BLACK / ANTHRACITE									
LEATHERETTE - BROWN									
LEATHERETTE - BEIGE				(X)					
LEATHERETTE - GRAY		(X)		(X)					
LEATHERETTE - BLACK / ANTHRACITE									
LEATHERETTE - BROWN	(X)								
LEATHERETTE - BEIGE									
LEATHERETTE - GRAY					(X)				
LEATHERETTE - BLACK / ANTHRACITE									
LEATHERETTE - BLACK / ANTHRACITE									
KUNSTLEDER - BRAUN									
LEATHERETTE - BEIGE									
LEATHERETTE - BLACK / ANTHRACITE									
LEATHERETTE - BEIGE									
LEATHERETTE - GRAY									
LEATHER - BLACK / ANTHRACITE			(X)			(X)		(X)	
LEATHER - BEIGE									
LEATHER - GRAY									
LEATHER - BLACK / ANTHRACITE									
LEATHER - BROWN									
LEATHER - BEIGE						(X)		(X)	
LEATHER - GRAY						(X)		(X)	
LEATHER - BLACK / ANTHRACITE									
LEATHER - BROWN									
LEATHER - BEIGE									
LEATHER - RED			(X)						
LEATHER - GRAY									
LEATHER - BROWN									
LEATHER - BEIGE									
LEATHER - GRAY									
LEATHER - BLACK / ANTHRACITE							(X)		(X)
LEATHER - RED							(X)		(X)
LEATHER - GRAY							(X)		(X)
LEATHER - RED									
FABRIC - BLACK / ANTHRACITE									
HEADLINER FABRIC BLACK	(X)		(X)				(X)	(X)	(X)
HEADLINER FABRIC BEIGE				(X)	(X)	(X)		(X)	
HEADLINER FABRIC GRAY	(X)	(X)	(X)	(X)	(X)	(X)		(X)	
HEADLINER ALCANTARA/DINAMICA BLACK									
HEADLINER ALCANTARA/DINAMICA BEIGE									
HEADLINER ALCANTARA/DINAMICA GREY									
REGULATIONCODE SOFTWARE FRESH-UP STAFFEL 3									
STEUERCODE MASSNAHMENPAKET 12 / 2016									
STEUERCODE 330 X 32 - BREMSE BEI 18 ZOLL BEREIFUNG									
PARAMETRIC-STEERING									
ADAPTIVE DAMPING SYSTEM (ADS) WITH SKYHOOK									
ADAPTIVE DAPING SYSTEM PLUS (ADS+)									
REVERSING CAMERA	x	x				x	x	x	
REAR BACK REST ADJUSTMENT AND HEAD RESTRAINTS, ELE									
ACTIVE PARKING ASSISTANCE	x	x	x			x	x	old	
ACTIVE BLIND SPOT ASSISTANT									
ACTIVE LANE DEPARTURE-ASSISTANT									
DISTRONIC PRO									
FRONT SEAT LH ELECTRIC ADJUSTABLE WITH MEMORY									
FRONT SEAT RH ELECTRIC ADJUSTABLE WITH MEMORY									
ANALOG CLOCK									
SEAT ADJUSTMENT ELEC. ALSO OPERABLE FROM REAR									
MIRROR PACKAGE	x	x	x			x	x	x	x
REAR COLLISION MITIGATION SYSTEM									

Addendum E: Interview guidelines

Introduction to interviewees

As part of my master's degree, I am spending six months of conducting research in an internship capacity at Demand and capacity planning (SC/KP). I am conducting research in the field of CKD-vehicle demand and capacity planning processes. This interview aims to contribute to identify the following:

- The main processes for demand and capacity planning currently in place
- Positive aspects of these processes
- Negative aspects of these processes
- Potential improvements to the processes for demand and capacity planning for CKD-vehicles

The contribution to this research is on a voluntary basis. If you feel, at any stage, that you would like to withdraw or interrupt the interview you are free to do so without providing any reason. Your contribution is of benefit to Daimler AG and much appreciated.

No preparation is required from your side. If available, a Microsoft Powerpoint presentation about your team/department can be integrated into the interview process as an introduction. The presentation of other supporting documents or tools is encouraged.

The interviews will be done in three rounds. If you were unable to attend all three rounds, kindly advise who can represent your department on the dates you are unavailable. You can find the appointments in an attachment to this email.

Structure of the interview process

Stage	Topics	Aim
Exploratory stage (First round)	Description of tasks of department	Identification of relevant activities to study Develop an understanding of process flow
	Involvement with CKD-vehicle planning	Understand the link to CKD-business Developing an understanding of process flow
	Current projects outside of daily operations	Understand development of department
	Interaction with other departments	Develop an understanding of process flow and links between departments Understand who is responsible for which tasks
	Evaluation of current situation CKD-vehicle demand and capacity planning	Identify positive and negative aspects of demand and capacity planning for CKD-vehicles
	Expectations in project and improved processes	Understand individual department's needs Identify requests for improvement
Data confirmation (Second round)	Discussion of process flow, activities, input and output	Identify incorrect process steps and flow
	Clarification of information specific to department	Identify corrections of incorrect process steps and flow Identify additional information missing
	General feedback	Identify suitability of processes Further input of interviewees, e.g. with regards to positive and negative aspects
Process verification (Third round)	Presentation of three key processes (draft)	Identify incorrect process steps and flow
	Confirmation of process flow, activities, input and output	Confirmation of correctness
	General feedback	Identify suitability of mapped processes Identify input and output

Addendum F: Agenda focus group

Introduction to participants

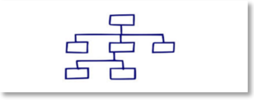
As part of my master's degree, I spend six months of doing research in form of an internship at Demand and capacity planning (SC/KP). I conduct research in the field of CKD-vehicle demand and capacity planning processes. This focus group session aims to contribute to identify

- the main processes for demand and capacity planning currently in place
- positive aspects of these processes
- negative aspects of these processes
- potential improvements to the processes for demand and capacity planning for CKD-vehicles

The contribution to this research is on a voluntary basis. If you feel, at any stage, that you would like to withdraw or interrupt the interview you can feel free to do so without any reason. Your contribution is of benefit to Daimler AG and much appreciated.

No preparation is required from your side. The meeting will take part in two parts. The first session aims at the gathering of information, while the second session intends to verify the gathered information. If you are unable to attend both or one of the sessions, kindly advice who can represent your department on the dates you are unavailable. You can find the appointments in attachment to this email.

Agenda

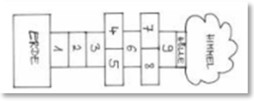


1. Introduction

- Introduction of topic
- Introduction of participants

2. Brainstorming

- Activities in demand and capacity planning
- Responsibilities in demand and capacity planning



3. Evaluation

- Expectations of demand and capacity planning (CKD)
- Complications of demand and capacity planning processes (CKD)

4. Conclusion

- Outlook in the future
- Feedback round

Structure of the focus group session

Stage	Topics	Aim
Introduction	Introduction of the topic	Ensure that all participants understand the reason of this event
	Introduction of participants	Facilitate a familiar atmosphere Identify key actors of processes and responsibilities
Brainstorming	Activities	Develop an understanding of activities Identify different points of view of participants
	Responsibilities	Develop an understanding of responsibilities Identify different roles of participants
Evaluation	Expectations	Identify needs of demand and capacity planning for CKD-vehicles Evaluate feasibility of expectations
	Complications	Identify the different views of participants on negative (and positive) aspects
Conclusion	Outlook	Introduce expected outcome to the participants
	Feedback	Conclude session Gather general comments

Addendum G: Interview Schedule

Count	Date	Location	Participant(s)			Topic	Type
			Name	Department	Position		
1	07/02/2017	Böblingen	Reimund Weyland	Demand and capacity management	TL	CKD at MBC	Personal Interview
2	30/03/2017	Böblingen	Daniel Schweizer	Demand and capacity management		Demand and capacity planning at MBC	Personal Interview
3	18/05/2017	Stuttgart	Georg Moumtsilis	Market management		Sales & Operations Planning CKD - Gap identification	Focus Group
			Thomas Proebstle	Market management			
			Reimund Weyland	Demand and capacity management	TL		
			Christian Urban	Demand and capacity management			
4	17/05/2017	Böblingen	Reimund Weyland	Demand and capacity management	TL	CKD and KPIs	Personal Interview
5	18/05/2017	Stuttgart	Frank Weitmann	Central sales planning	Rep. TL	CKD / go Redesign	Personal Interview
6	22/05/2017	Böblingen	Rolf Miller	Logistics and order management		CKD programme planning	Personal Interview
7	22/05/2017	Böblingen	Alfred Horrer	Logistics and order management		CKD order and parts planning	Personal Interview
8	23/05/2017	Böblingen	Iris Urban-Brandau	Logistics and order management		CKD order administration	Personal Interview
9	23/05/2017	Böblingen	Fatma Yildiz	Logistics and order management		Managing packaging	Personal Interview
10	01/06/2017	Stuttgart	Ralf Zimmermann	Central sales planning		CKD programme planning	Personal Interview
11	20/06/2017	Böblingen	Michael Zuth	Local content and vehicle documentation	TL	Code-SA List and Local Content	Skype Interview
			Reimund Weyland	Demand and capacity management	TL		
			Christian Urban	Demand and capacity management			
12	04/07/2017	Böblingen	Lisa Marlen Mertens	Demand and capacity management		KPIs in SC	Personal Interview
13	06/07/2017	Böblingen	Reimund Weyland	Demand and capacity management	TL	Process review	Feedback
14	07/07/2017	Böblingen	Reimund Weyland	Demand and capacity management	TL	Process review	Feedback
15	11/07/2017	Böblingen	Christian Urban	Demand and capacity management		Process review	Personal Interview
16	12/07/2017	Stuttgart	Alfred Horrer	Logistics and order management		Process review	Skype Interview
17	13/07/2017	Böblingen	Thomas Proebstle	Market management		Process review	Skype Interview
18	17/07/2017	Böblingen	Sebastian Dettling	Central sales planning		CKD in SBE	Phone interview
19	17/07/2017	Böblingen	Matz Meier	Demand and capacity management		KPIs for programme planning	Personal Interview
20	18/07/2017	Böblingen	Konstantin Valasis	Sales operations	External	Take rates	Skype Interview
21	18/07/2017	Böblingen	Ralf Zimmermann	Central sales planning		Yearly production programme	Phone interview
22	19/07/2017	Böblingen	Michael Zuth	Local content and vehicle documentation	TL	Process review	Skype Interview
23	19/07/2017	Böblingen	Miriam Spanier	Sales operations	External	Take rates in GOP for CKD	Phone interview
24	20/07/2017	Böblingen	Thomas Proebstle	Market management		Process review	Skype Interview
25	21/07/2017	Böblingen	Pichler	Central sales planning	TL	GOP forecasting procedures	Phone interview
26	21/07/2017	Böblingen	Reimund Weyland	Demand and capacity management	TL	The relevance of CKD for SC/KP	Personal interview
27	27/07/2017	Böblingen	Frank Weitmann	Central sales planning	Rep. TL	CKD / go Redesign Update	Skype Interview

Addendum H: Coding results activities volume planning

Activities volume planning	Central sales planning	Focus Group	Logistics and order management	Market Management	PBK	Sales operations	Vehicle documentation and local content	Total
Central planning car classes	1	0	0	0	0	0	0	**1**
Coordination monthly CKD assembly programme	0	0	0	1	0	0	0	**1**
Final production programme planning	0	2	1	1	0	0	0	**4**
Local sales planning	0	3	1	2	0	0	0	**6**
Planning annual CKD production programme	2	1	5	3	0	0	0	**11**
Planning annual production programme	2	2	0	0	0	1	0	**5**
Request monthly production programme	0	0	1	0	0	0	1	**2**
Type of construction planning	1	1	1	2	0	0	0	**5**
Total	**6**	**9**	**9**	**9**	**0**	**1**	**1**	**35**

Addendum I: Coding results activities special equipment planning

Activities special equipment	Central sales planning	Focus Group	Logistics and order managemen	Market Manageme nt	PBK	Sales operations	Vehicle documentation and local content	Total
Buildability check	0	1	0	1	0	0	3	**5**
Generation of planned orders	7	0	0	0	4	0	0	**11**
Local market analysis	0	2	2	1	0	0	1	**6**
Local sales planning	0	3	1	2	0	0	0	**6**
Market analysis	1	0	1	2	0	0	0	**4**
Planning annual production programme	2	2	0	0	0	1	0	**5**
Planning of equipment	1	0	0	0	0	0	0	**1**
Planning of packing	0	1	7	2	0	0	0	**10**
Plausibilty check of orders	3	0	2	0	0	0	1	**6**
TBE	0	3	5	0	0	0	2	**10**
Type of construction planning	1	1	1	2	0	0	0	**5**
Validation of technical feasibility	0	1	0	1	0	0	2	**4**
Total	**15**	**14**	**19**	**11**	**4**	**1**	**9**	**73**

Addendum J: Coding results activities ordering and shipping planning

Ordering and shipping activities	Central sales planning	Focus Group	Logistics and order managemen	Market Managemen t	PBK	Sales operations	Vehicle documentatio n and local	Total
Local content management	0	9	3	2	0	0	3	**17**
Manual order input	0	0	1	0	0	0	0	**1**
Order planning	0	0	1	0	0	0	0	**1**
Order processing	1	0	0	1	0	0	0	**2**
Ordering of local content parts	0	0	0	0	0	0	1	**1**
Packing of local content parts	0	0	0	0	0	0	1	**0**
Planning of assembly of parts supplier	0	0	0	0	0	0	1	**1**
Planning of containerisation and shipping	0	0	4	0	0	0	0	**4**
Planning of containerisation and shipping local content	0	0	0	0	0	0	1	**0**
Planning of packing	0	1	7	2	0	0	0	**10**
TBE	0	3	5	0	0	0	2	**10**
Total	**1**	**13**	**21**	**5**	**0**	**0**	**7**	**47**

Addendum K: Coding results complications

Complications	Central sales planning	Focus Group	Logistics and order management	Market Management	PBK	Sales operations	Vehicle documentation and local content	Totals
CKD inaccurate forecast	0	2	1	0	0	0	0	**3**
Increase of derivates for CKD	0	0	1	0	0	0	0	**1**
Lead time	0	4	0	2	0	0	0	**6**
Manual edit	1	2	1	0	0	0	0	**4**
Unforseeable changes in demand	0	0	1	0	0	0	0	**1**
Totals	**1**	**8**	**4**	**2**	**0**	**0**	**0**	**15**

Addendum L: Coding results perceptions

Perceptions	Central sales planning	Focus Group	Logistics and order management	Market Management	PBK	Sales operations	Vehicle documentation and local content	Total
CKD own world	0	2	0	1	0	0	1	**4**
Negative perception of CKD	3	3	0	0	1	2	0	**9**
Neutral perception of CKD	2	0	0	2	0	0	0	**4**
Positive perception of CKD	0	2	4	1	0	0	1	**8**
Total	**5**	**7**	**4**	**4**	**1**	**2**	**2**	**25**

Addendum M: Coding results responsibilities

Responsibilities	Central sales planning	Focus Group	Logistics and order management	Market Management	PBK	Sales operations	Vehicle documentation and local	Total
3PL	0	2	3	1	0	0	0	**6**
Central sales planning	8	4	1	4	4	0	1	**22**
Demand and capacity planning	1	1	0	1	0	0	0	**3**
International supplier	0	1	2	0	0	0	0	**3**
Local production company	0	2	3	4	0	0	0	**9**
Local sales company	1	4	5	6	1	0	1	**18**
Local supplier CKD	0	2	2	0	0	0	1	**5**
Logistics and order management	2	5	14	7	0	0	2	**30**
Market management	2	5	3	8	0	0	1	**19**
Supplier in country of origin	0	0	0	0	0	0	1	**1**
Vehicle documentation and local content	2	15	3	4	0	0	4	**28**
Total	**16**	**41**	**36**	**35**	**5**	**0**	**11**	**144**

Addendum N: Coding results programmes and planning tools

Programmes	Central sales planning	Focus Group	Logistics and order management	Market Management	PBK	Sales operations	documentation and local content	Total
Cesar	1	3	0	1	0	0	0	**5**
Code-SA list	2	13	3	4	0	0	1	**23**
GO	1	1	3	1	0	0	0	**6**
GOP	3	2	1	0	0	1	0	**7**
ISP4D	0	0	0	2	0	0	0	**2**
JPP	1	4	4	5	0	0	0	**14**
MPP	0	0	3	1	0	0	0	**4**
Total	**8**	**23**	**14**	**14**	**0**	**1**	**1**	**61**

Addendum O: Coding results themes

Themes	Central sales planning	Focus Group	Logistics and order management	Market Management	PBK	Sales operations	documentation and local content	Total
BM	1	4	1	5	0	1	0	**12**
CoRe	2	0	0	0	0	0	0	**2**
Equipment list	0	0	0	3	0	0	1	**4**
GO Redesign	4	3	0	1	1	0	0	**9**
NST	0	10	0	4	0	2	0	**16**
PBK	4	0	0	0	4	1	0	**9**
Real orders	1	6	0	0	0	0	0	**7**
Rest of World	1	0	0	0	0	0	0	**1**
SA take-rate	7	3	0	6	3	2	0	**21**
Shortfall	1	2	0	0	0	0	0	**3**
Short-term planning	0	1	1	2	0	0	0	**4**
TKL	0	1	0	5	0	0	0	**6**
Volume planning	1	0	0	2	0	0	0	**3**
Total	**22**	**30**	**2**	**28**	**8**	**6**	**1**	**97**