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How to create a service-oriented company when going through a technology shift

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Preface and acknowledgement

This report was written as a master thesis project at Lund University Faculty of Engineering, at the division of Production Management during the spring of 2021. The master thesis is the last part of the author's five-year MSc in Industrial Engineering and Management with a specialization towards business and innovation. The thesis project has given the author the opportunity to apply his academic knowledge and show that he has acquired the relevant skills.

The year of 2020/2021 has been different in many ways. Due to the epidemic of COVID-19, most of the thesis project has been conducted digitally on distance. The author and the people he's interacted with has adapted to the circumstances by finding new ways to make this research project possible.

The author would like to acknowledge his supervisor at Lund University for her guidance and support throughout the project. The author would furthermore like to acknowledge Scania who has acted as a hosting case company, and have accommodated with guidance, support, interviews and resources. The author would especially want to thank his supervisors at Scania for their contributions.

As a final remark, the author sincerely hopes that the academia, Scania, or anyone else find this report useful and welcomes further studies and research.

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Abstract

Technical advancements and changes to the environment imply that industries may experience technology shifts. During those times, mature manufacturing companies are vulnerable, and it is of outmost importance they can respond to the new circumstances. To do so, mature manufacturing companies need to know which consequences they will experience to their offer, business model, resources and capabilities. Furthermore, it is increasingly popular for manufacturing companies to emphasize their service offers more, known as servitization.

The purpose of the report was to describe and analyze a mature manufacturing company's current offer and anticipate the consequences of a technology shift to the company's future offer, business model, resources and capabilities. The report was conducted as a case study of Swedish truck manufacturer Scania and how they anticipate the consequences from electrification in the transport industry. To collect and analyze empirical data, a theoretical framework called *the technology shift steering wheel* was constructed which can be used to anticipate the consequences of a technology shift from the three perspectives in the purpose. Empirical data was primarily assembled through semi-structured interviews with knowledgeable interviewees from the case company, but also through an interview in the ecosystem and an archive review of both company and external resources.

The report found that a technology shift in the company's industry substitutes the core technology, and in response the company adopt a technology strategy to acquire, manage and exploit the new technology. They do, as a consequence, make changes to their business model to connect the new technological core to the customers' needs. They must then construct an offer around the new core technology that embodies the value proposition. They will furthermore need to build or possess the necessary resources and capabilities to deliver the desired business model. The consequences are therefore implications of each other. By helping companies anticipate a technology shift's consequences to their offer, business model, resources and capabilities, the technology shift steering wheel steer them through the ambiguous alleys of a technology shift.

Keywords: *technology shift*, *servitization*, *electrification*, *offer*, *business model*, *resources and capabilities*.

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1. Introduction

In the following chapter, the report is put in a context by describing the background and the problem to be investigated. The purpose of the report is then established along with the chosen delimitations.

1.1 Background and problem description

Technology shifts and innovation have always impacted society. Technology shifts changes our behaviors, habits and not least our businesses (Philbeck & Davis, 2019). A technology shift can be seen as the emergence of a new technology paradigm which is defined as a broad cluster of innovations that are based on a common technology. A technology shift is ignited by a radical 'macro invention' that offers a new penetrating technology that can be used in a broad context in society as opposed to an incremental innovation that only offers development in the current technological trajectory (Cantwell, 2019). Technology shifts especially impact business models, and the companies that fail to adapt risk losing their competitive edge in the new paradigm (Tongur & Engwall, 2014).

The industrial revolution, driven by fossil fuels, paved the way for today's welfare, technological development, and globalization. Technological change drives economic growth and is therefore central to societal development (Allen, 2017). However, the previous century had consequences to our planet in the form of global warming due to greenhouse gas emissions. Furthermore, fossil fuels are becoming increasingly difficult to extract and a very unsecure resource (Boulanger et al, 2011). Climate change and increasing energy consumption means something has to change (Tongur & Engwall, 2014). The United Nations' ambitious but critical climate targets imply changes in all of society – not least in the industry (FN, n.d.).

Electricity is one of modern society's most important discoveries and constitutes an indispensable part of modern life, technological development, and globalization. The fields of application are manyfold, and the ways to extract electricity just as many. The renewable energy supply is practically infinite given the solar radiation and its effects on water and wind. Furthermore, the technology available to extract electric energy is continuously developed, and the more efficient it becomes, the better we can supply our increasing energy needs (Ehrlich & Geller, 2017). In the early days of the automotive industry, the crucial decision was made to make vehicles run on fossil fuels. Despite that electric solutions already existed in the beginning of the 20-th century, the combustion engine became the dominant

technology during the past century (Kirsch, 1997). However, the idea of fully or partly electrified vehicles have existed in parallel and a strong commercialization, primarily in the car industry, began in the 21-st century (Alamgir, 2017). The increasing supply of electricity and the broad societal use of electrification makes it a more appropriate technology than its predecessor going forward (Kirsch, 1997).

The transport sector contributes to a quarter of the world's energy-related carbon dioxide emissions (UN, n.d.). Increasing trade, globalization and societal growth furthermore increase the need for transportation globally. Since the transport industry is such a prominent source of emissions, the impact of technological advancements in the industry is very significant to the global emissions (Boulanger et al, 2011). Recently, the transformation of the transport industry is no longer only targeting the light-vehicle sector (e.g. cars) but also the heavy-duty vehicle sector (e.g. trucks) who produce a third of all the transport industry's emissions (Tongur & Engwall, 2014). Policies and regulations from both private and public stake holders increase the demand for a technology shift in the industry that promise sustainable solutions, and electrification is generally accepted as the main alternative (Boulanger et al, 2011). However, for the electrification of the transport industry to be successful, coordinated efforts from both the public and private sector will be necessary to get the surrounding ecosystem in place, such as charging infrastructure, energy supply, and services. The new electrified vehicles furthermore have different cost structures, challenges and restrictions than their predecessor, which affect the manufacturers business models (Boulanger et al, 2011).

A general trend among manufacturing companies is to move from a product centric approach towards using services to improve their offer, referred to as servitization (Vandermerwe & Randa, 1988; Lay, 2014; Kowalkowski & Ulaga, 2017). Servitizing may create the company competitive advantages, but they may also find themselves stuck in their product centric mind-set and investments in their service business might not yield the anticipated results (Kowalkowski & Kindström, 2012). The intersection between technology shifts and servitization is a research field that has not been studied thoroughly (Tongur & Engwall, 2014).

1.2 Purpose

Describe and analyze a mature manufacturing company's current offer and anticipate the consequences of a technology shift to the company's future offer, business model, resources and capabilities.

1.3 Delimitations

The report is a case study of the electrification of trucks at Scania from the three perspectives of offer, business model, resources and capabilities.

2. Methodology

In this chapter, the methodology will be presented. The methodology is the frames and principles for how to perform research (Höst et al, 2006). The chapter will begin by motivating the research strategy chosen. It will then explain the methods for collecting data and proceed by presenting the method for analyzing the data. The chapter will end with discussing potential sources of criticism and how they are addressed.

2.1 Research strategies

The choice of research strategy should reflect the goals and characteristics of the research. The four most common research strategies are *survey*, *case study*, *experiment* and *action research* (Höst et al, 2006). According to Swanborn (2010), if the research question is broadly defined and concern a social process, a case study is a suitable research strategy (Swanborn, 2010). A technology shift is a social process that is new to the company undergoing the shift, and due to the limited knowledge about the shift's consequences, the purpose in this report is kept very general. As a result, case study is identified to be a suitable research strategy for this report.

2.1.1 Case study

Case studies provide in-depth knowledge of events, circumstances, experiences or processes from one or a few cases of a phenomenon. To be suitable for a case study, the cases have to be independent and have clear boundaries. Organizations and processes are examples of case objects (Denscombe, 2016). The drawback of a case study is that the results generally can't be generalized to other cases. However, by doing a series of case studies the conclusions can be regarded as more general (Höst et al, 2006). Furthermore, by choosing a "typical" case that is similar to other possible cases, chances are that that the result can be generalized to similar objects (Denscome, 2016).

To perform this case study, a suitable independent case with clear boundaries must be chosen that enables the studying of the phenomenon of a technology shift's consequence to the offer, business model, resources and capabilities. Therefore, a case technology shift and a case company who's offer, business model, resources and capabilities can be studied has to be selected.

2.1.1.1 Selecting case technology shift

Electrification is defined as the process of making a machine or a system operate using electricity when it did not before (Cambridge dictionary, n.d.). In the case of the transport industry, electrification imply electrifying the

vehicles' powertrains, building the necessary infrastructure, adapting the business models etc. The transport industry is arguably experiencing its biggest disruption since the introduction of the diesel combustion engine. A previously stable industry has become one of the most disruptive (Boulanger et al, 2011). Diesel combustion has dominated the truck industry for over a century, but its many drawbacks has ignited electrification to take over more and more (Tongur & Engwall, 2014). Electrification is furthermore generally seen as the main solution to decarbonize the transport industry in favor of UN's sustainability targets (We et al, 2020). Technical revolution can imply both threats and opportunities to existing companies, and it is therefore of outmost importance to understand how suppliers of trucks in the transport industry are affected by electrification since they have not experienced a technology shift in their industry for over a century. Since the shift from diesel combustion to electrification is a contemporary shift that will change a growing industry with significant effect on global emissions fundamentally, it has been selected as case technology shift.

2.1.1.2 Selecting case company

With consideration to the purpose, the case company should be a mature manufacturing company undergoing the selected technology shift. Swedish truck manufacturer Scania is a mature manufacturing company in the transport industry currently transforming from diesel combustion technology to electrification. Scania is therefore identified to be a suitable case company for the study.

However, it should be disclosed that the author of the report is also part of a student program and has committed to writing this master thesis on behalf of the case company. According to Denscombe (2016), that may imply that the researcher is restricted in choosing a representative case to study (Denscombe, 2016). Nevertheless, the chosen company prevails a suitable case as previously motivated. The specific department from where the author will conduct his study is the Strategy and Portfolio Management department, specifically the Strategy and Business Support team. The team is anticipated to able to connect the author with the right expertise in the fairly large organization and support him with the necessary guidance and resources.

2.2 Data collection

When collecting data in a case study, the general methods are *interviews*, *observations* and *archive reviews*. The choice of method and the way data is collected has implications to the research quality and should therefore be chosen with consideration (Höst et al, 2006). It would be hard to observe the

case company's anticipations about the technology shift, and observations is therefore not found to be a suitable method. Furthermore, the most reasonable place to find the case company's anticipations should be with experts working at the case company. However, a lot of theory and expertise can likely be found also outside of the company. The preferred data collection methods are therefore found to be interviews and archive reviews, with case company interviews as the main method.

2.2.1 Data type

There are two major data types: quantitative and qualitative data. Quantitative data can be presented as numbers and quantities and are suitable for statistical research. Qualitative data is words and descriptions measured in existence and frequencies (Höst et al, 2006). The data collected from a case study is generally qualitative (Höst et al, 2006; Denscombe, 2016). Due to the nature of the chosen research method, case study, the data type that will be collected is qualitative.

2.2.2 Interviews

2.2.2.1 Semi-structured interviews

Interviews is a method for collecting qualitative data in a case study by questioning people with insight in the studied phenomenon. Interviews can be *structured*, *semi-structured* or *open*. The structured interviews follow a fixed set of questions and are basically oral surveys. The semi-structured interviews have supporting questions and themes, but the developments of the interview can change the structure in new directions and let the interviewee develop areas they find interesting. The open interviews let the interview object steer the discussions, and the interviewer only asks clarifying questions and keep the discussions relevant to the purpose. Interviews should be recorded and preferably transcribed to ensure reliability (Höst et al, 2006).

Semi structured interviews have been selected as the primary method for data collection. Since the phenomenon is difficult to quantify, in depth interviews with a relevant selection group is anticipated to give the most relevant data for further analysis. The semi-structured format also allows the respondents to speak freely, develop answers and touch upon subjects they find particularly interesting that may not otherwise be covered in the original questions.

2.2.2.2 Selecting interview objects

Sampling can be random or non-random. The non-random sampling methods are applicable when it is difficult or not desirable to use random sampling methods. That is practically the case when the researcher doesn't think it is possible to find a big enough population, don't have enough information about the population, or find it hard to contact the population with the random methods at hand (Denscombe, 2016). For this report, a non-random sampling method is chosen since it would be hard to create meaningful populations with the necessary expertise through random sampling methods.

Amongst the non-random sampling methods, subjective sampling has been selected as sampling method. According to Denscombe (2016), in subjective sampling a small group of objects are handpicked based on their relevance to the subject or due to their expertise (Denscombe, 2016). It is important to select interview objects as representatively as possible to get a diverse picture of the phenomenon. As a result, age, sex, occupation, education etc. should be taken into consideration (Höst et al, 2006).

When selecting interview objects for this research, the ambition is to cover areas needed to fulfill the purpose. The interview objects will furthermore be selected with diversity in mind. The people interviewed at the case company will be from a broad spectrum of departments, occupations, seniorities and other relevant diversifiers, but still with the expertise to answer the questions as accurately as possible. Practically, the interview objects will generally be selected with the help of the Strategy and Business Support team of the case company due to their orientation of where the right competence is found in the relatively large organization. Apart from the case company, one interview is to be conducted with someone from the ecosystem, in this case someone with expertise in the charging infrastructure. By request of the case company, the interview objects will be anonymized by not disclosing their real title. However, the anonymized titles have been selected to give an indication towards the interviewees' expertise and seniority.

The following broad categories of expertise are identified:

- To understand the organization of the case company; an internal processes director with expertise in the general organization will be interviewed along with a service strategy director with an overview of the service organization.
- To understand the technology shift; a senior expert, a senior advisor, a shift director, and a CEO in the ecosystem will be interviewed to understand the shift from an outer ecosystem and an inner company perspective. It is worth mentioning that the CEO is managing an electric road system start-up and is not employed by the case company.
- To describe the contemporary offer of the case company; a product planning director and a service portfolio director will be interviewed to understand both the product and services.
- To describe the consequences of the technology shift from the three perspectives of offer, business model, resources and capabilities; a strategy director, a new technologies director, an electrification director, a shift director, a strategy manager, and a service strategy director will be interviewed.
    - The strategy director will provide perspectives on what it means to be a solution provider.
    - The new technologies director will provide expertise regarding the new electric truck.
    - The electrification director will provide expertise regarding the anticipated business model, resources and capabilities.
    - The shift director will provide expertise regarding the business model, resources and capabilities, but also perspectives on the technology shift within the company.
    - The strategy manager will provide expertise regarding the digital services in the electric era and have recently conducted a project on the subject.
    - The service strategy director will provide perspectives on the consequences to the services from a strategic perspective.

The interview objects identified are anticipated to provide sufficient answers to allow the author to make conclusions, and thus fulfill the purpose. They have been listed in table 1 with title, area of expertise, and the perspectives they provide.

Table 1. Identified interview objects.

Title	Expertise	Perspectives
Internal processes director	General organization	How the case company is organized
Product planning director	Contemporary trucks	Contemporary product
Service portfolio director	Service portfolio	Contemporary service offering
Senior expert	eMobility	Technology shift
Senior advisor	Infrastructure	Technology shift
Strategy director	Solution provider	Business model, resources and capabilities
Strategy manager	Digital services	Future services
Service strategy director	Service strategy	Future services and service organization
New technologies director	New technology	Future product
Electrification director	Electrification	Business model, resources and capabilities
Shift director	Electrification	Technology shift, business model, resources and capabilities
CEO	Electric road systems	Ecosystem

2.2.2.3 Performing the interviews

The interviews will be conducted in two phases. The first phase will focus on describing the case company's current offer and understanding its organization. The second phase will focus on understanding the technology shift and the anticipated consequences of the case company.

2.2.3 Archive review

In archive reviews documentation for other purposes than the particular study is reviewed. However, the original purpose of the document must be critically reviewed (Höst et al, 2006). Archive review will be used to explore the general technology shift in the industry independently of the case company and as a complement to the interviews.

2.2.3.1 Company material

Being a large company, Scania have plenty of information available. A lot of second-hand information regarding Scania and its electrification is publicly available on their website and in the annual report. This material will be used to complement the interviews when necessary, but also to introduce the case company. The benefit of the public information is that it can be reviewed by people outside of Scania.

2.2.3.2 Literature

To approach the research question, a literary study will be conducted to identify relevant theories found in the academic literature to build the necessary knowledge to fulfill the purpose. Furthermore, a theoretical framework will be constructed from the theory to support the collection and analysis of the empirical data.

There is also a lot of literature available on subjects related to the technology shift, both regarding the diesel combustion paradigm and electrification. These (mainly academic reports) will be used to get a general industry understanding of the technology shift.

2.3 Analyzing method

The analysis of qualitative data is very different from quantitative data (Höst et al, 2006). Analyzing qualitative data is about finding patterns and connections in conversation and literature as opposed to extracting statistical measures from numerical data (Denscombe, 2016). Analyzing qualitative data can be difficult since it consists of more or less unstructured documentation from multiple sources with descriptions and claims that has to be made into meaningful categories and conclusions (Bryman, 2011). Swanborn (2010) particularly emphasize the challenges of presenting qualitative data in tables and "comparing the incomparable". He does, on the other hand highlight that the heterogeneity in the data is what makes it interesting (Swanborn, 2010).

In case study research, the purpose and the prerequisites of the research strategy should guide the analyzing method (Swanborn, 2010). There is no concrete all-purpose strategy for case study analysis. It is therefore crucial to describe and motivate the chosen strategy in each case study (Yin, 2007). When studying changing organizations, an empirical-analytical approach is very useful. The researcher should choose a theory-base strategy for analyzing the data, or if no sufficient theory is available, develop a theoretical framework that allow them to do so (Swanborn, 2010).

With these perspectives in mind, the method that will be used in this report is to develop a theoretical framework consistent with the purpose and use the framework to collect and analyze the empirical data. The framework itself will be described in section *3.6.2,* and how it is applied for collection and analysis of empirical data in sections *3.6.3.1* and *3.6.3.2*.

2.4 Research quality

When conducting research, the choice of methodology has implications for the research quality. The quality of a report can be seen from various perspectives such as how well-founded the conclusions are, if the research answers the purpose, if the results are general, and if someone else can draw the same conclusions with the same procedure. These perspectives can be categorized as *reliability*, *validity* and *representativity*:

- The reliability of a report implies the trustworthiness in the collection and analysis of the data. The foremost question is if a replication would give the same results. To ensure good reliability, it is important to be transparent about the research process and the analysis.
- The validity of a report implies a methodology that measures what is anticipated to be measured, in other words systematical impurities in the methodology.
- The representability depicts how general the conclusions are. This is amongst other things highly dependent on the research method.

(Höst et al, 2006)

The relevance of reliability and validity as quality measures in qualitative research has been questioned, but by adopting a different approach they may still be useful. It is important to distinguish between external and internal aspects. The external perspective is the environment in which the research has been conducted, and the internal perspective the researcher's procedure. From a reliability perspective, replicating a qualitative research is difficult because it is often hard to create the same environment and conditions. Furthermore, researchers have to be uniform in the way they interpret data. From a validity perspective, there should be a conformity between what the researcher observes and the theories he/she develop. From an external perspective, good validity is achieved when the conclusions can be generalized in other environments, which in case studies is rarely the case (Bryman, 2011).

2.4.1 Reliability

To ensure reliability, the interviews will be recorded, transcribed and reviewed by the interviewees to ensure the reproductions are accurate. Throughout the report, a clear and thorough referencing will be conducted according to the Harvard system. The outmost research ethics and consideration will be given to selecting sources and reproduce their content as accurately and independently as possible. Furthermore, the research process will be thoroughly described. All the reasoning will be explained throughout the report to make it possible to conduct a similar research and let the reader follow the reasoning from empirics to conclusions. However, it should be mentioned that it would be more or less impossible to reproduce the same setting. A technology shift is a moving target which is not an ongoing shift for eternity, and the interviewees and their anticipations might change from one time to another. Lastly, supervisors from the university and the case company will review the process to ensure it is reliably conducted from an academic and content perspective.

2.4.2 Validity

The non-random selection implies a few risks to the validity. It is important to cover a representable selection group to get the most accurate answers. In this case however, selecting randomly could mean that the adequate expertise isn't covered and that could in turn have worse consequences to the validity. There is also a risk that people have different perspectives and that it is reflected in the way they answer to the same questions. It is therefore important to distinguish between the interviewees personal believes and corporate standpoints. Since the research is conducted with a company, there is also a risk of limitations towards the transparency of certain aspects of their strategy. The subject is by the author identified to be sensitive from a competitive perspective, and thus the answers of the interviewees can be anticipated to be more general. The research therefore risk losing some of its depth. In the case of retention, the interview object will be replaced with similar expertise. Furthermore, the interview objects are almost exclusively identified by the case company. Therefore, there is a risk of them presenting interview objects that share personal beliefs or agendas. Regardless, it is still identified as the best method to find the right expertise in the organization. There is also a risk of making systematic errors during the interviews and the analysis of the material, therefore the empirical data and the discussions that the conclusions are based upon will be provided in the report to make it possible to follow the reasoning. Lastly, the report is written on behalf of the case company, and by not having full freedom when choosing the case, some validity may be lost. Scania is however regardless as a suitable case company.

2.4.3 Representability

A case study can generally not be generalized, especially if it is based on one single case. However, if the results are transferred to a similar case, chances are the studied object behaves similarly (Höst et al, 2006). The representability is generally the biggest source for criticism in case studies. However, the conclusions of individual case studies are not meant to be universal, they are meant to be theoretical statements to develop theory about why a certain phenomenon is observed in a certain context (Denscombe, 2016). The findings of this report hence should generally be regarded as representable primarily to similar companies experiencing the same shift. They may however offer an indication towards the consequences of a technology shift in other industries and shifts as well. The report will furthermore distinguish between Scania specific findings and "general" findings. The theoretical framework on the other hand is not by any means designed to be bound to the transport industry or electrification and is meant to be used in a broader context on different companies and different shifts.

3. Theory

To fulfil the purpose, a proper theoretical framework has to be constructed to support the collection and analysis of empirical data. The framework will, in consistence with the purpose, be used to describe and analyze a mature manufacturing company's current offer and anticipate the consequences of a technology shift to the company's future offer, business model, resources and capabilities. In a technology shift, a technology strategy is used to adapt and align the company in response to the changing environment. A new technology strategy implies consequences to the company's offer, business model, resources and capabilities. Hence, these are the three perspectives that have been selected to construct the theoretical framework.

The following chapter is divided into six sections. The first five sections describe theory regarding the offer, technology shifts, technology strategy, the business model, and lastly the resources and capabilities. The chapter ends with a summary of the theories presented, the creation of a theoretical framework called "the technology shift steering wheel" and a description of how the framework is used to collect and analyze empirical data.

3.1 Offer

3.1.1 What is an offer?

An *offer* is a combination of products, services, information or experience bundled to serve a customer's need or want (Kotler et al, 2013). It may be regarded from various perspectives such as *the three product levels* (Kotler et al, 2013) or *the value proposition* (Osterwalder & Pigneur, 2010).

3.1.2 The product offer

3.1.2.1 What is a product?

Kotler et al (2013) broadly define a product as "anything that can be offered on the market for attention, acquisition, use or consumption that might satisfy a want or need" (Kotler et al, 2013, p. 238). The product definition can include more than just tangible objects, such as intangible services, events, persons, places, organizations and ideas (Kotler et al, 2013).

3.1.2.2 Classifying products

Products can be classified in two main groups based on the customer's purpose for buying the product. The main groups are *consumer products* and *industrial products*. A consumer product is bought for personal consumption

by the end customer. Industrial products are bought to be used in a business context. The consumer products can be divided into the categories of *convenience-*, *shopping-*, *specialty-*, and *unsought products*.

- Convenience products are bought frequently, immediately, and with minimal comparison between offers.
- Shopping products are purchased less frequently, and more effort is invested into comparing different offers.
- Specialty products have unique characteristics or brand identification that appeals to a specific group of consumers.
- Unsought products are not yet known by the customer or something they anticipate buying. This generally applies to innovative products.

(Kotler et al, 2013)

The second group, industrial products, can be divided into *material and parts*, *capital items* and *supplies and services*.

- Material and parts consist of raw materials, manufactured materials, and parts intended for production.
- Capital items aid a buyer's production or operation and can further be divided into *installations* and *accessory equipment*.
    - Installations are fixed equipment or facilities.
    - Accessory equipment is more portable in nature and simply aid the production.
- Supplies can be divided into *operating supplies* and *repair and maintenance items*. They can be regarded as the convenience product of industrial products.

(Kotler et al, 2013).

3.1.3 The service offer

3.1.3.1 What is a service?

Service can be defined as "a process consisting of a series of more or less intangible activities that normally, but not necessarily always, take place in interactions between the customer and service employees and/or physical resources or goods and/or systems of the service provider, which are provided as solutions to customer problems" (Grönroos, 2000, p.46). The "systems" referred to in the definition does to an increasing extent imply digital systems. Kotler et al (2013) define services as "a form of product that consists of activities, benefits or satisfaction offered for sale that are essentially intangible and do not result in the ownership of anything" (Kotler et al, 2013, p.238).

Services share three common characteristics:

- Services are processes consisting of activities or a series of activities rather than things.
- Services are at least to some extent produced and consumed simultaneously.
- The customer at least to some extent participate in the service production process.

(Grönroos, 2000).

3.1.3.2 Classifying services

There are many taxonomies to describe services. Grönroos (2000) classifies services into high-touch and high-tech services. High-touch services depend mainly on people and high-tech services depend mainly on physical resources such as information technology (Grönroos, 2000). Samli et al (1992) further suggest a typology dividing services into *presale* and *after sale*. Presale services are related to the purchase decision and adoption of the product and after sale services are connected to installation and training as well as customer satisfaction (Samli et al, 1992). Tukker (2004) divide services into *product-*, *use-* and *result oriented services*.

- Product oriented services are related to the use-phase of the product. Product ownership is transferred to the client, but services are offered during the product life cycle to ensure efficiency and function. Product oriented services may consist of consulting, supply of consumables, maintenance contracts, or take-back agreement for recycling.
- Use oriented services are relevant when the ownership of the product is not transferred to the customer. The seller is then responsible for maintenance, repairs etc. and the customer pays for the service of using the product. Some examples of use-oriented services are leasing, sharing, renting etc.
- Result oriented services is the most advanced service type. The ownership still stays with the seller, and the seller is responsible for all the obligations of use-oriented services, but furthermore promise a certain level of output or quality. The customer in this case doesn't pay for using the product, but for its output.

(Tukker, 2014).

Kowalkowski & Ulaga (2017) presents a final classification targeted at business-to-business services. Firstly, the value proposition of a service can either be to achieve performance as an output or perform deeds as input. Secondly, the services are either targeted towards improving the functioning of customers' goods or improving customers' business processes. Depending on the nature of the value proposition on one hand, and the service recipient on the other, four generic categories of B2B services are defined as *Asset Efficiency Services*, *Product Lifecycle Services*, *Process Delegation Services* and *Process Support Services* (see figure 1).

- Product life cycle services are deeds aimed at the supplied goods. They facilitate the access and functioning of the products sold to customers during their lifecycle. Examples are calibration, inspection, and installation. These services are often necessary to be able to sell any products at all but can also be very strategic to the service portfolio.
- Asset efficiency services are services that increase the performance of the goods supplied to the customer. Examples are uptime agreements, on-site preventive maintenance, and remote monitoring.
- Process support services are deeds aimed at assisting customers in improving their own processes rather than improving the functioning of the products. Examples of such services can be diagnosing of processes, auditing, training, and consulting. The value proposition in this case focuses on leveraging resources and competences to help the customers. However, the manufacturer will not take responsibility for the process or the outcome. These services can serve as a great differentiator in the market.
- Process delegation services are also directed to the customers' processes, but the supplier furthermore takes control and responsibility of the outcome. Examples could be fleet management of tires for a trucking company, total gas-supply management for a production plant, and document management for an industrial company. By combining goods and services, the supplier can perform processes on behalf of the customer. However, the manufacturer is also exposed to the risk associated with the process. Hence, risk management becomes a very critical capability when offering this service type.

(Kowalkowski & Ulaga, 2017).

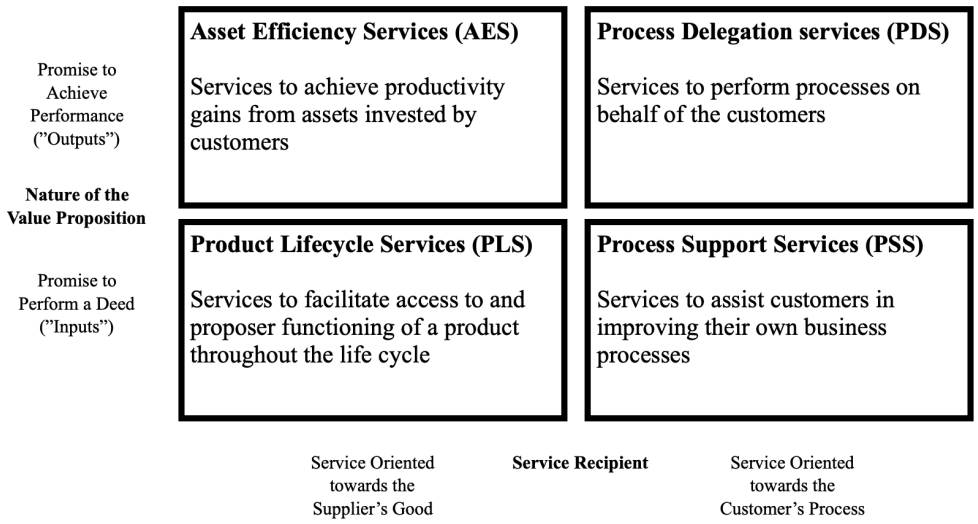

Figure 1. B2B service classification. Adapted from Kowalkowski and Ulaga (2017) "The B2B Service Classification Framework" (Kowalkowski & Ulaga, 2017).

3.1.3.3 Service as a strategy

A trend among manufacturing companies is to move from a product-oriented strategy where services had low strategic importance towards a customer centric strategy were service is the main competitive differentiator in the market, a phenomenon known as *servitization* (Vandermerwe & Randa, 1988; Lay, 2014; Kowalkowski & Ulaga, 2017). Many companies in the same industry have very similar business models and differentiation is essential to their competitiveness (Tongur & Engwall, 2014). In servitization, the company recognizes that the customer doesn't buy the product but rather the solution it provides (Lay, 2014; Grönroos, 2000). Services are therefore no longer regarded as expensive marketing efforts or necessary evils, but as important strategic tools. The companies therefore bundle goods, services, support, self-service and knowledge into more competitive offers (see figure 2)(Vandermerwe & Randa, 1988; Grönroos, 2000; Kowalkowski & Ulaga, 2017). Kowalkowski & Ulaga (2017) refer to these bundles as *hybrid offers* (Kowalkowski & Ulaga, 2017).

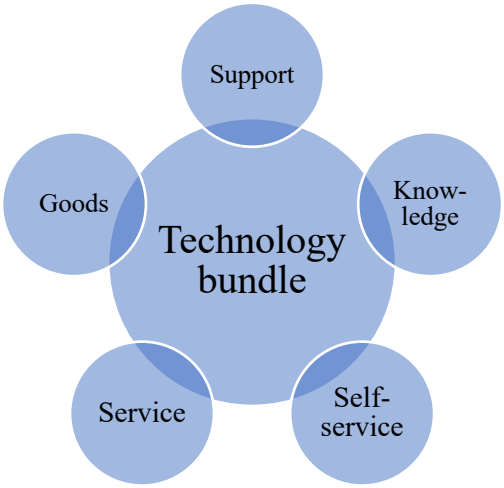

Figure 2. Technology bundle. Adapted from Vandermerwe & Randa (1988) "The technology bundle" (Vendermerwe & Randa, 1988).

Kowalkowski & Ulaga (2017) has identified the internal and external drivers for servitization. From an external perspective, the drivers are tied to the environment and may be a result of too many similar offers, customers demanding better services, or to many similar competitors. From an internal perspective, the drivers are tied to the company's internal motivators, such as a way to exploit expertise, capture value from strong customer relationships, or searching for new market opportunities. The drivers are listed in table 2.

Table 2. Drivers of servitization. Adapted from Kowalkowski & Ulaga (2017) "Key drivers for service growth" (Kowalkowski & Ulaga, 2017).

External factors tied to the environment	Internal motivators from the company
• Saturated and commoditized (product) markets • Customer pressure • Proliferation of competition	• Exploit product and technology expertise • Capture customer relationship value • Open new market opportunities

Furthermore, service margins are typically higher than product margins and may be a previously untapped revenue stream to many manufacturing companies (Lay, 2014). Servitization also bring the company closer to the customers by tailoring services to their needs, and they become more loyal as a result. Often, services can improve the customers' businesses by offering them to buy only what they will use and by selling services that increase their performance. The customers therefore derive more value from their products/services than previously (Vandermerwe & Randa, 1988; Lay, 2014; Tukker, 2004; Kowalkowski & Ulaga, 2017). Service sales are also generally more stable than product sales over economic cycles (Kowalkowski & Ulaga, 2017).

Kowalkowski & Kindström (2012) explains how a company servitizing can fall victims of the "service paradox" when transitioning from a manufacturing company to a service company (see figure 3). Many manufacturing companies have a strong engineering tradition, and to little strategic focus is put on service. Investments to improve the company's services may therefore not yield the full potential benefits. To avoid the service paradox, the company must move its perspective from being a pronounced manufacturer to being *solution providers* (Kowalkowski & Kindström, 2012).

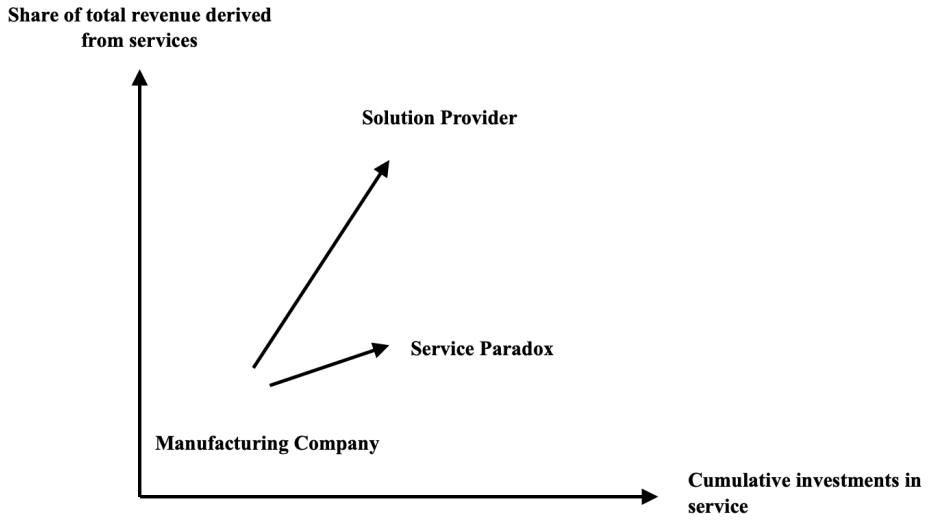

Figure 3. The service paradox. Adapted from Kowalkowski & Kindström (2012) "Tjänsteparadoxen" (Kowalkowski & Kindström, 2012).

Tongur & Engwall (2014) illuminates that the center of gravity in servitization literature only explains how to create services around the company's present core technology, but very few theories cover servitization in technology shifts were companies have to build strategies based on unverified technology (Tongur & Engwall, 2014).

3.1.4 Constructing an offer - The three product levels

According to *the three product levels* described by Kotler et al (2013), the product can be considered from three levels. Every level is associated with more customer value. Customers will evaluate all three aspects of the offer and all three levels must therefore be considered. The levels are *core customer value*, *actual product* and *augmented product* (see figure 4):

- The core customer value is what the customer buys given its perceived needs and represents the benefits of the product to the problem the customer wants to solve by buying the product. It is therefore important that the core customer value is considered from a customer perspective.
- The actual product is the tangible (physical) product and consists of the product's features, design, packaging, quality and brand name. The actual product translates the core customer value into a product that the customer can buy.
- The last product level is the augmented product which consists of everything surrounding the product in terms of service, warranty, financing etc. The augmented product offers the customer additional services and benefits to the physical product to improve the overall offer. The augmented product can therefore be a viable way to differentiate from the competition.

(Kotler et al, 2013).

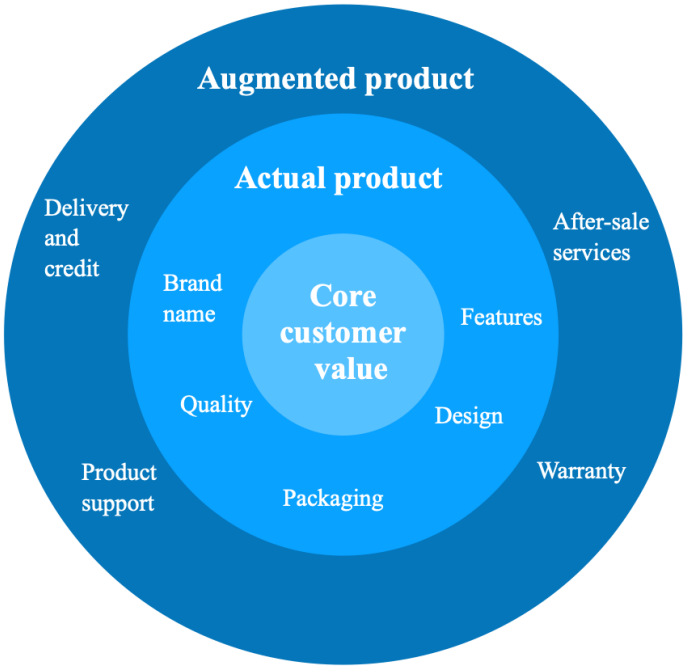

Figure 4. The Three Product Levels. Adapted from Kotler et al (2013) "Three levels of product" (Kotler et al, 2013).

3.2 Technology shifts

3.2.1 Defining technology shifts

There are many interpretations of *technology shifts*. Dosi (1984) recognizes the similarities between scientific and technological paradigms. He also describes the difference between continuous and discontinuous innovation. The prior is a result of a technological trajectory within a technological paradigm, and the latter marks a new technological paradigm. Discontinuous innovation is not just a result of changes in the market but should be seen as a result of many interplaying factors (Dosi, 1984). Cantwell (2019) extends the concept and define the technology paradigm as" a widespread cluster of innovations during a given era that rely on a common set of scientific principles and on similar organizational methods". The technological paradigm is ignited with a macro-invention in the form of a "general purpose technology" that has a wider application outside its primary field. The technology paradigm shapes the "cognitive frames" for innovation in which

problem solutions and assessment criteria are shared amongst companies. This results in innovation centered around the technology of the present paradigm. The similarities in innovation efforts observed amongst companies can be studied on many levels, such as industry, technical field or society (Cantwell, 2019). Technological changes can have a substantial role in creating opportunities for companies to influence its competitive status, especially if the new technology changes existing industry structures (Porter, 1985).

3.2.2 Incremental and radical innovation

Tushman & O'Reilly III (1996) uses the terminology of incremental and radical innovation to explain the phenomenon of technological paradigms and claim that the company mainly develop incrementally in existing technologies and radically during technology shifts. The long-term survival of companies is therefore a result of the ability to both master incremental and radical innovation. During incremental change, the company must adapt its culture and strategy, but not in a way that it makes them unable to tackle radical change, something they refer to as the "ambidextrous organization". They also describe a phenomenon they call *the success syndrome*. A company that prospers in a market in a current technical paradigm becomes slow in adaption and may not survive a technology shift (Tushman & O'Reilly III, 1996).

3.2.3 The technology s-curve

A common way to look at the evolution of a technology is through the *technology s-curve* (see figure 5). The relative improvements that can be achieved to a product's performance in a technological era changes over time. In the early phase, improvements in performance are relatively low. As the technology is better understood, improvements happen much faster during the technology's growth phase and peak when the technology matures. Thereafter, improvements to the technology stagnates and becomes harder and more costly to achieve. At this point, the contemporary technology is substituted by a new technology. The technologies can co-exist for some time, but the shift will happen as soon as the new technology reaches superior performance (Adner & Kapoor, 2015). However, the s-curve has been criticized for the fact that empirical results seldom show the smooth shape suggested in the theory (Adner & Kapoor, 2015; Christensen, 1992).

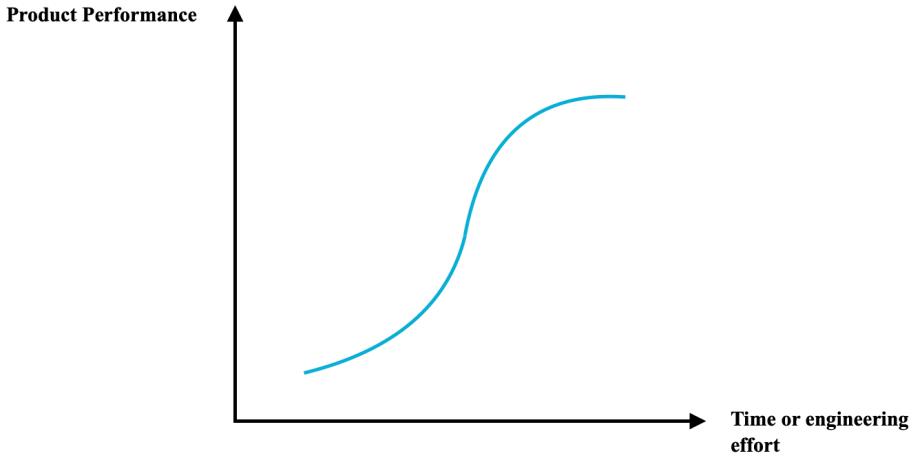

Figure 5. Technology s-curve. Adapted from Christensen (1992) "The technology S-curve" (Christensen, 1992).

3.3 Technology Strategy

3.3.1 What is strategy?

Tregoe and Zimmerman (1980) define strategy as "a framework to guide those choices that determines the nature and direction of an organization" (Tregoe & Zimmerman, 1980, p.17). Strategy pioneer Michael Porter suggests a more competition-based view on strategy: "strategy is about being different. It means deliberately choosing a different set of activities to deliver a unique mix of value" (Johnson et al, 2015, p. 3). Strategy can also more simply be defined as "the long-term direction of an organization" (Johnson et al, 2015, p. 2). Strategy can be studied on both corporate-, business-, and operational level:

- The corporate level strategy explains how value is added and covers the overall scope of the organization. Aspects of the corporate strategy to consider are geographical scope, diversity of products and services, acquisitions, and resource allocation between organizational elements. A clear corporate strategy is very important to the integration of the company's strategy on all levels.
- The business level strategy is the business units' competitive strategies in different markets. It may include innovation, response to competition etc.
- The operational level strategy concerns how the components of the organization effectively deliver the corporate and business level strategy with the resources, people, and processes available.

(Johnson et al, 2015).

Since the core of a company is what it knows and what it can do, not its products or its markets, companies should form a deliberate functional strategy related to their technology (Ford, 1988).

3.3.2 Technology strategy

Ford (1988) defines technology strategy as plans, policies and procedures to successfully *manage*, *exploit* and *acquire* technology for sustained technology-based competitive advantage (see figure 6). The acquisition of technology is about obtaining new relevant technologies to the company. New technology can either be made or bought. The managing of a company's technology is the internal control, transfer and absorption connected to the technologies possessed or not possessed by the company. The exploitation of a company's technology is about creating value from the technologies and can either be internal or external. The technologies possessed by the company have different implications and can be categorized into distinctive technologies, basic technologies, and external technologies. The first category consists of technologies that are unique to the company in the market and therefore create competitive advantage. The second category consists of technologies that are essential to the company's existence. The third consist of technologies that are obtained from external actors (Ford, 1988).

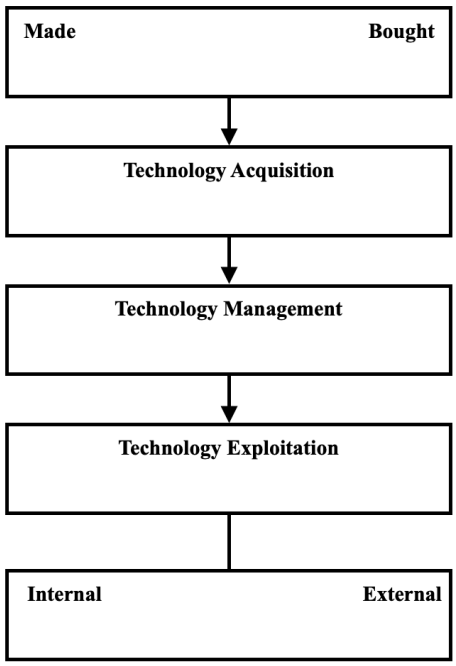

Figure 6. Technology strategy. Adapted from Ford (1988) "The elements of technology strategy" (Ford, 1988).

Davenport et al (2001) develops Ford's concept further and extends the manage, exploit, and acquire concept. They emphasize that there are numerous ways to acquire technology. Technologies can be acquired through networks and alliances, mergers and acquisitions, in-house development, lead users, technology licensing, and through outsourcing. From a managing perspective, to make use of the acquired technology it has to be absorbed by the organization. That is referred to as the company's *absorptive capacity*. The company also understand which new knowledge is needed and acquire new technology in an iterative way. The company then uses their technological competences and capabilities to exploit the technology they possess. To create sustained competitive advantage, the authors explain how the technology must be exploited as intellectual property, through continuous innovation or through technological lock-in (Davenport et al, 2001).

3.4 Business model

3.4.1 Technology shifts' impact on business models

Tongur & Engwall (2014) problematize how radical changes in technology may affect the business model of companies. They explain how a technological shift can be a significant threat to a company, especially a mature one. They say that none of the general strategies proposed in prior literature to tackle technology shifts are sufficient by themselves. The first strategy of investing in R&D to transform the company's technological competence may imply losing the ability to meet customer needs. The second strategy of transforming the company's value proposition and improving the product and services may imply losing the company's technological edge. In order to both "survive" a technology shift and adapt the business model to the new unknown competitive context, both technological and value innovation is necessary. As a result, the authors conclude that successfully managing a technology shift is not only a technology problem, but a business model problem. Companies that suffer from a business model inertia are therefore very vulnerable to technology shifts (Tongur & Engwall, 2014).

3.4.2 Defining business models

When discussing *business models*, there are many possible interpretations. Johnson et al (2015) defines business models as "how an organization manages income and costs through the structural arrangements of its activities" (Johnson et al, 2015, p. 188). Tongur & Engwall (2014) articulates a more technology driven approach to business models and define them as "connecting the company's technological core to the fulfillment of its customers' needs" (Tongur & Engwall, 2014, p. 257). A more value driven

definition by Osterwalder and Pigneur (2010) suggests that a business model "describes the rationale of how an organization creates, delivers and captures value" (Osterwalder & Pigneur, 2010, p. 14). Even though business models have a strong purpose of value capture (earnings), it may from an innovation perspective also include value creation. This implies that invention, innovation, R&D and production are core capabilities to the company (Tongur & Engwall, 2014).

3.4.3 The Business Model Canvas

Osterwalder & Pigneur (2010) have developed a tool to describe the business model known as *The Business Model Canvas* (see figure 7). The canvas consists of nine blocks: *value proposition*, *customer segments*, *channels*, *customer relationships*, *key partnerships*, *key resources*, *key activities*, *revenue streams,* and *cost structure*. These nine blocks can be divided in four main areas: customers (customer segments, channels, customer relationships), offer (value proposition), infrastructure (key partnerships, key resources, key activities), and financial viability (revenue streams and cost structure)(Osterwalder & Pigneur, 2010).

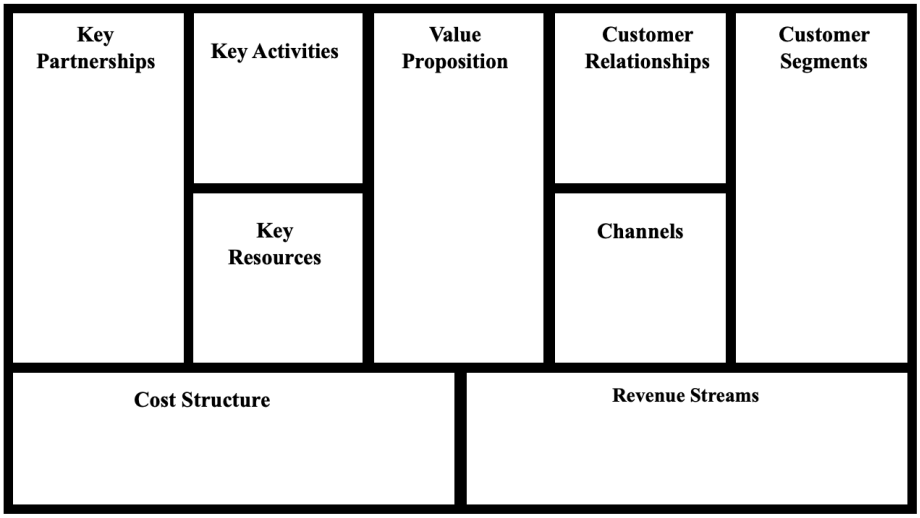

Figure 7. The Business Model Canvas. Adapted from Osterwalder & Pigneur (2010) "The Business Model Canvas" (Osterwalder & Pigneur, 2010).

The nine building blocks will now be described:

- Value proposition – the value proposition constitutes how the offer, a distinct mix of elements to address the customer's needs, will create value to the customer. It is therefore essential to the competitiveness of the company to have a unique value proposition and tailor it to the targeted customer segments. Relevant issues are:
    - What value do we deliver to the customer?
    - Which problems are we helping to solve?
    - Which needs are we satisfying?
    - What bundles of products and services do we offer?
- Customer segments – customer segments are customer types with similar needs, behaviors and attributes that can be clustered into meaningful segments. A segment is considered unique if it requires a distinct offer or if the segment is willing to pay for certain aspects of the offer. The company wants to serve the customer segment in question with the products or services it offers. The targeted segment/segments must be selected and carefully studied to understand their needs and wants.
- Channels – channels are the ways the company communicate with their customer segments in the process of delivering value. The channels are "customer touch points" and can significantly impact the customer's experience with the company. Channels can roughly be divided into awareness, evaluation, purchase, delivery and after sales.
- Customer relationships – the customer relationships can be everything from very personal to automated depending on the segment. Customer relationships can be a useful tool to acquire customers, avoid retention and to sell additional services. Examples of customer relationships could be communities, co-creation, and personal assistance.
- Key partnerships – the key partnerships form the network of suppliers and partners in which the company has to take part to successfully deliver its value to the customers. Partnerships may have an important strategic role in a successful business model. Some drivers of partnering can be reducing risk and uncertainty, optimize the business model and economy of scale, and acquiring resources.
- Key resources – key resources are the most crucial assets in serving the customer segments and delivering the desired value. There are many types of resources, such as human-, financial-, technical-, and intellectual resources. The relative importance of different assets to the business model varies depending on other blocks in the canvas.
- Key activities – the key activities of a company are the actions it must perform to deliver the value to the customers. Key activities vary

widely between sectors, companies and business models. Key activities are often related to the fulfillment of other blocks in the canvas, such as key resources, value proposition etc. Key activities may roughly be categorized as production oriented, problem solving, or platform/network oriented.

- Revenue streams – revenue streams are the ways the company generate money. Each customer segment can provide numerous revenue streams and may have different pricing strategies. It is also important to recognize that there are numerous ways to make payments other than a one-time purchase.
- Cost structure – the cost structure describes all the costs that goes into the business model. Preferably, revenue streams should exceed costs to ensure economic viability. The fulfillment of various blocks in the business model are all associated with costs, and the cost structure is therefore very relevant to the business model. Cost structures can roughly be divided into cost driven and value driven cost structures, where minimizing costs is more crucial in the prior and less prominent in the latter. Similar to payments, costs are not necessarily fixed. Costs may be variable, may benefit from economy of scale, or may be shared between many parts of the company.

(Osterwalder & Pigneur, 2010)

3.5 Resources and capabilities

3.5.1 The resource-based view

The view of the company as a set of resources emerged from a more product-based paradigm. A resource is anything that can be regarded as a strength or a weakness to the company, tangible or intangible. A company's resources can play a major role in their strategic options, and the company must continuously balance exploiting existing and building new resources to be competitive (Wernerfelt, 1984). Companies are not homogenous in terms of resources and are therefore not equal from a competitive perspective (Johnson et al, 2015). Barney (1991) therefore describe the company's resources as a source of sustained competitive advantage (Barney, 1991).

3.5.2 Capabilities and capability types

A company's *capabilities* are determined by its resources and the competences to use them. Capabilities can further be divided into physical, financial and human resources (see table 3)(Johnson et al, 2015). Barney (1991) further defines *organizational resources* (see table 4)(Barney, 1991).

Table 3. Capability types. Adapted from Johnson et al (2015) "components of strategic capabilities" (Johnson et al, 2015).

Resources: what we have	Type	Competences: what we do
Machines, buildings, raw materials, products, patents, databases, computer systems	Physical	Ways of achieving utilization of plant, efficiency, productivity, flexibility, marketing
Balance sheet, cash flow, suppliers of funds	Financial	Ability to raise funds and manage cash flows, debtors, creditors, etc.
Managers, employees, partners, suppliers, customers	Human	How people gain and use experience skills, knowledge, build relationships, motivate others and innovate

Table 4. Organizational capability. Adapted from Barney (1991) "organizational resources" (Barney, 1991).

Resources	Type
Formal reporting structure, formal and informal planning, controlling, coordinating systems, informal relations	Organizational

3.5.3 Dynamic capabilities

A company's capabilities are not static, but rather dynamic. Changes in customer preferences, industry structure, and technology can make resources less valuable over time. The relative importance of capabilities to a company's competitive advantage is also highly path dependent. Companies may have competitive advantage in one time period due to developments and acquisitions of resources in the previous (Barney, 2002). Teece et al (1997) define a company's *dynamic capabilities* as the company's ability to integrate, build, and reconfigure its internal and external competences to address rapid changes. Dynamic capabilities are especially crucial to the competitive advantage of the company (Teece et al, 1997). There are three types of dynamic capabilities: *sensing*, *seizing* and *reconfiguring*.

- Sensing is the ability to recognize and find new opportunities in terms of markets and technologies. Sensing is practically conducted through R&D activities or customer interactions.
- Seizing is the ability to capture the opportunities the company has sensed and incorporate it in its products, processes, and services to create value.
- Reconfiguring is the ability to renew and reconfigure capabilities to be able to seize the opportunities that have been sensed.

(Johnson et al, 2015).

3.5.4 Distinctive capabilities

For the capabilities to be valuable from a competitive perspective, they also need to be *distinctive capabilities* (Johnson et al, 2015). The VRIO framework proposed by Barney (2002) can be used to evaluate if a company's capabilities are distinctive. The criteria are *valuable*, *rare*, *inimitable* and *organizational support*.

- Valuable – valuable capabilities are valued by customers or enable the organization to respond to opportunities and threats. Valuable capabilities also have to generate higher revenues and/or lower costs to be considered valuable to the company.
- Rare – resources and competences unique to the company or attributed to only a few competitors in the market are considered rare capabilities. If they are not rare, they unlikely contribute to competitive advantage because competitors can easily also obtain them.
- Inimitable – an inimitable capability is difficult or costly for other companies to imitate, obtain or substitute. If a capability can easily be imitated, it doesn't create any long-term competitive advantage. These capabilities are generally intangible and based around

competence. The barriers restricting imitation is often linkages between people, skills, and knowledge in and outside the company. Such barriers may be a result of complexity, culture and history, and difficulty for competitors to understand how the linkages interact.

- Organizational support – to make a valuable, rare and inimitable capability a competitive advantage, the organization of the company must also support the exploitation of it. The level of organizational support is therefore crucial to the competitive advantage. Organizational support can be achieved by formal and informal managerial processes and systems in the company.

(Barney, 2002).

The level of fulfillment of the criteria in the VRIO framework has implications for the competitive advantage. To enjoy sustained competitive advantage, all criteria should be fulfilled. If none of the criteria is fulfilled, the capability may even be a competitive disadvantage to the company. If the capability is valuable, but not rare or inimitable, it could offer competitive parity in the market. If a capability is valuable and rare, but not inimitable, it may offer the company a temporary competitive advantage. If a capability is valuable, rare, and inimitable, it may offer sustained competitive advantage. Like mentioned, it does however also need the organizational support (Barney, 2002). The implications are demonstrated in table 5.

Table 5. Competitive implications of the VRIO framework. Adapted from Johnson et al (2015) "The VRIO framework implications" (Johnson et al, 2015).

Valuable	Rare	Inimitable	Organizational support	Competitive implications
No	-	-	No/Yes	Competitive disadvantage
Yes	No	-	No/Yes	Competitive parity
Yes	Yes	No	No/Yes	Temporary competitive advantage
Yes	Yes	Yes	No/Yes	Sustained competitive advantage

3.5.5 Service capabilities

Kowalkowski & Ulaga (2017) presents a framework (see figure 8) of how unique resources often possessed by manufacturing companies can be leveraged into competitive advantage through distinctive capabilities in servitized markets. If the unique resources are not possessed, manufacturing companies wishing to servitize should internally develop, acquire, or access the unique resources. The unique resources are *installed base product usage and process data, product development and manufacturing assets, product sales force and distribution network* and *field service organization.*

- Manufacturing companies may already have an installed base of products being used by their customers. This installed base is likely much larger than the company's new product sales. Therefore, if data is gathered from the contemporary installed base, it can be a very valuable resource already today. By having access to many different customers, the data possessed by the company is unique compared to the data one single customer can obtain and can offer customers unique services in that sense.
- A manufacturing company often possess valuable resources tied to product development and manufacturing. It may be tangible resources such as machines and tools or intangible resources such as intellectual property and competence.
- The third unique resource is the company's product sales force and distribution network. These form strong customer channels and often consist of knowledgeable people that can be very useful to deploy a successful service strategy. However, to be a unique resource, the sales force and distribution network must be fit for service and aligned with the manufacturer's service strategy.
- The last unique resource, field services and spare parts, is not only an important revenue stream for the company but also important to deliver the service offering. Field service employees are first to see opportunities, and they are the ones making the everyday choices that create cost savings and satisfied customers.

The unique resources of the company can with distinctive service capabilities be leveraged into competitive advantage in servitized markets. The distinctive capabilities are: *Data processing and interpretation capability, execution risk and mitigation capability, design-to-service capability, services sales capability,* and *services deployment capability.*

- The data processing and interpretation capability is the ability to transform the data possessed by the company into meaningful services that yields revenue or lower costs in delivering services to the customers. The manufacturer must understand the customer needs and improve its analytical skills.
- Since services to an increasing extent become contractual outcomes, the execution risk and mitigation capability become important to the company. The ability to assess and mitigate risk and estimate the need for future resources to fulfill contractual obligations becomes very important to service providers. The company needs to avoid committing to outcomes they can't deliver. Examples of ways to mitigate risks are pooling risks of different accounts, setting price buffers etc.
- The design-to-service capability is the system and culture that enables the company to provide a service down the road as early as possible in the innovation process. It is vital that product and service innovation is made synergistically so that services are not just added to existing product specifications. The design-to-service capability allows manufacturers to both offer better hybrid offerings and identify cost reduction opportunities during the innovation process.
- The services sales capability is simply the manufacturer's sales skills which obviously needs to be strong in a servitized company. The more complex the service offers become the better sales skills are needed. The purchasers of service solutions are often different than those of product procurement, they are often of higher hierarchical positions. To improve the services sales capabilities the company can hire "service-savvy" salespeople, establish new sales material that can be shown to potential clients, and educate the current sales force. The field technicians also play a major role by identifying opportunities at the customers' facilities. Many manufacturers also have a distribution network, and their service strategy has to be aligned with them as well to form a strong services sales capability.
- The services deployment capability is the ability to balance giving customers what they need and keeping the delivery profitable. To be successful in this sense, the company must master both customization and standardizing the delivery. If the manufacturer regards the service delivery from the perspective of a production-line, it allows them to improve its efficiency. A service delivery process can also be standardized to a certain level in the "back-office", while still keeping front-line service customized. There are three sub capabilities tied to this distinctive capability. Firstly, manufacturers must achieve

repeatability and economy of scale in the service delivery. Secondly, they must implement modularity in their service elements. Thirdly, the manufacturer must take a proactive approach to the management of costs in the service delivery. Even though service delivery can feel more diffuse than production, it is according to the authors possible to develop skills to improve efficiency though the above-mentioned capabilities.

By leveraging the manufacturing company's unique resources with distinctive service capabilities, competitive advantage can be achieved either by offering a differentiated offer in the market or by cutting costs to a level where price leadership can be achieved (Kowalkowski & Ulaga, 2017).

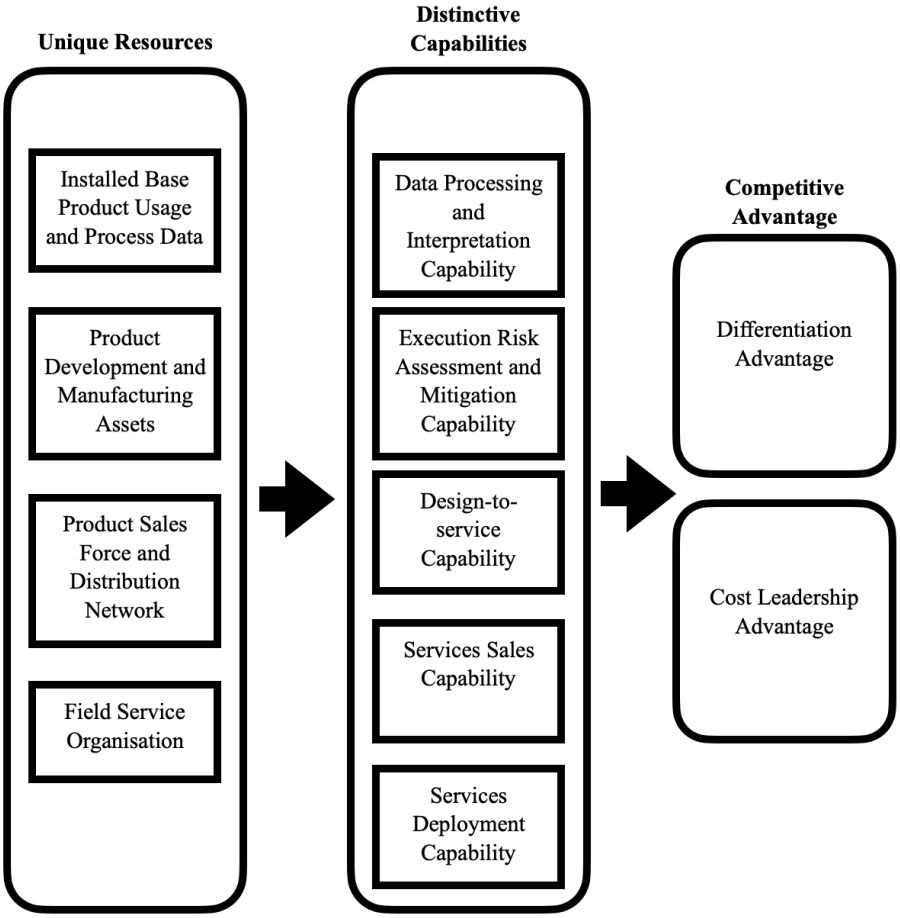

Figure 8. Service capabilities. Adapted from Kowalkowski & Ulaga (2017) "Unique Resources and Distinctive Capabilities for Successful B2B Service Growth" (Kowalkowski & Ulaga, 2017).

3.6 A theoretical framework – the technology shift as a steering wheel

In light of the purpose, theories relevant to describe and analyze the company's offer and the consequences of a technology shift from the perspectives of the company's offer, business model, resources and capabilities have been presented. Three theoretical perspectives were identified as particularly important to study the company during a technology shift being the offer, the business model, and the resources and capabilities. In addition, the theoretical fields of technology shifts and technology strategy were presented to align and give context to the three perspectives. In the following section, the theoretic fields will be summarized and then synthesized into a theoretical framework.

3.6.1 Theoretical summary

The chapter started by presenting what products and services are, how they are classified, and how to build an offer. Products were defined as "anything that can be offered on the market […] that might satisfy a want or need". Products are mainly classified into *consumer-* and *industrial goods*. Consumer goods are classified as *convenience-*, *shopping-*, *specialty-*, and *unsought products* and industrial goods as *material and parts*, *capital items*, and *installations and accessory*. However, in today's business environment products and services go hand in hand and theory on both products and services were needed. After discussing different definitions, a service was concluded to be identified by three characteristics: services are processes consisting of activities rather than things, services are produced and consumed simultaneously, and the customer participates in the service production process. Services were then classified into *high-touch* and *high-tech* services, as well as *presale* and *after sale* services. An additional categorization divided services into *product-*, *use-*, and *result oriented services*. A final categorization was presented that distinguish if the value proposition provides input or output, and if the services are targeted at improving the products sold or the customer's processes. The theory then recognized the shift amongst manufacturing companies from a product-oriented strategy to a service-oriented strategy, known as *servitization*. It is especially important for manufacturing companies with a product centric tradition to not fall victims of the *service paradox* by investing in services, without fully yielding the benefits. The section ended by presenting the *Three Products Levels* as a way to conceptualize a company's offer. In the model, more value is created in each of the three levels: *core customer value*, *actual product* and *augmented product*.

To better understand the nature of technology shifts and their implications, both classic and recent theory was presented. The section started by defining technology shifts as the emergence of a new technological paradigm. A new technological paradigm begins with a "macro invention" that has general application and forms the "cognitive framework" for innovation efforts during the subsequent era. The phenomenon is described as *discontinuous innovation*. Then, the *ambidextrous organization* was defined as the company's ability to cope with both incremental and radical change simultaneously to not fall victim of *the success syndrome*. The section ended with the *technology s-curve* which explains that the relationship between improvements to a product's technical performance and the time or engineering effort invested isn't linear, but rather follows an s-curve. As the technological improvements stagnates, the technology is exchanged when there is a superior alternative.

The subsequent section discussed the manyfold definitions of strategy. Strategy was then divided into *corporate-*, *business-*, and *operational strategy*. The opportunities, risks and organizational preparedness of technology shifts implied strategic importance, and a sub strategy regarding the company's technology was found to be essential in response to technological change. The theory on technology strategy first described by Ford (1988) was therefore presented with its central concepts *manage*, *acquire* and *exploit*. The developed model by Davenport et al (2001) incorporated a wider definition and suggested further aspects of acquire, manage, and exploit such as different ways to acquire technology, the *absorptive capacity*, the *technological competencies and capabilities,* and different ways to exploit the technology.

The proceeding section recognized the impact of technology shifts to the company's business model. A technology shift should be seen as a business model problem, not just a technological problem. To survive a technology shift, a company must both improve its technological edge and adapt its value proposition to the new context. Different approaches to defining a business model were presented, and the Business Model Canvas was selected as a suitable analytical tool to analyze the company's business model. The "canvas" consists of four areas covering nine building blocks relating various aspects of a business model to each other.

The last theoretical field was the resources and capabilities of a company. The section started by explaining how theory on companies has shifted to a resource-based view. Resources were defined as anything that can be a

strength or a weakness to a company and can be tangible or intangible. The company's differences in possessed resources is what creates their competitive advantage. The section then introduced *capabilities* as the company's resources and their competences to use them. The capabilities were classified as *physical*, *financial*, *human,* and *organizational*. The theory then emphasized that capabilities and their relative importance to the company is not static over time, and a company's *dynamic capabilities*, i.e., their ability to *sense*, *seize* and *reconfigure*, is crucial to address changes in the company's environment. Then the *VRIO-framework was presented as* a tool for identifying capabilities that yield competitive advantage. Such capabilities are *valuable*, *rare*, *inimitable* and have strong *organizational support*. The section ended with presenting a framework to analyze how unique resources often possessed by manufacturing companies can be leveraged into competitive advantage through certain distinctive service capabilities.

3.6.2 Creating the "technology shift steering wheel"

The interconnection between the theoretical models and their implications to the purpose is illustrated through the "technology shift steering wheel" (see figure 9) which is a framework aimed at "steering" through the ambiguous alleys of technological change towards a new business model in a new technological context. The blue steering wheel represents the technology shift that the company is undergoing. The center of the technology shift steering wheel is the company's technology strategy. The technology strategy controls the direction of the company and align the other theoretical perspectives of the technology shift steering wheel. The first field in the steering wheel is the company's business model which connects the technological core to the customers' needs and wants. The second field, the offer, studies the company's offer and is the embodiment of the value proposition in the business model. The third field, the resources and capabilities, covers the capability types as well as the dynamic, distinctive and service capabilities. These capabilities are closely tied to the key resources that are used to deliver the business model.

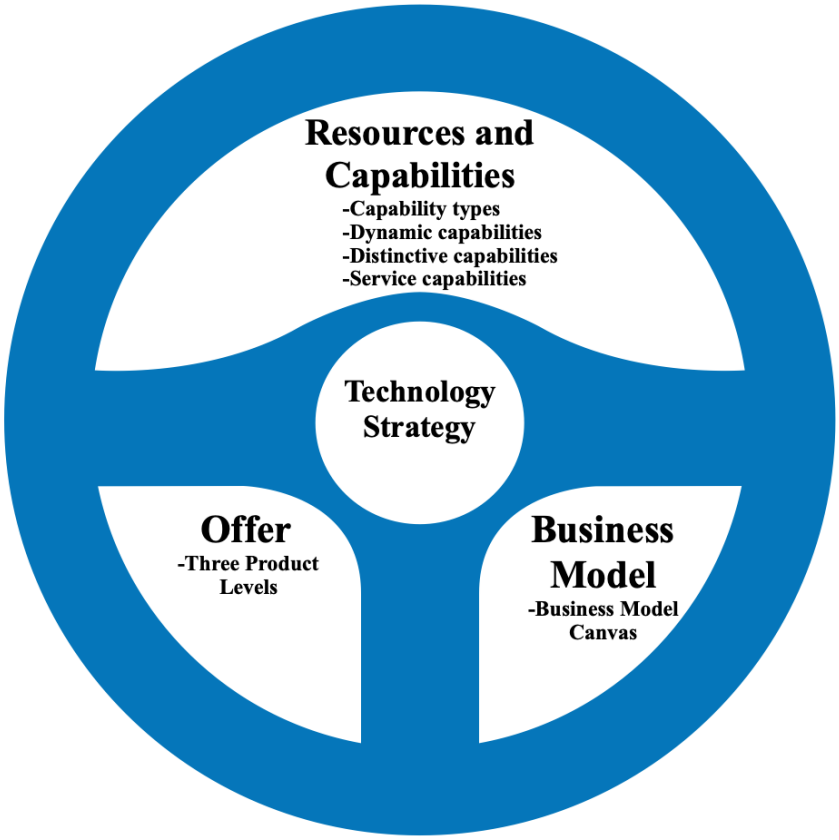

Figure 9. The Technology Shift Steering Wheel.

3.6.3 How to apply the theoretical framework

3.6.3.1 Collecting empirical data

To collect empirical data with the technology shift steering wheel, the first step is to describe the contemporary offer of the case company through the structure of the Three Product Levels. The second step is to describe the technology shift from a general perspective by describing the contemporary technology and the new technology from an industry perspective. The third step is to describe the case company in relation to the shift and their anticipated technology strategy. The contemporary offer together with a general and a company specific description of the technology shift is the fundament needed for understanding the consequences of a technology shift to a company. With the fundament in place, the fourth step is to describe the

consequences that the case company anticipates from the three perspectives of offer, business model, resources and capabilities. To describe the offer, the company is requested to anticipate consequences based on core customer value, actual product, and augmented product according to the Three Product Levels. To describe the business model, the case company is requested to anticipate the consequences to the nine fields of the Business Model Canvas. To describe the resources and capabilities, the case company is requested to anticipate the consequences to their resources and capabilities.

3.6.3.2 Analyzing empirical data

To analyze the empirical data with the technology shift steering wheel, the first step is to analyze the contemporary offer of the case company with core customer value, actual product and augmented product from the Three Product Levels. The second step is to analyze the general technology shift in the industry, primarily with the technology s-curve. The third step is to analyze the case company's technology strategy based on acquire, manage and exploit. With the analysis of the contemporary offer and the analysis of the shift from an industry and company perspective in place, the fourth step is to analyze the consequences of the technology shift from the three perspectives of offer, business model, resources and capabilities.

From the first perspective, the consequences to the offer are analyzed through the Three Product Levels of core customer value, actual product and augmented product. From the second perspective, the consequences to the business model are analyzed through the nine building blocks of the Business Model Canvas. From the third perspective, the consequences to the resources and capabilities are analyzed. To analyze this perspective, the first step is to identify which capabilities that see consequences from the technology shift. The second step is to use the capability types of physical, human, financial and organizational capabilities to analyze which capability type that is most affected by a technology shift. That is practically done by analyzing which capability types that is most often implied in the capabilities mentioned by the case company. The third step is then to use the theory on dynamic capabilities to understand a technology shift's consequences to the dynamic capabilities by determining if the identified capabilities will help the company sense, seize or reconfigure. The fourth step is to use the VRIO framework to understand the competitive implications of the identified capabilities by for each capability analyze if they are valuable, rare, inimitable and have organizational support. The last step is using the service capability framework to analyze if the company have unique resources and the service capabilities to leverage them into competitive advantage in the new era. That is practically

done by identifying which of the unique resources that are possessed, if the company have the distinctive service capabilities to leverage them, and if that will give the company any useful competitive advantage in the new era. After analyzing the above, the last part of the analysis is to analyze how the perspectives are related to each other and conclude the general consequences of the technology shift.

4. Description of the case company

In the following chapter the case company will be described to give a context to Scania and to explain where in the organization the author has conducted his research. The chapter will start by generally presenting Scania. It will then explain Scania's strategy and Scania's innovation. It will then explain Scania's organization from corporate governance down to the specific team that has assisted the author in his research. The chapter will end with a description of the product and service development at Scania.

4.1 About Scania

Scania is a global provider of transport solutions and primarily manufacture trucks and buses for heavy transport applications. In 2019, Scania's net sales were 152,419 billion SEK (2019) and Scania employed 51 278 people in over 100 countries globally. Scania's sales and service network covers most parts of the world. Research and development activities are mainly conducted at the headquarters in Södertälje (Sweden), but also in Sao Paolo (Brazil) and Bengaluru (India). Scania's production is mainly conducted in Europe, Latin America, and Asia, but additional regional production is performed in Africa, Asia, and Eurasia (Scania AB, 2019).

Scania have six main business areas: trucks, buses, used vehicles, engines, service-related products, and others. Trucks is Scania's biggest business area and generate 64% of the company's total revenue, corresponding to 97,5 billion SEK in 2019. Being a transport solution provider, the business area of *services* is growing and generated 19% of Scania's net sales in 2019 (see figure 10)(Scania AB, 2019).

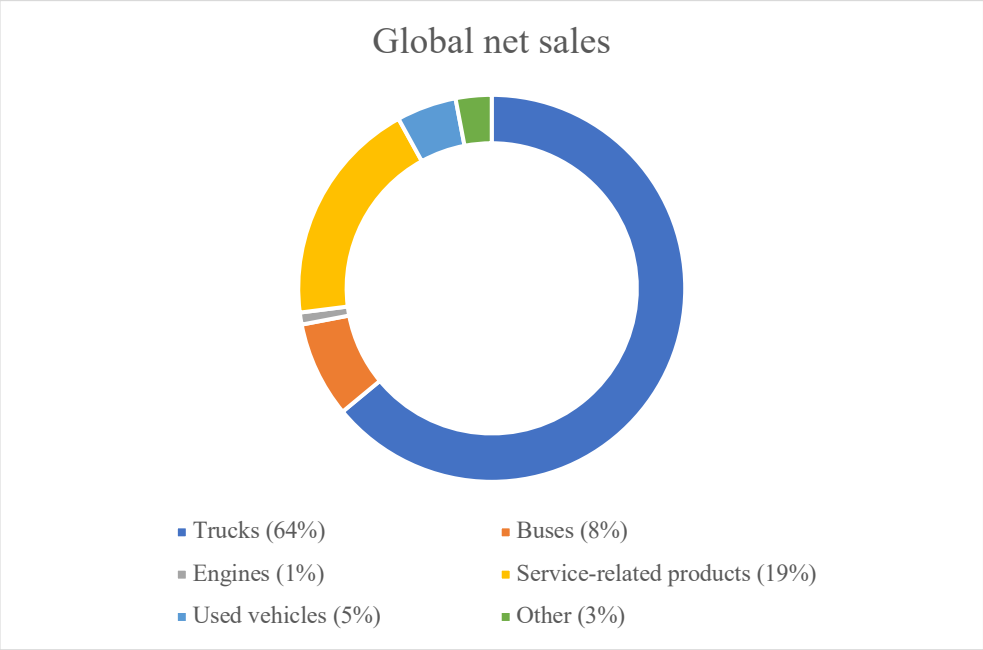

Figure 10. Scania's net sales (Scania AB, 2019).

Scania offer an extensive product line of trucks for different applications, such as long-haul, regional, and urban transports. Each transport solution is tailor-made to fit every customer's individual needs. Europe is by far Scania's biggest truck market corresponding to 64% of total truck sales in 2019 (See figure 11). Scania also have an extensive service offering. Europe is Scania's most service intensive market, corresponding to 69% of service sales. (See figure 12)(Scania AB, 2019).

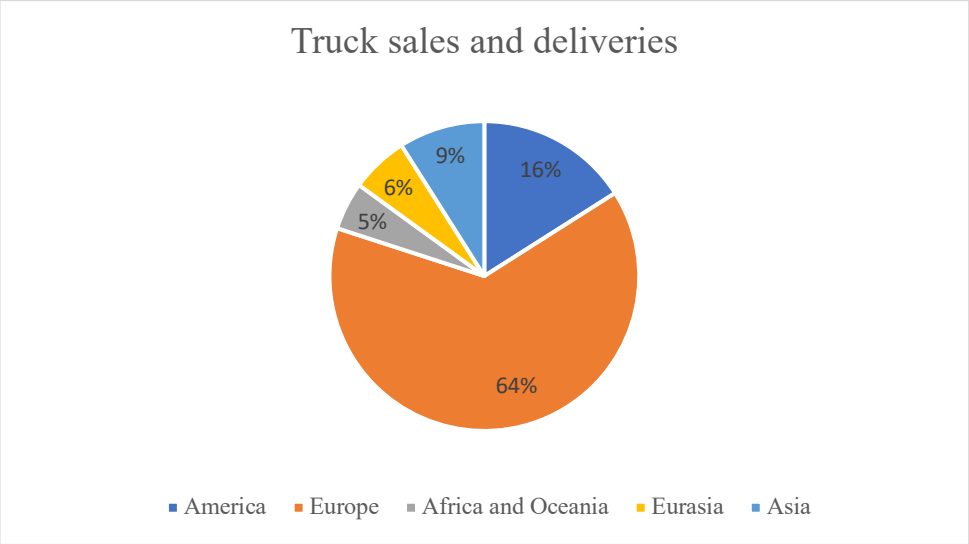

Figure 11. Global truck sales and deliveries (Scania AB, 2019).

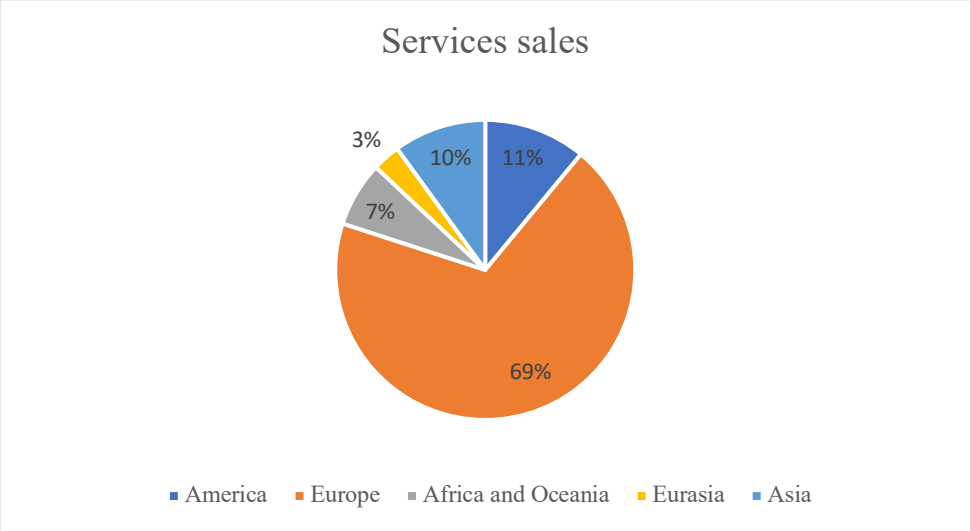

Figure 12. Global services sales (Scania AB, 2019).

4.2 Scania's strategy

Scania's purpose is "driving the shift towards a sustainable transport system, creating a world of mobility that is better for business, society and the environment" which gives context to their whole strategy called Strategy 2025. Scania have a strong emphasis on sustainability and have committed to many science-based sustainability targets such as the Climate Action Summit implying net zero (green gas) emission by 2050. To reach its targets, Scania has set up three pillars: *increase of energy efficiency*, *renewable fuels and*

electrification, and *smart and safe transport*. Essentially this means using the best fuel available, without wasting any unnecessary resources, in a responsible way. Scania is focusing on emerging technologies such as electrification and aim to reduce 50% of its CO2 emission from their operations and 20% from their products before 2025. Scania also adopt a life cycle perspective and take responsibility from design and production to use and recycling (Scania AB, 2019).

Scania is also very customer oriented in their strategy. Scania say they are successful when their customers are successful. Scania strive to not only understand their primary customers who buy the trucks, but also their customers' customers who buy the transports. By a better understanding of the whole system, Scania believe they can better impact their customers and their businesses positively. By eliminating waste and inefficiencies in the whole value chain and enable maximum uptime of customers' vehicles, Scania can increase their customers' revenue. By fuel economy, repair and maintenance, and financing; Scania can reduce the customers' costs (Scania AB, 2019).

Scania refer to themselves as solution providers, and to meet every customer's specific needs Scania tailor-make solutions. Scania therefore use a modular system approach which allows customers to create hundreds of combinations through a limited variety of choices. The solution provider perspective also implies a service strategy of offering a complete solution that bundles relevant products and services to create more value (Scania AB, 2019).

Scania strongly believes that value creation starts and ends with the people in- and outside the organization. Scania's culture, values and principles permeates the way everyone works at Scania, something known as "the Scania way" (Scania AB, 2019).

To succeed with its strategy, an ecosystem approach is necessary to Scania. Scania believes a holistic approach create more value to all stakeholders. Therefore, it is central to work with multiple stakeholders in the daily work. These stakeholders can be customers, experts, or government decision makers. Stakeholders can help Scania with everything from promoting adoption and developing technology, to enabling favorable conditions for Scania's solutions (Scania AB, 2019).

4.3 Scania's innovation

Since Scania has committed to leading the shift, innovation is very central to their strategy. Scania's innovation is built on *technology push*, *customer pull* and *ecosystem partnerships*.

- Technology push is the way Scania capture emerging technologies and bring them to market through strong development capabilities. Scania participates in various pilot projects and can therefore access some of the best technical innovations. Scania also have internal innovation initiatives such as *Scania Smart Engineer Lab* and *Scania Smart Factory La*b.
- Customer pull is the way Scania co-operate and provide early adopters with new innovative solutions. Together with key customers, Scania can test new innovations in small scale, and if successful scale them up to full production.
- The ecosystem partnerships are the ways Scania share knowledge and build strategies together with the ecosystem. The ecosystem includes customers, decision makers, universities etc. and can be categorized as *technology partnerships*, *academic partnerships* and *government/industry partnerships*. An example of a technology partnerships is Scania's corporate venture fund *Scania Growth Capital* that invest in corporate ventures that explores disruptive technology or enables ongoing shifts in the ecosystem. An example of the academic partnerships is Scania's participation in the *Transport Research Lab* where academia and ecosystem stakeholders meet to innovate. An example of a government/industry partnerships is Scania's role as a key advisor in the Ministry of Infrastructure and Road Authority in Sweden.

These three perspectives of innovation create the conditions needed for capturing and seizing emerging technologies (Scania AB, 2019).

The current innovation at Scania focusses on sustainable transport solutions. However, the innovation at Scania does not only include new technology and product development, but also the innovation of business models and services. Scania's innovation is about embraces the new, while still building on core strengths, always with business opportunities in mind (Scania AB, 2019).

4.4 Scania's organization

4.4.1 Corporate Governance

Scania AB, and its fully owned affiliate Scania CV, together form *Scania*. Scania is part of a larger group owned by Traton SE and its subsidiary MAN SE. Scania, MAN and Volkswagen Caminhões e Ônibus together form *Traton Group,* a subsidiary of Volkswagen AG (Scania AB, 2019).

The Chief Executive Officer (CEO) has the overall responsibility of Scania. The CEO is supported by the executive board. The executive board consist of the CEO, the Finance and Business Control director (CFO), the directors from Scania's different departments, and the most recent addition – the "mobility-as-a-service" director.[1]

Overall, Scania is organized as a traditional industrial organization with the primary functions *Research and Development*, *Production and Logistics*, *Purchasing*, *Sales & Marketing* as well as the supporting functions *Human Resources* and *Financial Services.* However, Scania is different from other industrial organizations from mainly three perspectives. First of all, since Scania own most of the retail network, they have decided to separate the manufacturing and the selling organization, and as a consequence let a department called *Commercial Operations* buy vehicles from the "manufacturing organization" via Sales and Marketing. The second difference is that Financial Services organizationally is the responsibility of the CFO even though it is retail financing and not corporate financing. The CFO is therefore responsible not only for the corporate finance, but also the profitability of Financial Services. The third aspect is that some areas of particular interest to the company that are not represented in the executive board still report directly to the CEO, such as "digitalization" and "communications". They are referred to as "CEO-functions". The organization should overall be regarded as a functional organization where the departments have a lot of independent responsibility. However, cross-functional coordination between the departments does occur regularly.

[1] Internal processes director, Scania AB, digital interview 2021-03-23

In the following sections the different departments will be presented:

- Research and Development develops hardware and software for Scania's products. There is no explicit CTO at Scania, but the head of R&D is responsible for the technology development of the company. The R&D department follow cost-budgets when developing but has no profit and loss responsibility.
- Purchasing purchases components and consultative services. They are also involved in partnering with other companies. They have no profit and loss responsibility.
- Production and Logistics manufacture and assemble the company's products. The products are then sold to Sales and Marketing at a base cost that includes costs for components, value-adding in the production, purchasing costs and development costs. Production & Logistics does not have a profit and loss responsibility.
- Commercial Operations is the wholesale and retail network of Scania. They buy trucks and spare parts from Sales and Marketing at individually negotiated prices and execute the selling and delivering in the different markets. Commercial Operations has a profit and loss responsibility since they sell with a margin to end-customers.
- Sales and Marketing works with product management, strategy and the enabling of sales in Commercial Operations by preparing, planning and organizing processes to facilitate their work. They buy finished products at the base cost, and then sell the vehicles to the Commercial Operations with a base margin.[2] Commercial Operation's salesforce then sell the vehicles with the support from "presale" at Commercial Operations who get their tools, knowledge and systems from Sales and Marketing.[3] Sales and Marketing can't influence the base cost too much. However, Sales and Marketing have a few services they sell themselves and therefore they have their own revenue streams. Spare-parts are also a major share of Sales and Marketing's income. Due to the revenue streams, Sales and Marketing has a profit and loss responsibility.
- Finance at Scania consist of Finance and Business Control and Financial Services. Finance and Business Control are responsible for bookkeeping, treasury, and corporate control. Financial Services offer insurance and financing solutions to the customers of Scania. Apart from Financial Services, who has a profit and loss responsibility, the financing department is a corporate support.

[2] Internal processes director, Scania AB, digital interview 2021-03-23
[3] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19

- Human Resources is the central human resource function at Scania, but it is supported by human resource "islands" throughout the organization. The Human Resources department has no profit and loss responsibility.[4]

4.4.2 Sales and Marketing

The core of Sales and Marketing is its five business areas. The business areas generally have two major activities: product management and area management. Product management has a strategic perspective and a future perspective. From a strategic perspective the business area decide how Scania should respond given its contemporary offer to increase revenue and find opportunities and efficiencies in the processes. From the future perspective, the business areas identify future needs and respond accordingly. The second activity is area management which is very operational. The different teams are responsible for Scania's different geographical markets and create volume plans, price lists, process orders, negotiate prices etc. The business areas of Sales and Marketing are *trucks*, *buses*, *power solutions* (powertrains and engines), *spare parts*, and *services*. As a consequence of electrification, an additional business area for electric solutions has been established. Sales and marketing furthermore have four support functions.[5]

4.4.3 Service portfolio and delivery

The business area of services is called *Service Portfolio and Delivery* and gather all the ingoing components needed for delivering services under one umbrella. They have two major responsibilities. First of all, they develop and manage the end-customer service portfolio of Scania. Secondly, they own the supporting systems and processes that Commercial Operations need to sell, deliver and invoice those services.[6] All this is collected in one organization with the ambition to make the process leaner. Within Service Portfolio and Delivery there are a few units with different responsibilities such as external and internal systems, workshops, digital systems for end customers, technical support, service development, and service strategy and portfolio management.[7]

[4] Internal processes director, Scania AB, digital interview 2021-03-23
[5] Internal processes director, Scania AB, digital interview 2021-03-23
[6] Internal processes director, Scania AB, digital interview 2021-03-23
[7] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01

4.4.4 Strategy and Portfolio Management

The strategic decisions and portfolio management of Scania's services is conducted from the *Strategy and Portfolio Management* unit. They work with strategic and tactical questions to find gaps in the service portfolio, needs for new services, and to provide the service organization with business support.[8] Within the unit, there are two teams, *Strategy and Business Support* and *Portfolio Management*. The Strategy and Business Support team is a pure support function to the Service Portfolio and Delivery organization and support them with strategy and business support.[9] It is from the Strategy and Business support team that the author has conducted his research.

An organizational cone that represents an overview of the different levels presented in the previous paragraphs can be seen in figure 13.

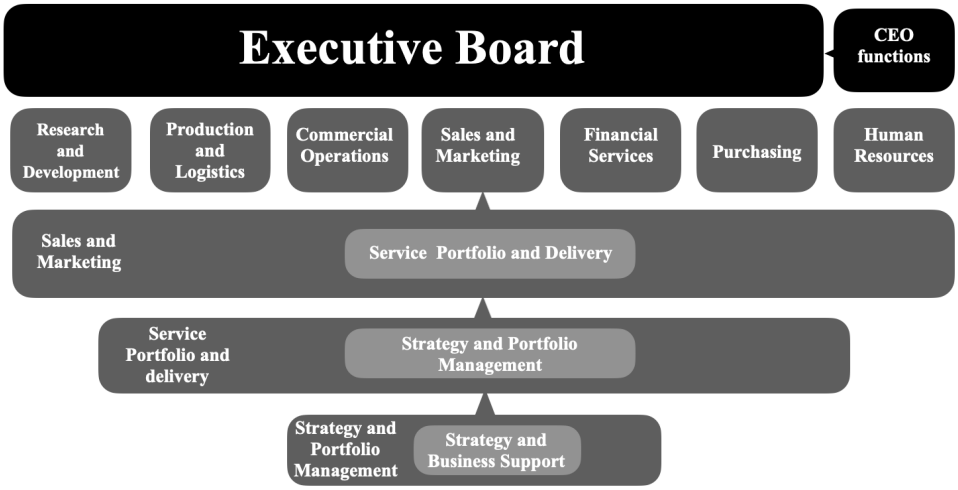

Figure 13. Organizational cone from Executive Board to Strategy and Business Support.

4.5 Product & service development within the organization

There are two main development muscles at Scania, Research and Development who develops hardware and software related to the products and Service Portfolio and Delivery who develops services for in-house and end-customer purposes.[10] The two development muscles are different in many ways, but still need to coordinate. In development projects where Service Portfolio and Delivery are stakeholders, they are part of the steering-

[8] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[9] Strategy manager, Scania AB, digital interview 2021-04-09
[10] Internal processes director, Scania AB, digital interview 2021-03-23

groups, such as for connectivity and electrification. However, in projects more connected to the powertrain and cab, other parts of Sales and Marketing may be represented, such as the business area of trucks. That is the interaction between the two departments on steering level; but meetings, discussions and workshops are part of the daily coordination as well.[11]

Moving further into the service development, it is distributed throughout the organization. Some services are developed close to the customer in the retail network. A lot of service development also happens at the business units by the responsible for different markets when adapting to local regulations and preferences. Then, a lot of service development is also performed centrally at Scania, foremost within Service Portfolio and Delivery and within Financial Services.[12]

Service Portfolio and Delivery is undergoing a transformation in the way they work from a traditional project organization towards a more agile way of working with sprints, iterations and tribes.[13] Every employee at Service Portfolio and Delivery has an organizational belonging in a team but also work cross functionally in a tribe, referred to as a value stream.[14] The teams have the main purpose of communication and staff appraisal and the tribes are where the different functions at Service Portfolio and Delivery collaborate in operational projects.[15] The tribes are devoted a domain depending on the type of service they develop. The tribes must then gather all the competence needed from the organization to understand business aspects, concepts, development and launching of the new service. This way of working is relatively new to Scania.[16]

[11] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[12] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[13] Service portfolio director, Scania AB, digital interview, 2021-03-24
[14] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[15] Strategy manager, Scania AB, digital interview 2021-04-09
[16] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01

5. Empirics

The following chapter will present the empirical results and study the technology shift from an internal (company) and external (industry) perspective. The chapter will initially describe the contemporary offer of Scania. The chapter will then proceed by describing the technology shift from diesel combustion to electrification. The chapter will then follow the structure of the three perspectives of the purpose presenting empirical findings regarding the consequences to the offer, the business model, and the resources and capabilities.

5.1 Description of Scania's offer in the diesel paradigm

5.1.1 Core customer value

It is important to emphasize that the customer doesn't buy the vehicle for the sake of the vehicle, but as a tool in their operation to fulfill another purpose, such as transporting goods in the best possible way.[17] Customers today buy the trust and peace of mind connected to the Scania brand. The customer gets a product that to a high degree gets the job done and an organization that is available if the customer encounters any problems.[18]

There are three core customer values of Scania's trucks today: fuel economy, uptime and "driver's choice".[19]

Starting with fuel economy and uptime, the customers today buy *total operating economy* (TOE), in other words how profitable it is over time to have a Scania truck, which is a consequence of both high uptime and low fuel consumption. Scania's vehicles cost comparatively more up-front than most competitors, but over time Scania's solutions are more economic due to fuel savings, low maintenance costs and fewer disruptions. This is the *total operating economy* (TCO). Uptime is when the vehicle is on the road, and the customer earns revenue. Together with good TCO, high uptime offers the customer high TOE.[20] Since uptime give the customer more revenue, it is something the customers are prepared to pay a premium for.[21]

[17] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[18] Service portfolio director, Scania AB, digital interview 2021-03-24
[19] Product planning director, Scania AB, digital interview 2021-04-15
[20] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[21] Service portfolio director, Scania AB, digital interview 2021-03-24

Customers also choose Scania because the drivers appreciate that Scania's vehicles are comfortable to drive and stay in overnight. Especially smaller haulers emphasize this core value since the purchasers are often drivers themselves. Larger haulers also value "driver's choice" since they have to offer competitive working conditions for their drivers, but it is generally not as central to them as the TOE.[22]

5.1.2 Actual product

The contemporary actual product of Scania is its heavy trucks driven by its internal diesel combustion engines. Scania is regarded as a premium brand in the automotive industry as a result of its well-engineered diesel combustion engine.[23] Both the high uptime and the low operational costs are a consequence of Scania's engines. Furthermore, the engines are, generally, compatible to run on biofuels as a substitute for diesel. Scania strive to be premium and are successful in charging a price premium in comparison to their competitors. When it comes to quality, Scania also have a good reputation in the market. Scania may not be unique in that sense but sustain a high-quality level which makes the vehicles very durable.[24]

Scania's contemporary product line practically support any transport application (in its class) through Scania's modular system. Scania can practically build all applications over 16 tons from one toolbox through standardized interfaces.[25] Through modularity, customers can choose from different engines, cabs, gearboxes, axels and frames which makes it possible to tailor-make the truck for every customer's needs with relatively few components (see figure 14)(Scania AB, 2019).

[22] Product planning director, Scania AB, digital interview 2021-04-15
[23] Service portfolio director, Scania AB, digital interview 2021-03-24
[24] Product planning director, Scania AB, digital interview 2021-04-15
[25] Product planning director, Scania AB, digital interview 2021-04-15

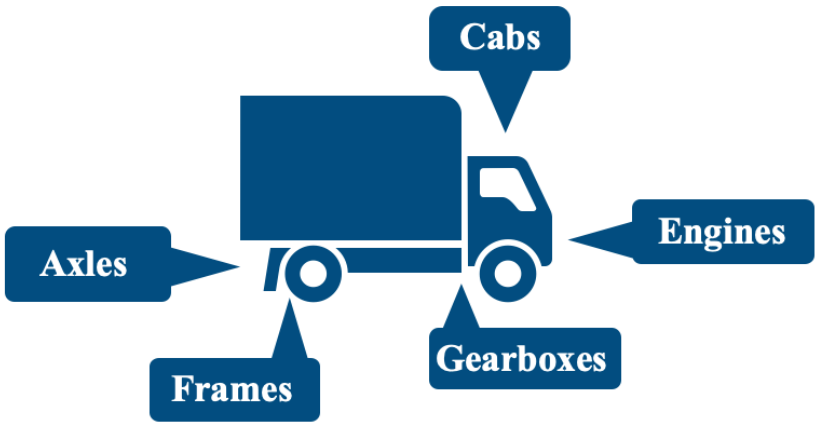

Figure 14. Scania's truck modularity.

From a digital perspective, the trucks are equipped with 10-12 computers. They are also equipped with a CAN (controller area network) system that connects the electronic systems, and a communicator called C300 which extracts data from the computers which is sent wirelessly to Scania. The hardware for connected vehicles has been standard in all vehicles since 2012.[26]

The vehicles can also be equipped with *power take out* (PTO) which is a superstructure fitted to a truck or a trailer for specific applications that is powered by the engine or gearbox of the vehicle through a generator or a machinery. A vehicle could as an example be equipped with cooling units, tippers, cranes etc. About half of all vehicles sold by Scania are estimated to be equipped with some kind of PTO.[27]

[26] Service portfolio director, Scania AB, digital interview 2021-03-24
[27] Product planning director, Scania AB, digital interview 2021-04-15

5.1.3 Augmented product

Scania's augmented product today consist of services targeted at the contemporary fleet of (mainly) diesel combustion vehicles. Many of the services are based on the data that is sent back to Scania by the more than 500 000 connected vehicles on the roads globally. The purpose of the service offering is to make sure the product properties of the vehicles are maintained over time. The services can be divided into *digital services*, *vehicle services*, *workshop services, rental services and financial services*:

- Digital services are data insights customers can use themselves in their logistics systems. The vast majority of the digital services are connected services. Digital services prove to the customer that the product still deliver the way it did as new.
- Vehicle services use insights from vehicles and package solutions to improve the vehicles' uptime.
- Workshop services are mainly repair and maintenance services.[28]
- The rental services of Scania enable customers to be flexible towards their capacity limitations, without tying up vehicles or capital. The services guarantee high availability of a broad range of vehicles and flexibility towards changing vehicle type and returning vehicles (Scania a, n.d).
- The finance and insurance services are aimed at giving customers predictable costs and manageable risks over the life cycle of their vehicles. Experts at Scania help customers to tailor-make financing and insurance products that suits their individual needs (Scania b, n.d).

Today, the center of gravity in the service portfolio is workshop services and vehicle services, about 80-85%. Services related to the vehicle and the workshop creates much of Scania's competitive edge today. Digital Services is a relatively small fraction of the contemporary service portfolio. However, the digital services are important to the service offering, especially since customers digitalize at increasing speed.[29]

Upon purchase, customers are given a monitoring package free of charge with access to data regarding the status and usage of their vehicle and a basic maintenance plan that maximize uptime given that the vehicle is used in the same way as when it was purchased. [30] As part of the augmented offer, Scania also offer Global Technical Support and Scania Assistance for when

[28] Service portfolio director, Scania AB, digital interview 2021-03-24
[29] Service portfolio director, Scania AB, digital interview 2021-03-24
[30] Service portfolio director, Scania AB, digital interview 2021-03-24

customers might experience disruptions.[31] All new vehicles are also offered with a warranty of one year. However, in markets where additional warranty is industry standard additional warranty is offered through *extended product coverage* which is a contract between the local dealership and Service Portfolio and Delivery.[32] Scania charges customers for any additional services. [33]

Scania are unique in their offering due to the competence they have built over time around connected vehicles. As a consequence, vehicle services that use the vehicles' own data, especially to maximize uptime, are really popular among customers.[34]

5.1.4 Summarizing description of Scania's offer in the diesel paradigm

Scania's offer in the diesel paradigm have been summarized in table 6.

Table 6. Summary of Scania's offer in the diesel paradigm.

Level	Attributes

Core customer value	• Not a truck, a tool in the customer's operations.
	• TOE/TCO
	  ○ Fuel economy
	  ○ Uptime
	• Driver's choice
	• Trust and peace of mind

Actual product	• Premium • Well-engineered diesel combustion engine • Generally compatible with bio diesel • High quality level • Support most applications in its class through the modular platform • Vehicles are connected since 2012 • Can be equipped with PTO

[31] Service portfolio director, Scania AB, digital interview 2021-03-24
[32] Product planning director, Scania AB, digital interview 2021-04-15
[33] Service portfolio director, Scania AB, digital interview 2021-03-24
[34] Service portfolio director, Scania AB, digital interview 2021-03-24

Augmented product	• Maintain the product properties over time
	• Extensive service offer
	  ○ Digital services
	  ○ Vehicle services
	  ○ Workshop services
	  ○ Financial services
	  ○ Rental services
	• Mainly workshop and vehicle services
	• Onboarding package of monitoring and basic maintenance plan
	• Global Technical Support and Scania Assistance
	• One year warranty + extended product coverage

5.2 General description of the technology shift

The automotive industry is arguably experiencing its biggest transformation since the introduction of the combustion engine, and a previously stable industry has become one of the most disruptive (Boulanger et al, 2011). International climate targets are frame setting for the continued path of sustainable transports. To reach the targets, the transport industry has to be fossil free by 2050, and decarbonization is the way to reach there (EU, 2017).

5.2.1 The diesel combustion paradigm

Diesel internal combustion engines are very well equipped for heavy duty vehicles due to their durability and high torque at low speeds (Tongur & Engwall, 2014). Internal diesel combustion engines are also reliable, efficient and have low operating-costs (Reşitoğlu et al, 2015). Diesel fuels have a higher energy density than gasoline and can therefore be driven for longer distances with the same amount of fuel. However, the diesel combustion engine only extracts about 30-50% of the fuel's energy potential, the rest is wasted through heat. The first diesel truck was introduced in 1920 and the technology have since then been improved a lot. Today's diesel engines are very fuel efficient but emits a lot of emissions (Tongur & Engwall, 2014). Even though the CO2 emissions are lower than those of gasoline, diesel emissions consist of many pollutants and is considered one of the largest contributors to exhaust emissions. These emissions have consequences not only to the environment, but also to human health (IEA, 2017). The four main

diesel emission pollutants are carbon monoxide (CO), hydrocarbons (HC), particulate matter (PM) and nitrogen oxides (NOX)(see figure 15)(Reşitoğlu et al, 2015).

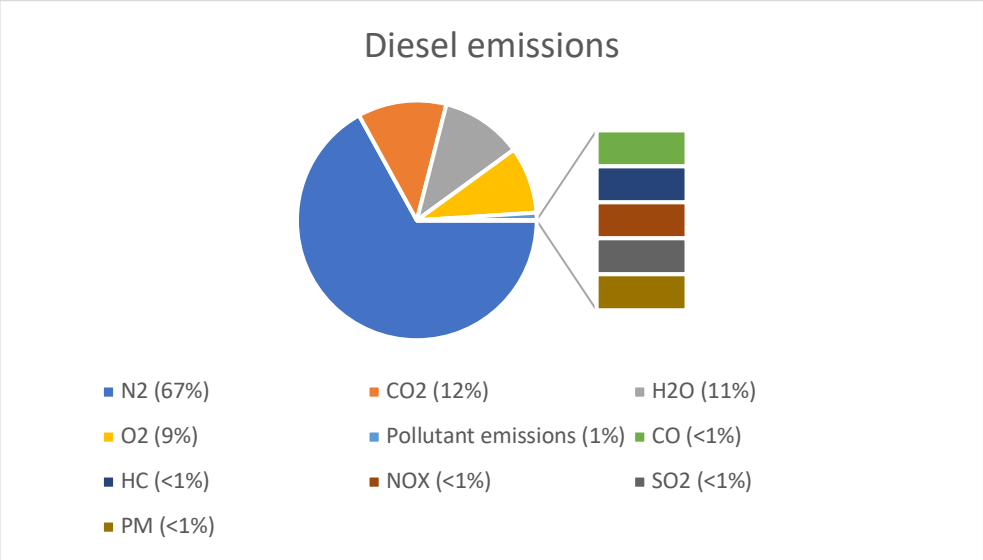

Figure 15. Diesel emissions. (Reşitoğlu et al, 2015).

The innovation focus since the introduction of the diesel combustion engine has been to increase the efficiency of the engine. However, the relative improvements are becoming more and more expensive and difficult to achieve. The center of innovation has therefore shifted towards creating engines that can run on biodiesel with less or no fossil fuel content and aftertreatment exhaust control technology that can better capture diesel emissions. These improvements can still only be seen as incremental innovation within the existing paradigm, and also imply their own restrictions. As an example, biofuels alone cannot supply the whole transport fleet and the production of raw material for the fuel is often criticized for conflicting with food production (Tongur & Engwall, 2014).

The business practice of the diesel paradigm has been to sell trucks to the customers on contractual basis according to customer specifications, which meant big initial investments for the customer. The customer therefore value reliability and fuel efficiency to decrease costs during the vehicle's lifecycle, thus making TCO a key measure in the industry. The manufacturers made most of their margins from after sale services such as maintenance and spare parts. Many truck manufacturers have in the recent time expanded their

offerings to additional services such as fleet management, leasing, driver training and fuel control systems to differentiate in an increasingly commoditized market. The new offering involves discussing needs with both haulage companies and their customers to capture benefits and savings in the whole transport delivery process (Tongur & Engwall, 2014).

The diesel paradigm's impacts on global and local emissions have challenged the technology's future existence. The transport sector is highly dependent on oil and also a big consumer, which makes them vulnerable to stricter political policies and limited supply (Tongur & Engwall, 2014; IEA, 2017; Boulanger et al, 2011). Being an industry responsible for much of the world's total emissions, a technological change in the transport industry is inevitable (EU, 2017).

5.2.2 The electrification paradigm

Even though electric powertrains have existed since the 20-th century, low oil prices and customer preferences meant that combustion engines dominated the transport industry during the preceding century (Kirsch, 1997). However, the transport industry today has major impacts on emissions globally and has to decarbonize one way or another (IEA, 2017; EU, 2017). There are many factors driving the shift towards a more sustainable transport system such as international and national policies (EU, 2017), the industry's dependency on fossil fuels, and the increasing demand for transports (IEA, 2017). Electrification is generally identified as a viable technology to decarbonize the transport industry (We et al, 2020). Electrification as a technology offer a much more efficient powertrain than the internal combustion engines does (IEA, 2017; EU, 2017; Tongur & Engwall, 2014). Electrification also gives the transport system access to renewable energy sources. Driving electric does not only improve global emissions but improves local emissions such as noise levels, air quality etc. (EU, 2017). Even though the initial cost of electric vehicles is significantly higher, lifetime costs are often lower, especially with cheap electricity and favorable policies (Boulanget et al, 2011).

Electrification has its own challenges though. Electric trucks today are limited in range compared to diesel, they are expensive compared to diesel trucks, and they need a significant ecosystem to be a viable option (Boulanger et al, 2020; EU, 2017). Even though electric and hybrid vehicles emit less emissions than diesel vehicles during the user phase, they can create significantly more during their production (EU, 2017). Electrification does not only change the powertrain either, but also the underlying mobility,

business and financing models (EU, 2017). Even though driving electric is a clear improvement of emissions compared to diesel combustion from a powertrain perspective, it is a much more complex relationship from a system perspective when including energy and battery production (Boulanger et al, 2011; IEA, 2017).

5.2.2.1 The technology in the electrification paradigm

5.2.2.1.1 Electric powertrains

Electric engines are very efficient and reliable. They can extract about 95% of the energy potential of a battery, and the whole electric powertrain converts about 85-95% of the electric energy to mechanical work. Electric drive is also safe, quiet, clean, and flexible. The engine also has the benefit of flexibility when being mounted on the chassis compared to an internal combustion engine, it can be fitted directly to the wheels as an example (IEA, 2017).

5.2.2.1.2 Electric vehicle types

Electric vehicles can have different levels of electrification depending on how much of the power that derives from an electric engine (see figure 16). When choosing vehicle type; range, energy consumption, performance, geographical constraints and temperature requirements needs to be taking into account. Which vehicle type that is the most beneficial to a certain application is difficult to determine beforehand (Berg, 2015). If the power source of the vehicle is not purely an internal combustion engine, the vehicle is considered electric. If the electric vehicle has two or more power sources, and at least one is electric, it is a *hybrid electric vehicle* (HEV). By saving regenerated energy from breaking, a HEV can improve the energy efficiency of the vehicle. A HEV can however not be charged from an external power source. A HEV can have different levels of electrification, from mild HEV that is unable to drive purely electric to the strong HEV which have the option of driving short distances in pure electric mode. If the HEV can be charged by an external power source, it is a *plug-in hybrid* (PHEV). It does, just like the HEV, combine electric engine power with combustion engine power to improve fuel or energy efficiency. The ability to charge externally makes it possible to drive longer distances electric but also longer total distances. A PHEV can often be driven in the modes of pure electric, pure combustion and hybrid (an optimized combination to the two). The battery capacity is higher in a PHEV than a HEV. Hybrid technology is however complex, and the *energy management strategy systems* are important to its performance. The most electric vehicle is the *battery electric vehicle* (BEV). It is also the technically simplest type of electric vehicles and is only powered by one or

more electric engines and one or more batteries. The range of a BEV is limited to the total battery capacity and by the way the vehicle is used. The BEV is also limited by the relatively long charging times. The flexibility and lower battery need offered in a HEV or a PHEV compared to a BEV makes hybrids a compelling option for the early phases of electrification (Berg, 2015).

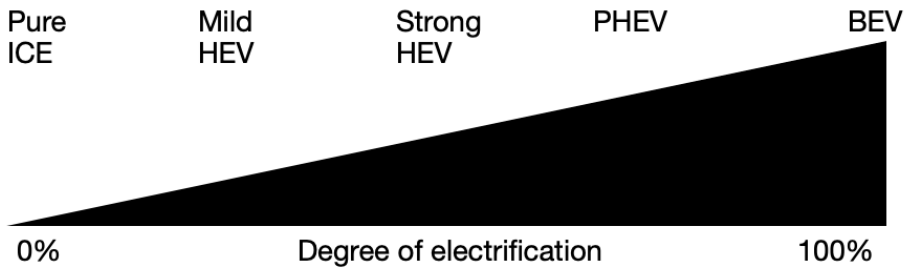

Figure 16, Electric vehicles. Adapted from Berg (2015) "Degree of electrification for different types of vehicles" (Berg, 2015).

5.2.2.1.3 Batteries

Maybe the most significant component in enabling electrification is the battery (IEA, 2017; Wu et al, 2020; EU, 2017). Nearly all challenges of electric vehicles can be traced back to the battery's limitations such as range, charging time and cost (Wu et al, 2020). Batteries store the electric power that the vehicle is charged with chemically and allows the vehicle to run for a limited time without the supply of an external power source. The most common battery type in heavy duty vehicles is lithium-ion batteries (Berg, 2015; Wu et al, 2020).

A good battery should not only be able to deliver and receive power, but also be robust, reliable, durable and require minimal service and maintenance (Berg, 2015). The speed of development in battery technology is increasing rapidly (Wu et al, 2020). However, the battery as an energy storage technology still implies some challenges in energy and power capacity, lifespan, safety and costs (Aphale et al, 2020; EU, 2017). From a sustainability perspective, battery life cycles also have implications to the environment.

The energy and power capacity of a battery is measured in energy density. The energy density of a battery is far less than that of fossil fuels which implies battery needs for similar applications are higher. Higher battery needs

in turn imply less loading capacity in the vehicle and high costs (Aphale et al, 2020). Especially for long-haul transport applications, big and bulky batteries may reduce cargo capacity in an unsustainable way (Tongur & Engwall, 2014). The battery also has to be charged regularly, which impose challenges to the daily operation as static charging takes far more time than refueling (Aphale et al, 2020).

The lifespan of the battery imposes an important challenge since they are costly to replace. The lifespan is impacted by the aging of the battery's physical properties, the operating temperature and the way the battery is charged and used. By using *battery management systems* (BMS), optimal use of the battery can increase the lifespan. From an economic perspective, batteries also offer an after-life opportunity. Batteries that are no longer fit for transportation can still have a second life potential for other applications. They may also be recycled as a way to cope with material scarcity (Apahle et al, 2020; Berg, 2015).

Batteries are sensitive to extreme temperatures. While a battery can be optimized for both higher and lower temperatures, it is difficult to optimize it for both (Apahle et al, 2020). Even though it may not be the most significant factor, operating temperature of batteries is important to maximize the capacity since the energy is lost if the battery is too cold (Boulanger et al, 2011). Lithium-ion batteries can experience problems charging already at temperatures as low as 10 degrees Celsius (Berg, 2015).

The safety aspect of a battery is also a significant challenge. Failures, such as overheating and demolition, does not only hurt the battery but can be a significant safety hazard. There are many safety actions that can be implemented to improve battery safety such as fuses, cooling systems, ventilation, and deformation frames. However, it is still an important aspect to keep in mind (Apahle et al, 2020; Boulanger et al, 2011).

Costs is maybe the most important challenge of batteries since the initial cost difference to combustion technology is one of the main barriers to widespread electrification (Apahle et al, 2020; IEA, 2017; Boulanger et al, 2011). Even though operating and maintenance costs are low for electric vehicles, the relatively high initial investment is repulsive to many customers (Boulanger et al, 2011; EU, 2017). Regardless of the higher initial investment, total cost of ownership of an electric vehicle is better than that of a combustion vehicle due to rebates, incentives, operating and maintenance costs (Boulanger et al, 2011). However, battery cost is reducing at high speed and dropped by 85% from 2010 to 2018. The potential for cost reduction is further enhanced by

replacing expensive material with less expensive substitutes, however at the cost of beneficial material properties (Apahle et al, 2020; Boulanger et al, 2011). Improvements in manufacturing practices will also be an important part of cost reductions as producing batteries is a very resource intensive process (Apahle et al, 2020).

Regarding the sustainability of batteries, the majority of a battery's environmental burden is done during its production and manufacturing phase. It's burden during the user phase is mostly determined by the energy it is charged with. Clever battery management systems is the most important way to manage the environmental footprint during the user phase. The end-of life aspect must also be considered from an environmental perspective as it involves recycling, discarding, landfilling etc. (Wu et al, 2020).

5.2.2.2 The ecosystem in the electrification paradigm

5.2.2.2.1 Charging infrastructure

Access to charging is proving to be one of the major barriers to the adoption of electric vehicles. Therefore, a proper infrastructure is crucial to the success of electrification (Boulanger et al, 2011; EU, 2017). The need for large expensive batteries can with a thorough charging infrastructure in place become less of a challenge to electrification, which may also enable electrified long-haul transports (IEA, 2017). Since building the charging infrastructure is an extensive project with many stakeholders, the implementation of the infrastructure has to be a joint effort between private and public actors (Boulanger et al, 2011). In the flowing section, the two charging types of dynamic and static charging will be covered from an infrastructure perspective.

5.2.2.2.1.1 Dynamic charging – electric road systems

Dynamic charging charge electric vehicles while they are driving (IEA, 2017). That is practically done through *electric road systems* (ERS) which support dynamic charging from the road on which the vehicle is travelling. ERS offer a viable supplement to static charging. The principles of an electric road can be seen in figure 17. Power is transferred from the grid to the road and is then transferred to the vehicle via some transfer technology (Tongur & Egnwall, 2014; IEA, 2017).

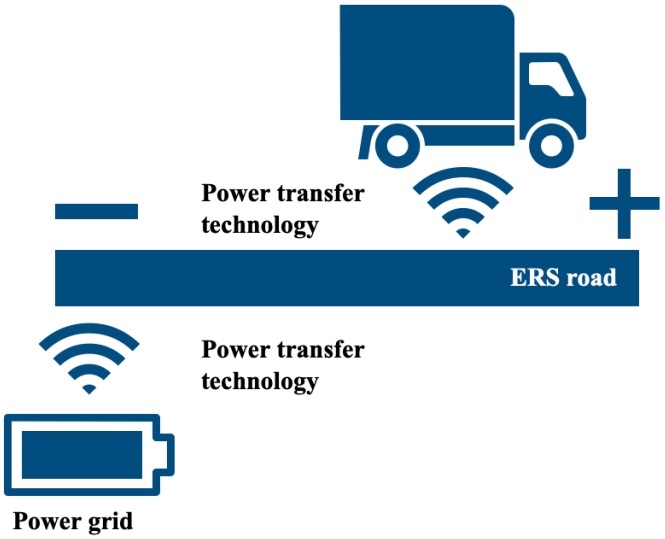

Figure 17. ERS principles. Adapted from Tongur & Engwall (2014) "Design principles of ERS" (Tongur & Engwall, 2014).

By enabling vehicles to charge while driving, smaller batteries are needed, and longer distances can be travelled electrically. ERS roads can be used by both hybrid and battery electric vehicles. Furthermore, vehicles travelling on electric roads will have the ability to do normal driving operations, such as overtaking and driving outside the electric road when needed. The vehicles however have to be fitted with the proper transfer technology to be able to accept the charging (IEA, 2017). The ERS has its relatively most important application where vehicles are utilized more frequently, like in commercial transport applications.[35]

There are two generic types of dynamic charging, *conductive* and *inductive*. Conductive charging requires contact to the ERS. As an example, the *Siemens System* requires over-head catenary lines above the road, and the vehicle requires the installation of overhead retractable pantographs (IEA, 2017). The second type of dynamic charging, inductive charging, does not involve contact but is based on electromagnetic fields. This system requires the installation of coils in the road and coils in the receiving vehicles for transforming the magnetic field into electric current. The deployment of this technology implies high costs, big obstruction to the infrastructure, and high material usage. This transfer technology also has a lower efficiency than

[35] CEO, ERS provider, physical interview 2021-03-09

connective charging technology. However, inductive charging may have beneficial application in urban areas, such as at bus stops and red lights (IEA, 2017).

Installing different technologies in the infrastructure implies problems in terms of standardization. In both national and international transportation, competing technologies would create problems. Even though a truck theoretically could run on both over-head charging and road charging, a more realistic scenario is that one will dominate.[36] As a result, it is necessary to have international collaborations to form proper standards (EU, 2017).

The installation cost of ERS is significant, and a kilometer of electric road can cost USD 1 million or more. Therefore, it is an important question who own and finance the development of such an infrastructure (IEA, 2017). The business model and value chain of ERS is not established yet. Many other actors in the ecosystem like power suppliers and frequent transport users may see significant benefits of electrifying road sections and therefore provide the up-front investment. The energy suppliers may then charge vehicles using the power transfer, either by charging for the power transferred or through a subscription-based model. Frequent transport users could also see benefits from savings on alternative costs by electrifying their main transport routes and use that as a rationale for providing the up-front investment.[37] However, the premium associated with recovering the infrastructure investments for electricity in the ERS compared to retail energy prices makes the viability of such business models questionable (Boulanger et al, 2011).

5.2.2.2.1.2 Static charging – charging stations

Static charging takes place when the vehicle is standing still, such as at the home depot or during loading and un-loading. The static charging infrastructure would create opportunities to charge when the vehicle is standing still, even during longer journeys. Static charging can be divided into fast charge and normal charge. The fast charging is similar to today's behavior of refueling, it reduces distance anxiety amongst customers and enables further travel distances (EU, 2017). The drawback of fast charging is that it is more harmful to the battery (Boulanger et al, 2011). The bulk of the charging infrastructure would however be normal charging points (EU, 2017). There are different charging standards around the world. The prevalent standard in Europe is the *combined charging system* (CCS). For the static charging infrastructure to work, there has to be a standard in place in terms

[36] CEO, ERS provider. physical interview 2021-03-09
[37] CEO, ERS provider. physical interview 2021-03-09

of communication, plugs, interfaces, power, installation, access; and also a high availability (Boulanger et al, 2011). It is also relevant to think about the availability of static charging at customers' sites and at the operator's facilities (non-public spaces) to enable charging when loading/unloading and when the vehicle is at the home depot (Taljegård, 2019).

5.2.2.2.2 Energy supply

The transport industry has always had a significant impact on the energy sector (IEA, 2017). Electrification would drastically increase the demand for electric energy. The current electrical grid needs to either support additional demand or be improved (Dyke et al, 2010; Taljegård, 2019). The energy market by nature is fluctuating both in supply and demand throughout the day, which makes it vulnerable to peaks and lows, such as similarities in charging behaviors amongst its users (Dyke et al, 2010; Taljegård, 2019; EU, 2017). Another aspect of the energy supply is that even though electric driving emits no local emissions the electric operation can only be regarded as fossil free if the electric power is from a renewable energy source. Simply running on electricity may not be an improvement to diesel combustion in terms of the global emissions if the electricity production is carbon intensive (such as the burning of coal). The relative life cycle improvement of electric vehicles is therefore very dependent on the decarbonization of energy production as well (IEA, 2017; Taljegård, 2019; Wu et al, 2020; Boulanger et al, 2011; EU, 2017). Unfortunately, most renewable energy sources are variable in nature which makes the supply uncertain. Wind and solar radiation vary in space and time causing the production to fluctuate and it needs to be accompanied by sophisticated systems for optimizing usage and storage (Taljegård, 2019). However, the technology is being improved, and the ability to produce renewable energy will only increase (Ehrlich & Geller, 2017). According to Dorr & Seba (2020) a 100% renewable energy system replacing the resource-based energy system is possible before 2030 and is also the cheapest alternative long-term. They anticipate that solar power, wind power and storage batteries are becoming 70% cheaper in 10 years and thus make the technology more and more viable. The renewable energy system would be able to provide not only the existing demands, but also the needs of a fully electrified transport system (Dorr & Seba, 2020). Connecting vehicles to the gird would also create a potential to use their storage capabilities to stabilize the energy market (Boulanger et al, 2011; EU, 2017).

5.2.2.2.3 Policies and regulations

Policies and regulations enable the shift both from a manufacturer and a customer perspective (IEA, 2017; Boulanger et al, 2011). Examples of policies could be giving and restricting access to geographical areas, deploying necessary infrastructure, and creating international standards for charging (EU, 2017). In "quiet zones" and "clean zones" in cities, electric drive is (basically) the only alternative. Governmental policies may not only penalize the use of fossil fuels, but also give incentives to adopt the electrified solution and build the necessary infrastructure (IEA, 2017). Furthermore, policies can improve the TCO of electric trucks compared to diesel trucks signifying the comparatively higher initial investment. By offering help to install charging stations or give rebates on the initial investment, policies could also help "jump-start" electrification. Instead of discussing the costs of electrifying the transport system, the hidden alternative costs of not doing so to society due to environmental issues should be central in the policy making discussions (Boulanger et al, 2011).

5.3 Description of the technology shift at Scania

5.3.1 Transitioning from diesel combustion to electrification

Scania electrify because it is good for the customers and because it is a critical step towards the goals of Strategy 2025.[38] Scania have realized that electrification is an important candidate to satisfy customer needs and can economically demonstrate that electrification is the most attractive technology long-term. However, if the customers' needs are not benefited by electrification, such as if the customer have insufficient charging infrastructure, they shall not electrify yet. Which technology that is suitable for a customer in other words depends on the customer's needs.[39]

When studying cost parity, the technology that is available today is compared with the new technology. When electric solutions reach the same cost as the contemporary solutions, there is no major economic boundary to substitute one technology for another. However, cost parity is just one part of the shift. Since the transport ecosystem is not fully developed, the products are not viable for all applications yet.[40]

[38] Senior advisor, Scania AB, digital interview 2021-04-16
[39] Senior expert, Scania AB, digital interview 2021-03-31
[40] Senior expert, Scania AB, digital interview 2021-03-31

In practice, the shift starts with closed logistic systems. The simplest example is a larger industry with transport flows within the own facility. It is already today possible to transfer such a closed system to electric transports. Electrification will also early be a viable solution in cities where the own internal traffic can be precisely monitored. The development then continues with longer distances where it is no longer possible to have a closed transport system. Even though it is already economically interesting to electrify such a system, it will take longer since more stakeholders needs to be involved. The slowest part in electrification is building enough grid capacity.[41] The infrastructure must guarantee its users that their vehicles reach the customer, in time, at predictable cost. If the infrastructure is trusted, the market will shift.[42]

The technology shift is almost a societal transformation in itself. In principle nothing of what is done today can be done in the same way. As an example, the design of a petrol station is not suitable for charging needs. Mobility with the help of electricity is totally different from today. It's a system thinking and a system transformation in every aspect, both regarding services, products and society. All parts need to be reimagined for the system to work.[43]

From a technological perspective, hybrid vehicles may be an attractive solution due to the robustness for the user that the fully electric BEV can't offer today. BEV vehicles are, on paper, already outperforming the contemporary technology regarding cost and earning capacity. Therefore, PHEV is a feasible alternative during the transition, BEV is already today outperforming contemporary technology, but the system is not fully developed yet.[44]

However, the combustion technology will probably not disappear. For the next 10-20 years the interviewee believes there will be a transition period and still doesn't believe electrification totally erases the combustion vehicles from the market. Combustion engines have their advantages also in the future. The combustion engine offers the last percentage of transports where charging is not possible, like when transports from day to day are very different or in those parts of the world where electricity is not accessible enough. In most other cases BEV will take over.[45]

[41] Senior expert, Scania AB, digital interview 2021-03-31
[42] Senior advisor, Scania AB, digital interview 2021-04-16
[43] Senior expert, Scania AB, digital interview 2021-03-31
[44] Senior expert, Scania AB, digital interview 2021-03-31
[45] Senior expert, Scania AB, digital interview 2021-03-31

5.3.2 Scania's technology strategy in electrification

Electrification is a major part in Scania's work of transforming into a decarbonized transport system. Electrification is the main direction for the transport industry to reach zero carbon emissions in time for 2050, and therefore a key aspect of Scania's Strategy 2025 commitments (Scania AB, 2019). Traton group (where Scania is an affiliate) will spend 1 billion euros on electrification R&D until 2025 (Scania c, 2020).

Scania does not build a separate venture for electrification, the way Scania does it is incorporating it throughout the whole organization from the beginning. All departments still work with today's normal business while at the same time introducing electrification. Electrification is not profitable now, the next year or in the nearest future, but Scania will start to gain from electrification when they sell high volumes of electric solutions – today it is an investment period. Once most new trucks are electric, electrification will already be a part of the day-to-day business at Scania. If every mechanic, salesperson and businessperson is to feel like electrification is the new normal at Scania, then it has to be part of the normal processes which today is almost exclusively based around the combustion engine.[46]

From a more technical perspective, since Scania have chosen to have a modular toolbox, they are quick to adapt to new technologies since they don't have to develop separate technical platforms. They adapt the components and integrate them to the platform they already have. The modularity hence makes it easier to spread electric solutions.[47]

According to one interviewee, many actors believe it is the responsibility of society to build the necessary infrastructure for electrification, but the ones that do investments themselves creates an advantage by creating their own business opportunities. Therefore, it is important for Scania to be in the forefront of the shift, however that may mean that Scania seek good partnerships and alliances rather than creating the whole ecosystem in-house.[48] To remain the most competitive supplier in the market Scania has to drive the shift. Scania realized more than a decade ago that the technology was coming. If Scania wanted to drive the shift, they had to shift first and pave the way.[49]

[46] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19
[47] Product planning director, Scania AB, digital interview 2021-04-15
[48] Senior expert, Scania AB, digital interview 2021-03-31
[49] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19

5.4 Description of the shift's consequences to Scania

5.4.1 Consequences to Scania's offer

5.4.1.1 Core customer value

The customer doesn't ask for an electric truck, they want to electrify their transports. They then expect Scania to provide the expertise, scenarios and solutions to have the transformation as painless as possible.[50] Even though electric trucks cost significantly more to purchase, they will offer a better TOE and TCO than their predecessor. The interviewee therefore believe that TCO and TOE will play an even more important role as a core value in the electrified era.[51] Customers use their vehicles as commercial work-tools and have to make money from them.[52] If it is cheaper to perform the same transport on electric power, few customers will demand to transport with diesel fuel.[53] In the beginning however, customer uncertainty will be big, and as a result it will be harder to convince the customer about the TOE.[54]

The customers have also started to request more sustainable solutions, which is something Scania have long offered but not previously seen the same willingness to pay for.[55] This is a result of Scania's customers' customers demanding more green transports.[56]

5.4.1.2 Actual product

Exteriorly, the design of the electric vehicles can be very similar to the contemporary trucks. The customers, just like before, will still expect a modern work tool which is "state of the art" when electrifying. The most obvious difference is that the vehicles drive much quieter. However, the human machine interface (HMI) in the cabin is adapted, the digital platform of the vehicles will be improved to handle new digital services, and the vehicle will provide the driver with a better overall customer experience.[57]

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[50] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19
[51] Service portfolio director, Scania AB, digital interview 2021-03-24
[52] New technologies director, Scania AB, digital interview 2021-04-12
[53] Senior advisor, Scania AB, digital interview 2021-04-16
[54] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[55] Strategy director, Scania AB, digital interview 2021-04-09
[56] Electrification director, Scania AB, digital interview 2021-04-19
[57] New technologies director, Scania AB, digital interview 2021-04-12

Like previously mentioned, the electric vehicles cost significantly more than their predecessor initially, mainly due to the cost of the batteries. However, the operational cost of electric vehicles are generally anticipated to be lower than those of diesel vehicles due to lower maintenance needs and better energy efficiency.[58] The electric powertrain does not have the same need for oil and filter changes since the technology is replaced by an engine with fewer moving parts.[59] However, it is important to remember that the electric fleet today is too small to draw solid conclusions about the maintenance needs.[60] Nevertheless, as a consequence, the operating cost compared to initial cost is a major difference that makes the long-term economy of electric vehicles better. However, the lower maintenance need is a relatively small part of the TCO, but less frequent visits to the workshop may have a positive effect on the customers' TOE.[61] The vehicle is also much more than its powertrain. Components like springs and tires still need to be replaced and maintained. There are also new types of components that are subject to maintenance, such as the battery's cooling system. In total however, less maintenance is anticipated to be needed, by how much is something Scania will learn over time. As a consequence of the new relationship between operational and initial cost, the utility rate of electric vehicles becomes very important. It is first with high utility rates that the customer benefits from better energy efficiency. It therefore becomes important to provide the customer with high uptime. Therefore, the quality also becomes an important aspect. The simpleness and robustness of the electric powertrain have implications to the quality of the electric vehicle, the quality is anticipated to be just as good if not better than previously.[62] An electric vehicle however has many advanced components such as battery, energy transfer, and charging. Electric vehicles will therefore be just as sensitive to disruption for a certain time period as diesel vehicles, but over time the electric vehicles will experience less problems than the diesel vehicles.[63]

[58] Product planning director, Scania AB, digital interview 2021-04-15
[59] New technologies director, Scania AB, digital interview 2021-04-12
[60] Service portfolio director, Scania AB, digital interview 2021-03-24
[61] Product planning director, Scania AB, digital interview 2021-04-15
[62] New technologies director, Scania AB, digital interview 2021-04-12
[63] Product planning director, Scania AB, digital interview 2021-04-15

Apart from the better quality and operating economy of the electric powertrain, an important consequence is also the significantly lower emissions "well-to-wheel" of electric vehicles. The system effectivity of a BEV is also much better than that of diesel vehicles, almost 73% from well-to-wheel compared to about 27% for a diesel combustion powertrain. Furthermore, the "tank-to-wheel" efficiency of an electric powertrain is almost 100%.[64]

Another obvious difference to the vehicle is the battery. Initially, the vehicle is restricted in many ways by the energy density of the battery. Diesel fuels have extremely high energy density, and the customer can perform most tasks with a full tank. The diesel tank can also be modified to fit most chassis configurations. In the initial phase of electrification, that is not the case for some applications. Batteries are heavy and also need a certain geometry to function properly. Batteries are as a consequence not as flexible to tailor to different chassis configurations. This will be a restriction for some applications until better energy density is achieved. Bigger batteries also penalize the loading capacity which has negative effects on the customers' TOE.[65] Scania must go from being best at combustion powertrains to understanding how battery and powertrain fit together as a system. The goal is to have an efficient truck with minimal battery needs that can perform the toughest tasks. That in turn imply lower capital investments and maximum loading capacity to the customer.[66]

The refueling (or charging) of the vehicle is also a major consequence to the actual product. It is much more complex to charge than it is to refuel.[67] The charging takes time and limited capacity reduces the distance that can be travelled, which has consequence to the vehicle's flexibility and productivity.[68] The vehicles will initially be charged over night with low power transfer. For vehicles who need to charge during shorter breaks megawatt charging will be needed, a technology which is not in place today. That implies big adjustments to the infrastructure. Scania believes in different methods of charging depending on customer needs. When deciding charging solutions, it is important to see it from a system perspective.[69]

[64] New technologies director, Scania AB, digital interview 2021-04-12
[65] New technologies director, Scania AB, digital interview 2021-04-12
[66] New technologies director, Scania AB, digital interview 2021-04-12
[67] New technologies director, Scania AB, digital interview 2021-04-12
[68] Product planning director, Scania AB, digital interview 2021-04-15
[69] New technologies director, Scania AB, digital interview 2021-04-12

The shift also has consequences to what it means to be premium in the market. During the diesel paradigm, providing a premium truck meant offering the best truck and foremost the best diesel combustion engine in the sense of fuel efficiency and durability.[70,71] Scania have spent many years to refine its diesel powertrain. When it comes to electrification, there are a lot of things that Scania have no historic competence in.[72] To remain premium Scania need to find additional or other premium aspect of the electrified vehicle that can replace the unique selling points of the diesel powertrain and give the customer the same sense of premium quality.[73] According to one interviewee, the meaning of premium to the product will become offering the customer the best profitability in their operation.[74] As a consequence, the solution become the new premium aspect of the vehicle.[75,76]

Scania will offer different levels of electrification. The electrification starts with hybridization through PHEV.[77] Hybrid vehicles is an important market since they are a first step towards electrification. They can be bought and used before the charging infrastructure is fully developed while also driving in areas where combustions engines are prohibited.[78] The main track at Scania however is BEV since they are efficient, but as a complement Scania work with hybrids until BEV is a viable solution for greater adoption. Scania have already launched its first PHEV and BEV.[79] The applications offered by Scania will not particularly change as a consequence of electrification. The new vehicle sales reflect the total market pretty well already. However, from the perspective of charging it is a huge difference between vehicles returning to the home base daily and vehicles that rely on public charging infrastructure. It is therefore easier to create electric solutions for urban transports initially, and Scania may experience more applications in that segment than previously.[80]

[70] Service portfolio director, Scania AB, digital interview 2021-03-24
[71] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[72] Product planning director, Scania AB, digital interview 2021-04-15
[73] Electrification director, Scania AB, digital interview 2021-04-19
[74] Service portfolio director, Scania AB, digital interview 2021-03-24
[75] Service portfolio director, Scania AB, digital interview 2021-03-24
[76] Strategy manager, Scania AB, digital interview 2021-04-09
[77] New technologies director, Scania AB, digital interview 2021-04-12
[78] Senior advisor, Scania AB, digital interview 2021-04-16
[79] New technologies director, Scania AB, digital interview 2021-04-12
[80] Product planning director, Scania AB, digital interview 2021-04-15

The modularity with standardized interfaces and interchangeable components will still play a major role to the actual product as a way to offer the customer the best electric solutions. The future toolbox will however consist of some new components, such as an optimized toolbox of batteries. The modularity is an important part in remaining premium according to the interviewee.[81]

Electric vehicles can be equipped with PTO as well, but instead of the engine or the gearbox the battery is used as an energy source, which is often referred to as an e-PTO. A challenge with the PTO regarding electrification is that many independent PTO workshops don't have the competence yet to build e-PTOs, so it is important to offer e-PTO from the factory.[82] Scania must continue to offer the opportunity to add PTO for various applications in a pain-free way. Scania also need to find a clever way to share battery capacity between the vehicle and the PTO since some applications will consume a lot of electric energy from the battery.[83]

5.4.1.3 Augmented product

Services will become a much more important part of the offer. Customers will want to buy complete solutions, or in other words bigger parts of the transport ecosystem. That implies a broader service offering and totally new service domains to Scania.[84] Many of the new service-components will also come from partners to an increasing extent.[85] To remain premium, Scania must broaden its service offering and start thinking of services outside the vehicle. It becomes necessary to offer charging services, battery solutions, logistics solutions, etc.[86]

Scania must grow in the areas "uptime" and "predictive models. The two areas of predicting and monitoring will according to the interviewee be the key to future services. Furthermore, it is most likely within the digital services the service portfolio will grow the most.[87] Since electric powertrains have a lower need for repairs and maintenance, significantly fewer workshop hours are anticipated to be needed, which is an important revenue stream of Scania today. To maintain and grow revenues, Scania need to find new ways – and

[81] New technologies director, Scania AB, digital interview 2021-04-12
[82] Product planning director, Scania AB, digital interview 2021-04-15
[83] New technologies director, Scania AB, digital interview 2021-04-12
[84] Service portfolio director, Scania AB, digital interview 2021-03-24
[85] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[86] Service portfolio director, Scania AB, digital interview 2021-03-24
[87] Service portfolio director, Scania AB, digital interview 2021-03-24

digital services are anticipated to be a good candidate.[88,89] Since much of Scania's competitive edge is built around the vehicle and workshop services, Scania must become much better at the digital services. The digital services will not only prove that the vehicles deliver as they did when they were new, but also that the customers' operations deliver at their best.[90]

However, many of the contemporary services will remain important.[91,92] It will still be interesting to increase the drivers' performance, but the focus will shift from lowering fuel consumption to how drivers can affect the valuable battery's life and range. The support systems that exist today regarding the transport planning will also continue to be important, but with a focus on planning electrified routes and charging. Workshop services such as repair and maintenance contracts will also still be important, but customers that electrify early will probably choose more advanced and predictive repair and maintenance contracts. Electrification is new to the customers and they have no experience to rely on. Therefore, they may be willing to pay a premium for transferring some of the risk to Scania. Service Level Agreements contracts thus become more important as a consequence.[93]

Some of the totally new services will be surrounding the charging and the battery. The battery is the most expensive component in the electric vehicle, and the customers may know nothing about batteries. The customers will therefore want services that ensure their most valuable asset is used in an optimal way.[94]

If diving deeper into the digital services in the electrified era, there is no such thing as one digital service offering that fits all customers. As a consequence, Scania need to offer a portfolio of digital services that complement each other or are modular in a way that they fit together according to individual customer needs. Therefore, Scania need to develop a digital service ecosystem where services are interconnected with each other. The complexity is significantly higher than before, and services must interact with each other. However, the

[88] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[89] Service portfolio director, Scania AB, digital interview 2021-03-24
[90] Service portfolio director, Scania AB, digital interview 2021-03-24
[91] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[92] Service portfolio director, Scania AB, digital interview 2021-03-24
[93] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[94] Service portfolio director, Scania AB, digital interview 2021-03-24

digital experience is a micro perspective of electrification and Scania should look at the full customer experience including vehicle, charging infrastructure and digital experience.[95]

Today, the onboarding of Scania is the free monitoring package and the basic maintenance plan. To convince customers to electrify, those two services may not be enough. Customers may want reports of the TOE of electrifying their fleet, environmental plans justifying the benefits to their customers of the electric alternative etc. Customers today rely on experience, but now they have to rely on Scania's experience. As a consequence, customers will need more services to get them started and to support them along the way.[96]

5.4.1.4 Solution provider in the electrified era

Previously, electrification at Scania has mostly been around the products, such as the powertrain and the battery. The electrification of the product is important but a fairly small part of offering the ecosystem and solution that is needed in the electrified era. The expression solution provider cannot be directly translated between transport ecosystems according to the interviewee. In a new electric transport ecosystem, to be a solution provider imply the capability to capture many more of the prerequisites of the new transport ecosystem. To be a solution provider now means a bigger commitment and may even involve the whole ecosystem from providing energy to helping customers perform their transports without interruptions.[97] According to one interviewee, Scania have always been a solution provider. However, in the beginning a solution was one truck, with no services. Scania has since then extended the solution with more trucks, busses, engines etc. Now, Scania want to leverage the solution provider meaning to new levels with services outside the traditional scope of Scania.[98] It is however important to emphasize that the service trend is not just something that happens at Scania, but a megatrend amongst many *original equipment manufacturers* (OEMs) in many industries.[99]

[95] Strategy manager, Scania AB, digital interview 2021-04-09
[96] Service portfolio director, Scania AB, digital interview 2021-03-24
[97] Senior expert, Scania AB, digital interview 2021-03-31
[98] Service portfolio director, Scania AB, digital interview 2021-03-24
[99] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01

The journey towards a solution provider is accelerated by electrification since services around electrification becomes more important. In the electric era, offering the full solution become more important since everything that is needed around electric transports isn't obvious to the customer.[100] The supplier that offers the best combination, or solution, will be perceived as premium.[101]

According to one interviewee, the consequences of the shift to being a solution provider is mainly about understanding which new problems the customer faces. Scania as a consequence must think about how to make electrification easy and understand how it affects the customer, and if customers in some cases shouldn't electrify yet. Customers will still want to transport, and Scania must understand how to make it easy for them. In the beginning that may imply Scania needing more knowledge than the customers and transferring some of the risk from the customer. Since electrification in many cases is a better solution to the customer, Scania should however help them electrify if it is the best solution available for them.[102]

The customer doesn't buy the vehicle for the vehicle, but as a tool in their operations to fulfill another purpose. A solution provider, as a consequence, offers the combination of vehicles and services that yields the best solution to the customer. From the customer's perspective it doesn't matter if the efficiency gains come from the vehicle or the services. Scania must make a mind-set shift and not see services and products as separate parts, but as a unity that together help the customer solve its problems. They need to shift from thinking more efficient vehicles to more efficient transport systems.[103]

[100] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[101] Strategy manager, Scania AB, digital interview 2021-04-09
[102] Strategy director, Scania AB, digital interview 2021-04-09
[103] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01

5.4.1.5 Summarizing description of the consequences to the offer

The anticipated consequences of the shift towards Scania's offer have been summarized in table 7.

Table 7. Anticipated consequences to Scania's offer.

Product level	Consequences
Core customer value	• Offer better TOE • Increasing interest in sustainability as a core value

Actual product	• Likely similar exterior design
	• Extended digital platform
	• Electric powertrain
	  ○ Quieter
	  ○ Lower maintenance needs
	  ○ Higher quality
	  ○ Lower emissions
	  ○ Better system efficiency
	• Higher initial cost
	• Lower operational cost
	• Premium becomes best profitability, not best engine
	• Battery becomes an important aspect of the vehicle
	• Charging is more complex than refueling
	• Modularity is still important
	• PTO driven by battery instead of engine or gearbox

Augmented product	• Services become more important to the overall offer • Customers want complete solutions, implying bigger parts of the ecosystem • Many new service domains for Scania • More services are offered through partners

	• Need to grow in uptime and predictive models • Onboarding needs increases • Digital services grow the most • Workshop services decreases due to lower maintenance needs • Customers may want to transfer risk to Scania • Being a solution provider imply a bigger commitment than in the diesel paradigm • Electrification accelerates the solution provider maturity • The best solution becomes premium in the market • A mind-set shift at Scania from selling services to enhance vehicles' performance to sell solutions to offer more efficient transport systems

5.4.2 Consequences to Scania's business model

The technology shift of electrification enables many new business models to Scania. Even though Scania and its customers have probably thought of other business models before, such as "vehicle-as-a-service", it is not until now that the interest amongst customers and Scania has actualized such business models. Since the battery is such an expensive component in comparison to the rest of the vehicle, the customers' ability to pay up-front is lower. As a consequence, fewer customers are able to make the initial investment with the contemporary business model. Electrification also implies uncertainty and risks to the customer, and the customer will not want to take the whole risk with electric vehicles themselves. Electrification thus becomes an accelerator for finding new business models to compensate for the challenges that arises through new cost and revenue structures, uncertainty and different service needs.[104]

[104] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01

Scania have not decided on one single business model for electric vehicles. Scania is both looking at the vehicle as a service and the transport as a service. Furthermore, different public subsidies for electrification in different markets imply different business models. To make the most out of electrifying, the business model must be adapted to local prerequisites. Scania have therefore created a modular toolbox of business models with different service levels and different ways to pay. The business model will be adapted according to customer needs just like any other thing at Scania.[105]

5.4.2.1 Value proposition

When it comes to the value proposition, it is important to always think about what the customer is willing to pay for, it doesn't matter if it happens in a solution or in individual services. It is about understanding which components at what time that creates a positive experience for the customer and a competitive advantage to Scania.[106] Customers use their vehicles as commercial work-tools and have to make money from them.[107] Scania furthermore talk about themselves as an actor in the transport system and not a supplier of vehicles.[108] As a solution provider of electric vehicles, Scania therefore strive to be the best integration to the customer regardless of the transport system.[109]

The customer sees Scania as much more than just a manufacturer of steel. Scania is obsessed with "customer first", and the customer processes mind-set is something very distinct to Scania. As a result, when customers find something new, they first ask Scania to have an overview of what is possible. Moving to electrification, customers would love to have Scania deliver everything. The customer doesn't expect Scania to manufacture chargers, but they expect Scania to provide charging solution experts who solve the challenges of charging.[110]

Electrification is the next step in Scania's current value proposition. With Scania, the customer has the most efficient, most reliable transport solution available on the market. Being an expert on providing the best solutions, Scania have for a century provided the customer with better and better

[105] Electrification director, Scania AB, digital interview 2021-04-19
[106] Strategy manager, Scania AB, digital interview 2021-04-09
[107] New technologies director, Scania AB, digital interview 2021-04-12
[108] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[109] New technologies director, Scania AB, digital interview 2021-04-12
[110] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19

efficiency, reliability, uptime, TCO and TOE based on the combustion engine. Now, Scania believe that the new electric technology will be, in the nearest future, the most efficient and reliable solution. The only difference is that Scania extend the offer with a new technology base. What replaces the combustion engine other than the electric powertrain is offering the best packaged solution in the electric ecosystem.[111] Another interviewee also believe that the value proposition Scania have chosen will remain as important. It will however be delivered with another technology with other prerequisites which means Scania must focus on new areas, such as batteries and charging technology.[112]

Scania is in a fundamental transport ecosystem transformation. As a consequence, Scania have started talking about a transport ecosystem and the necessary surrounding services. Electromobility (eMobility) is everything needed around an electric transport flow, that today is going from (primarily fossil) fuels and their transport system to an electric system. eMobility is in other words everything needed to support an electric transport system and can incorporate everything from energy to components.[113] From a service perspective the difference of the value proposition when comparing diesel trucks to electric trucks will be the new perspective of a service ecosystem. The purpose of the service ecosystem is to reduce the complexity that the customer will encounter in eMobility. The challenge is to harmonize charging, transport planning and operational factors, which becomes much more difficult to handle and predict. The consequences to the value proposition from a service perspective is therefore about making planning and transports in an electrified way easy, preferably as easy as in the previous diesel paradigm. Hence, Scania need to develop services and ecosystems that enable simplicity in a way that a customer can focus on their core operations, and not on operating different service systems.[114]

Another important consequence to the value proposition is that it becomes even more important with uptime. Since the vehicles cost more to purchase but offer better operating economy, uptime becomes more important in the electric paradigm to cover the investment over time.[115]

[111] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19
[112] Electrification director, Scania AB, digital interview 2021-04-19
[113] Senior expert, Scania AB, digital interview 2021-03-31
[114] Strategy manager, Scania AB, digital interview 2021-04-09
[115] Strategy manager, Scania AB, digital interview 2021-04-09

5.4.2.2 Customer segments

Scania believe they will target the bigger customers to an increasing extent as a consequence of the shift. The reason is that customers don't only substitute their vehicles but their whole transport system, which is challenging to smaller customers.[116]

One interviewee believes the customers will still mainly be haulers. The customers that will drive electric will be a subset of the customers who are today driving with combustions engines. However, Scania also face customers where their solutions have not previously been competitive. It is about building the business, not just the technology.[117]

Another interviewee also say Scania assume the customer segments will be the same. However, Scania don't have the product available yet for all customer segments. The goal is to have at least the same and maybe an extended range of customers and applications in the electrified era.[118]

Scania will likely also see a new customer segment who will choose to electrify as a way to offer their customers sustainable transports.[119]

5.4.2.3 Channels

Scania already have strong channels to their customers, and for that reason one interviewee don't think the contemporary channels will change.[120] However, with electrification Scania will have access to a bigger part of the customers' business. Scania will now access the energy as well. From that point of view, electrification becomes an opportunity. Scania would never think of extracting crude oil, build gas stations – and will neither produce electricity. However, Scania might be owning the technology and the data of the battery which gives them the opportunity to advice the customer on how to optimize the battery use. Scania believe they will have a good chance not only to maintain but also to extend the channels to the customers.[121]

Like previously mentioned, onboarding is important to sell and deliver digital services to customers. The onboarding becomes a new important channel that has to improve due to the bigger need for onboarding in electrification.[122]

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[116] Electrification director, Scania AB, digital interview 2021-04-19
[117] Senior expert, Scania AB, digital interview 2021-03-31
[118] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19
[119] Electrification director, Scania AB, digital interview 2021-04-19
[120] Electrification director, Scania AB, digital interview 2021-04-19
[121] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19
[122] Service portfolio director, Scania AB, digital interview 2021-03-24

5.4.2.4 Customer relationships

Electrification has more consequences to the customer relationships than to the channels according to one interviewee. The customer gets a stronger relationship to Scania as a consequence of electrification. Since electrification is a whole system transformation, Scania must lead customers through it.[123] It is however a natural step to Scania's contemporary solution mind-set. For Scania who are always into customers and solutions, electrification is a big step towards stronger customer relationships. As an example, if the current combustion engine truck breaks down, customers can choose to turn to Scania or to competing workshops. However, in electrification customers are initially much more reliant on Scania.[124]

5.4.2.5 Key partnerships

Scania will have to work with partners to an increasing extent when embracing the necessary ecosystem thinking. There are many aspects to the ecosystem that needs to be in place for electrified transports, and Scania need to supply those to the customer either themselves or through partners. Some parts of the ecosystem are often better supplied through a partner. With charging as an example, the best competence is more likely found from a partner closer to the energy industry.[125] Through partnerships, Scania try to navigate through new areas that they identify as important to the ecosystem going forward, but in which they have no prior competence. Partnerships is a risk mitigated way forward to access new technology or new business models.[126] Partnerships increase significantly in importance due to electrification.[127,128] Scania foremost need partners in the areas of charging and energy.[129]

[123] Electrification director, Scania AB, digital interview 2021-04-19
[124] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19
[125] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[126] Electrification director, Scania AB, digital interview 2021-04-19
[127] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[128] Electrification director, Scania AB, digital interview 2021-04-19
[129] Electrification director, Scania AB, digital interview 2021-04-19

For long-haul customer applications, a public charging infrastructure will be needed. No actor will want to invest everything needed for a public infrastructure before they are certain there will be vehicles to charge, and no customer wants to electrify before they know there are charging opportunities. The partnerships then become an important way to share risks amongst actors with a shared interest in electrification.[130]

Scania have already started the work of developing the necessary ecosystem through partnerships. Scania is a key advisor in the Ministry of Infrastructure and Road Authority and provide input over policies and actions in the transport system, and also participate in various ERS projects globally. Scania have also invested in companies in the ecosystem such as Northvolt who develops sustainable battery cells (Scania AB, 2019). Scania also work with key customers such as Norwegian hauler Asko who have committed to zero emission transports to develop better solutions.[131] Scania is also part of the Pathways Coalition which consists of Scania, Siemens, E.on, and H&M which jointly work to overcome challenges with the future transport system (Scania AB, 2019). Scania also have a partnership with Engie and EVbox who install energy solutions.[132] Furthermore, Scania is part of a consortium that develops batteries for transport applications.[133]

5.4.2.6 Key resources

Scania's competence within the electric powertrain is not yet as strong as for the diesel combustion powertrain. As a consequence, Research and Development is moving resources to build new competence.[134] Scania does however have a lot of data, history and experience from their diesel solutions which is an important resource of Scania that they build many of their services from. When a bigger share of the fleet is electric, Scania will know all the things they know today about diesel trucks at least as good if not better than before.[135] Scania will especially need competence regarding the battery which is anticipated to be a very important aspect of the offer. They need to know how batteries degrades as well as how to develop software around the battery.[136] Scania have also built their own battery pack factory to secure their battery needs.[137]

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[130] Electrification director, Scania AB, digital interview 2021-04-19
[131] New technologies director, Scania AB, digital interview 2021-04-12
[132] Electrification director, Scania AB, digital interview 2021-04-19
[133] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19
[134] New technologies director, Scania AB, digital interview 2021-04-12
[135] Electrification director, Scania AB, digital interview 2021-04-19
[136] New technologies director, Scania AB, digital interview 2021-04-12
[137] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19

Furthermore, Scania's connected vehicles will be very valuable in a more digital service landscape. The big challenge is asking the right questions. In electrification, Scania don't know yet what the customers will want to know from their digital services but are confident that the answers are already embedded in the data.[138] The connected vehicles have been and will be an important resource to Scania.[139]

Like mentioned before, Scania initially focus the electrification on their bigger customers. Scania will as a consequence have to increase the resources targeted at working with the bigger customers.[140]

The workshops are a key resource to Scania. The lower maintenance needs that have previously been discussed may impact the role of the workshops. However, the workshops are very skilled at adapting and can take new responsibilities tied to electrification to find a new role as key resource in the electric business model.[141]

It is also a strength to own a major part of the retail network since Scania can push electrification to the markets and give them all the resources needed to make the transformation. In that way, Scania can educate their retailers so they can offer electric solutions.[142] The retail network can also help Scania with risk sharing in the new business models.[143]

When transferring to electric vehicles, the customers have an increased need of services to guide and support them in their operations. As a consequence, Scania have to develop services and systems to support the salesforce in selling and delivering more complex electric solutions. This is new areas that needs to be handles on top of or prioritized against already existing activities.[144]

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[138] Service portfolio director, Scania AB, digital interview 2021-03-24
[139] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[140] Electrification director, Scania AB, digital interview 2021-04-19
[141] Strategy director, Scania AB, digital interview 2021-04-09
[142] Electrification director, Scania AB, digital interview 2021-04-19
[143] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[144] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01

To be able to tailor an optimal solution for the customer in the electrified era, Scania need to use its product modularity competence in their own and in their partners' services.[145] The demand to have partners in the modular toolbox will be higher in the new ecosystem.[146]

5.4.2.7 Key activities

Batteries becomes a very important part of the eclectic vehicle. In combustion engines, costs are fairly similar between different customers and applications, but batteries are such a significant cost and impact to loading capacity that battery needs must be tailored to every single customer and application. Tailoring battery needs becomes a key activity in the future to minimize initial cost and maximize capacity.[147] Handling the residual value of the batteries also becomes an important activity as batteries may contain a significant value also after its primary application.[148,149]

Another key activity becomes risk sharing. Many of the new business models imply Scania overtaking some of the customers' risk. Transferring risk from the customer to Scania is also one of the center points in a business model increasingly focused towards selling uptime.[150]

A key activity today is to develop a top tier engine and combustion technology with high performance, low fuel consumption, and high quality. Now, Scania must develop electric engines and batteries instead that offers the same total level of quality, which means new competences and new knowledge regarding electric powertrains.[151]

A key activity will also be to guide the customer through electrification. Scania will have to support customers to help them electrify. Since Scania believe that sustainability will become an increasingly important factor to customers, a key activity could also become providing them with evidence about how electrification improves their sustainability.[152]

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[145] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[146] Senior expert, Scania AB, digital interview 2021-03-31
[147] New technologies director, Scania AB, digital interview 2021-04-12
[148] New technologies director, Scania AB, digital interview 2021-04-12
[149] Strategy director, Scania AB, digital interview 2021-04-09
[150] Strategy director, Scania AB, digital interview 2021-04-09
[151] Strategy director, Scania AB, digital interview 2021-04-09
[152] Strategy director, Scania AB, digital interview 2021-04-09

It will also be important for Scania to position themselves in the value network, in particular to build charging possibilities for the customers. As a consequence, an important activity becomes to influence the ecosystem e.g., through partnerships.[153]

To offer customers complete solutions, Scania will have to become better at constructing them. As a solution provider Scania will have to put together a combination of products and services that give the customers the best solution to perform their commitments.[154]

5.4.2.8 Revenue streams and cost structure

One interviewee believes that if Scania changes business model it has consequences to the revenue streams and cost structure. If Scania as an example guarantee customers green energy, new costs arise from buying green energy, implementing charging infrastructure etc. In a business model where Scania sell vehicles as a service; service and maintenance becomes a cost to Scania rather than a revenue stream. The consequences to the cost structure and revenue streams are in other words dependent on what business model that is applied in each case, and many different business models are possible in electrification.[155]

Another interviewee also believe that the shift has consequences to the cost structure and revenue streams. Previously, Scania invested resources into producing a vehicle, and the customer covered the investment more or less immediately by purchasing the vehicle. By providing additional services, mainly workshop and vehicle services, more revenue was ensured over the lifecycle of the vehicle. However, in business models where customers pay more or less incrementally, it takes longer time for Scania to retain its investments.[156]

Today there are many questions regarding what the battery implies to the business model. At some point the battery is no longer enough for the transport application it was intended for. What happens then? There may be enough capacity left for other transport applications or energy storage solutions. Scania must therefore learn how to capitalize on the battery.[157]

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[153] Strategy director, Scania AB, digital interview 2021-04-09
[154] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[155] Electrification director, Scania AB, digital interview 2021-04-19
[156] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[157] Electrification director, Scania AB, digital interview 2021-04-19

5.4.2.9 Summarizing description of the consequences to the business model

The anticipated consequences to the business model have been summarized in table 8.

Table 8. Anticipated consequences to Scania's business model.

Building block	Consequences
Value proposition	• Electrification is an extension of Scania's contemporary value proposition, but with a new technology base • Scania need to offer a bigger part of the transport eco system and harmonize it to make the shift to electrification easy for the customer • Offering uptime becomes increasingly important
Customer segment	• Customers are still mainly haulers, but electric solutions may also be competitive in new foremost sustainable segments • Scania anticipates to initially target the bigger customers • Scania anticipate increasing demand from a sustainable transport segment
Channels	• The contemporary channels remain important • Accessing the energy aspect of transports offers a new channel

	• Onboarding becomes more important to convince customers to electrify
Customer relationships	• Customer relationships become stronger • Customers are more reliant on Scania than before • It is a natural step in Scania's solution value proposition
Key partnerships	• Partners will offer some parts of the eco system. • Partnerships are a risk mitigated way to access new technology and business models • Partnerships can be used to share risks in infrastructure development
Key resources	• Development resources are transferred to electrification • Scania initially don't have access to as much data and experience as they are used to • Need new competence, especially regarding the battery • Connected vehicles are even more important in a digital landscape • More resources are devoted to the targeted customer segment

	• Workshops adopt a new role as key resources in the business model • Since Scania own a major part of the retail network, it becomes a key resource for pushing electrification into the markets and share risks • The service organization becomes more important to the deliver the business model. • Modularity in services becomes a key resource
Key activities	• Tailoring battery needs • Risk sharing • Develop electric technology • Guide customers through electrification • Build the ecosystem • Construct eMobility solutions with the customer
Revenue streams and cost structure	• If the business model change, the revenue streams and cost structure change • In which ways depends on what business model that is applied • Revenue streams become more incremental • The battery may have consequences to the business model

5.4.3 Consequences to Scania's resources and capabilities

5.4.3.1 Description of anticipated consequences to Scania's resources and capabilities

To be a solution provider it is important to decide the intentions and make sure all resources and capabilities necessary are possessed by the company or its partners to deliver the solution. That entails amongst other things having the organization, decision structures, processes, products and services in place.[158] A solution provider does not offer a product and tell the customer why they need it. A solution provider understands the customer's needs and use its capabilities of own and partners' modules to, as an entrepreneur, create a solution that help the customers fulfill their needs.[159]

The electric solution implies many consequences to Scania's capabilities related to the technology shift. Starting off with the development, Scania must change the way they work and become better at handling uncertainty and more diffuse customer needs, at least during the transformation.[160] During the diesel paradigm Scania had an intuition of what improvements would offer the customer more value and improved its solutions accordingly. With electrification, development is much more uncertain and customer demands are not as predictable as they were before.[161] Scania must therefore build a capability to develop with a faster and more iterative process to mitigate the consequences of uncertainty.[162] To be successful in that, Scania need to look for new ways to work and new ways to think. It is therefore also important to mix experts from the previous paradigm with people that think new and differently.[163] As a matter of fact, Scania are currently undergoing the process of renewing the whole development process towards being more agile.[164] By working in agile value-streams, time consuming "hand-offs" during projects are anticipated to be eliminated and better solutions to be produced.[165] Scania have also created an organization to build minimal viable products and business models to test them before they undergo a more thorough development process. It is an important capability that is now in place in its first version. Scania have understood that capabilities to adapt and reorganize

[158] Strategy director, Scania AB, digital interview 2021-04-09
[159] Senior expert, Scania AB, digital interview 2021-03-31
[160] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19
[161] Electrification director, Scania AB, digital interview 2021-04-19
[162] Electrification director, Scania AB, digital interview 2021-04-19
[163] Strategy manager, Scania AB, digital interview 2021-04-09
[164] Electrification director, Scania AB, digital interview 2021-04-19
[165] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01

to new technology is important, and they get better and better at it.[166] Furthermore, when service development grows more important, Scania have to start thinking services from the beginning just as much as they think products when developing the offer.[167] The challenge from this perspective is that service development is much faster than vehicle development, so coordinating the two is difficult. The services also encounter more competition, and the service developers must work intense and iterative to keep up. Scania work hard to make service and hardware development keep pace with each other to deliver uniform solutions.[168]

From a hardware development perspective, Scania have to build a capability to develop electric components just as good as they developed hardware for diesel combustion vehicles.[169,170] Many of these components are completely new to Scania.[171] Scania is heading there today, the nature of the engineering profession means learning new things every day, and it is therefore not controversial to move from one technology to another over time. However, new knowledge is needed, but the interviewee believes that the people already working at Research and Development can learn to develop electric solutions. However, when recruiting new people, a background within electrification is particularly attractive.[172] Furthermore, from a capability perspective it is a strength that Scania have a lot of resources for development and as a consequence can invest in a fast transformation. In securing the capability to develop the important battery, Scania is building a battery factory and are co-owners of Swedish battery manufacturer Northvolt.[173]

If Scania want to be a real solution provider, they have to think service just as much as they think product when developing, and Scania is not there today. Scania on company level has to do a mind-set shift from thinking that services make the product more attractive to thinking complete solutions where services and products complement each other. That mindset shift is currently happening at Scania.[174] In that sense, Scania is not organized as a solution

[166] Electrification director, Scania AB, digital interview 2021-04-19
[167] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[168] Service portfolio director, Scania AB, digital interview 2021-03-24
[169] Senior expert, Scania AB, digital interview 2021-03-31
[170] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19
[171] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19
[172] Senior expert, Scania AB, digital interview 2021-03-31
[173] Electrification director, Scania AB, digital interview 2021-04-19
[174] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01

provider today according to one interviewee. Products are developed by Research and Development and services are developed by Service Portfolio and Delivery. Furthermore, the product is then managed by the business areas of trucks, and services managed by the business area of services. If Scania would be organized as a solution provider, the product manager of trucks would not be responsible for the product "trucks" but the solution "trucks and services". From a development perspective, when launching a new product as a solution provider it would naturally be with services that support the product. To some extent this is done today, but it requires a lot of unnecessary coordination.[175] However, as a response to the broader solution perspective, the service development function at Scania is strengthened as a consequence of the shift.[176]

Even though development capabilities are very important, the rest of the organization will also have to handle electric vehicles, or in other words a capability to sell, maintain and package everything with electric power in it. That means a transformation not only at the headquarters, but in all of Scania. Everyone must be capable of handling the new offer.[177]

Scania need to prepare the salesforce to sell and deliver electric solutions.[178] The salesforce must also adopt a new capability to help customers in the transition to the new technology. The salesforce has a very steep learning curve ahead, but also need good support.[179] Therefore, a needed capability is to equip the salesmen with the knowledge, tools, and support systems that allow them to put together an optimal combination of products and services together with the customer.[180] Scania can never convince customers to buy solutions that are sold in a complicated way. Customers expect to see one salesperson who understand all their needs and create a solution with products, contracts, services etc. and present them with one price. The salesperson must also be flexible towards adapting the solution in discussion with the customer. This implies that the salesforce must be supported with the right tools and systems.[181] Furthermore, even though the retail network strives

[175] Internal processes director, Scania AB, digital interview 2021-03-23
[176] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[177] Senior expert, Scania AB, digital interview 2021-03-31
[178] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19
[179] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19
[180] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[181] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19

to offer the customer the best solution, it is unnecessarily difficult today.[182] The salesforce according to one interviewee have to craft solutions themselves since there is no sufficient system for it, they therefore handle separate orders, invoices, etc. but still manage to provide the customer with one solution. Even though services need to be locally adapted to some extent, a solution provider must have a process for the four activities of offering, ordering, invoicing and delivering solutions.[183] The retail network as a resource could therefore be used better to improve Scania's offer through central support. After all, a transport solution is created with the customer for the customer at the dealership, with some parts of the solution originating from Scania and some from local providers. The retail network according to the interviewee is very important in being successful in crafting the best solutions.[184] How Scania offer the solution, and perform it internally, will be the differentiating factor in the market. Without the sufficient supporting systems, very few will be able to sell the electric solutions.[185] It's not about doing everything right from the headquarters, the most important thing is to supply the retailers in the markets with the capability to sell and deliver solutions.[186]

Anticipating being a premium solution provider in the electric era, the customer expects Scania to offer more individual customization than their competitors. The customer should get the most tailored solution to their needs as possible, while at the same time using a collection of standard components from Scania's perspective. Therefore, it is very important to master being modular in both products and services. Scania must stop selling package A, B and C and start selling tailored solutions to the customers. Scania will also need to be able to add modules from external partners with the services that Scania will not be able to offer themselves. That will however become a very complex system. Today, Scania don't use modularity in services to the same extent as in their vehicles.[187] The process maturity of service modularity is a few years behind that of products. A possible reason may be that product development is slower, and modularity is a way to ensure flexibility for customer needs in the meantime. Services on the other hand are developed

[182] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[183] Internal processes director, Scania AB, digital interview 2021-03-23
[184] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[185] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19
[186] Strategy director, Scania AB, digital interview 2021-04-09
[187] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01

much faster and can more easily be adapted along the way with an agile approach. The pressure on finetuning the service process has therefore not been as prominent before. Scania have however started implementing a modularity thinking also for the service portfolio.[188] Practically, for digital services that imply having a common base but the ability to make minor adaptions to local market or customer needs. For workshop services, it implies building the supporting systems and processes in a way that local workshops can make minor adjustments across markets with the same base. This capability is about having as much common as possible, but still allow variation that can improve the customer experience. Furthermore, delivering electrification also means physical changes. Workshops has to be adapted to service electric vehicles, which might include extending the electric supply in the workshops and provide other tools and processes.[189]

The capability to offer more advanced business models is something Scania need to develop further.[190] The capability to manage risk is especially important. The center of gravity in selling uptime is taking on more risk. It is very profitable to do so, especially with the capability to assess risks better than the competitors. Scania are aware of the value of risk and have worked many years to improve their risk capabilities. Scania's quality process, their extended product coverage and their predictive services are also important capabilities in that sense.[191] Furthermore, Scania already today deliver Service Level Agreement contracts, mainly as repair and maintenance contracts. Scania therefore already manages risks in various ways. There are therefore definitely capabilities within the company regarding risk management according to the interviewee.[192] A strong risk capability is to share risk in a clever way between the customer, Scania centrally, and the retail network. Since Scania own most of the retailers, they have an advantage in finding better arrangements to share risk. The risk should be shared between many actors, and the internal processes for that are probably easier to create than when involving external actors. External actors would maybe not want to take the whole risk themselves, and OEMs would then need to take the whole risk to offer such business models. One interviewee believes

[188] Service portfolio director, Scania AB, digital interview 2021-03-24
[189] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[190] Shift director, Scania AB, digital interview 2021-04-14 & 2021-04-19
[191] Strategy director, Scania AB, digital interview 2021-04-09
[192] Service portfolio director, Scania AB, digital interview 2021-03-24

that most of Scania's risk competence is today found in the Financial Services department.[193]

Scania must also develop a capability to understand and monitor the whole new eMobility-system. Scania must understand and interact with a much bigger part of the transport ecosystem than before by collaborating, building partnerships and creating alliances. This becomes important to a solution provider in order to offer a full solution that meet the customers' whole needs.[194] Firstly, an important capability will therefore be to coordinate within the company. Some parts of the solution will be developed by Research and Development, some by Service Portfolio & Delivery, and the owner of the whole eMobility solution will be the business area of electrification. In order to create an ecosystem that works smoothly and fit in the solution picture, strong coordination is needed.[195] Secondly, Scania must have the capability to participate in the ecosystem. They must have the capability to build partnerships, find ways to guarantee access to charging, and participate in the infrastructure development.[196]

In the increasingly digital service landscape, Scania has the benefit of an installed base of connected vehicles in different countries and applications. Scania also owns the right to use the data for the purpose of developing and delivering services. Scania also have experts at different levels for processing and analyzing data such as data scientist and platform developers in-house. The big challenge is to ask the right questions to extract the value from the data. It is not known yet what customers will want to know in the electrified era from the digital services, but within the data, Scania probably already possess the answers.[197] Connected vehicles have been a competitive advantage to Scania, and it will help them also going forward. If Scania takes a different role in the transport system, they need the capability to ask other questions and collect different data. Scania have a very good analytical capability when it comes to digital services but can be even better and do more. However, the data collection from connected vehicles gives Scania a very good starting point.[198]

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[193] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01
[194] Senior expert, Scania AB, digital interview 2021-03-31
[195] Strategy manager, Scania AB, digital interview 2021-04-09
[196] Senior expert, Scania AB, digital interview 2021-03-31
[197] Service portfolio director, Scania AB, digital interview 2021-03-24
[198] Service strategy director, Scania AB, digital interview 2021-03-25, 2021-03-25 & 2021-04-01

5.4.3.2 Summarizing description of the consequences to the resources and capabilities

The anticipated consequences to Scania's resources and capabilities have been summarized in table 9.

Table 9. Anticipated consequences to Scania's resources and capabilities.

Consequences to Scania's resources and capabilities
Electrification change the way Scania must work due to faster and more uncertain development
Scania work more agile as a consequence with minimal viable products and hypothesis-based development
Scania need the capability to develop electric powertrains
The battery as a resource may become important and Scania are therefore building a battery factory and have partnered with battery cell manufacturer Northvolt
Scania have to do a mind-set shift from thinking services as a way to enhance product performance to thinking solutions where services and products complement each other
The service organization is strengthened to develop services and systems to improve the solution
The salesforce needs a capability to support customers in electrification which imply new knowledge, tools and supporting systems
The sales force also need the capability to sell and deliver solutions implying new knowledge, tools, systems and processes
Scania must be modular in both products and services
Delivering electrification also imply adaptions to the workshops
Scania need a capability to offer more advanced business models, such as the capability to manage risk
Scania need a capability to understand and monitor the new ecosystem
Connected vehicles have and will be a competitive advantage of Scania

6. Analysis

In the following chapter, the empirical findings will be analyzed by using the technology shift steering wheel to draw general conclusions from Scania's anticipated consequences. The chapter will start by analyzing Scania's offer in the diesel paradigm. Then the technology shift in general and the technology strategy of Scania will be analyzed. The chapter will then analyze the consequences based on the three perspectives of offer, business model, resources and capabilities. The chapter will end with a summarizing analysis of the three perspectives and how they are part of a system in the technology shift steering wheel.

6.1 Analysis of Scania's offer in the diesel paradigm

The three product levels emphasize that the physical product is just one aspect of an offer. Each level is associated with more and more customer value, and all three levels will be evaluated by the customer.

6.1.1 Core customer value

Customers don't buy a truck for the metal and the rubber; they buy it as a tool for performing some sort of transport task. Looking at Scania's customers, the core of what they buy is first of all, since the trucks are used commercially, lifetime cost and earning potential. Customers hence choose Scania since its quality and specifically its engine offer a low operating cost (due to high fuel efficiency and low maintenance needs) as well as high uptime (due to quality and robustness). Furthermore, the comfort and work environment of Scania's trucks is something that appeals to many drivers and makes them choose Scania. Customers furthermore appreciate the trust and peace of mind they associate with Scania.

6.1.2 Actual product

It is evident that the qualitative engine and comfortable cabs position the vehicle as premium. The engine is the flagship and offer both reliability and low fuel consumption. The trucks can furthermore be adapted to more or less any transport application in its class due to the distinct modular system and ability to fit PTOs. Each vehicle also has the hardware necessary to be connected and transfer relevant data to Scania.

6.1.3 Augmented product

The truck is offered with an extensive augmented offer which induce the core and physical product through services by improving uptime, reducing risk, and reducing cost. The augmented offer consists of digital-, vehicle- and workshop related services that improve the vehicle and its performance. The

financial services and rental services reduce risk and give customers flexibility. Scania also offer customers an on-boarding package, market standard warranty as well as assistance and support to make it extra appealing.

6.1.4 Summarizing analysis of Scania's offer in the diesel paradigm

The contemporary offer of Scania is summarized in figure 18:

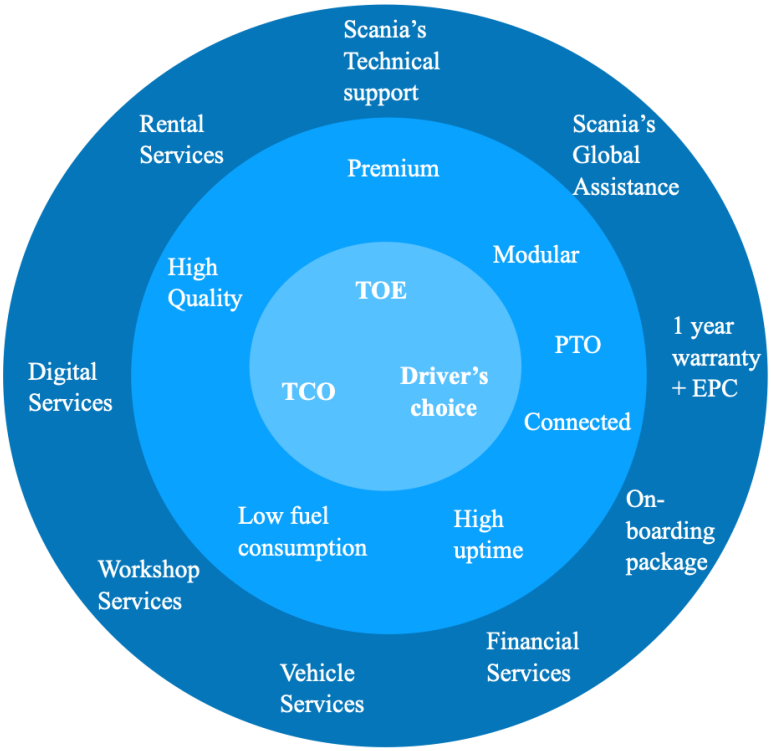

Figure 18. Scania's contemporary offer.

6.2 General analysis of the technology shift

As the theory suggests, electrification started with the "macro-invention" of the general-purpose technology electricity. The applicable fields of electricity are many and electrifying the transport system is a natural step. It is a general understanding that electrification is a key technology in the future transport system to decarbonize the transport industry and meet the global climate targets. The innovation efforts regarding electrification are not only tied to powertrains, but they also incorporate electric road systems, power grids, business models etc. That implies a new technical industry level paradigm.

It is becoming harder and more costly to improve the diesel engine through efforts in innovation. Diesel combustion has recently only experienced incremental changes in the form of minor efficiency improvements, the introduction of biodiesel and the development of exhaust-after-treatment-systems. The shy performance improvements in comparison to engineering effort is all in accordance with the nature of the technology s-curve (see figure 19) and indicates the end phase of the diesel paradigm (blue curve). At the same time, electrification as an emerging technology drastically changes each aspect of the transport system. Electrification still faces a lot of challenges, but many factors point towards a fast efficiency increase as the charging infrastructure is in place, customer uncertainty is eased, and companies redirect their resources and efforts to developing electric solutions (red curve). When electrification is the superior alternative, it will take over. In the meantime, the two technologies will probably co-exist in parallel (the transition period), either for niche applications where electric vehicles are not feasible or as supplements to each other in hybrid vehicles. The electric technology is already in cost parity with diesel, and as soon as the necessary ecosystem is in place electrification will grow while the diesel combustion technology stagnates. However, there is also an inertia in the adoption as the majority of the contemporary fleet, that may have many years left on their lifecycles, are diesel combustion vehicles. The ecosystem capabilities are not evenly distributed globally either, such as grid capacity. Incremental adaption in biofuels and exhaust purification is therefore important supplements on the way to decarbonize. To conclude, the industry is indeed experiencing a technology shift from the century long lasting paradigm of the diesel combustion technology to the clean, quiet and economic electrification. A complete transformation however doesn't happen overnight or might never happen.

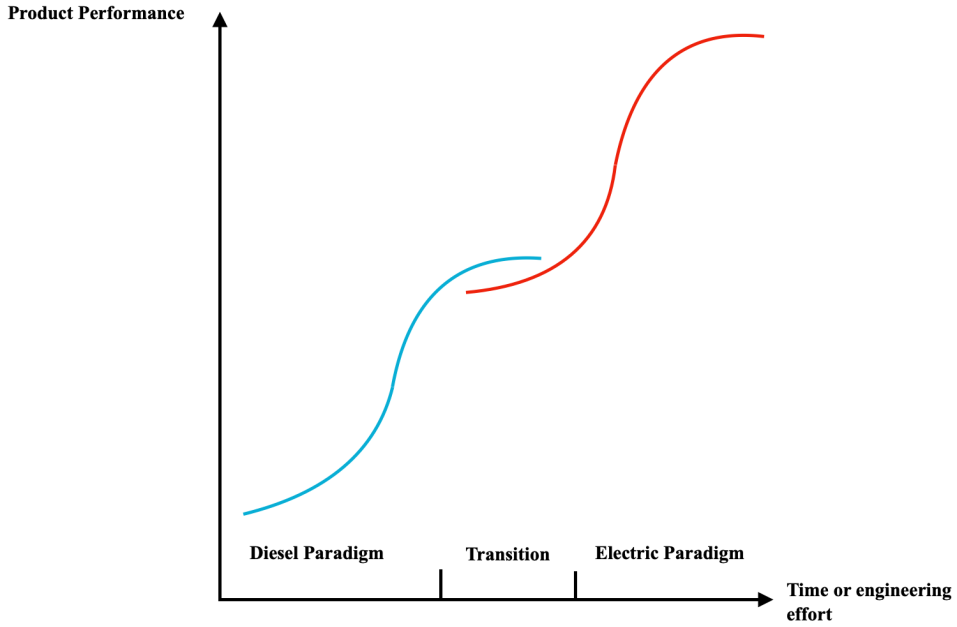

Figure 19. the technology shift from diesel combustion to electrification.

6.3 Analysis of the technology shift at Scania

The company's strategy guides its choices and determines its direction but should also differentiate it from the competitors. Since electrification is a major difference to the company's technology base, the technology strategy they apply is particularly essential to the consequences of the shift. Technology strategy is about how the company acquire, manage and exploit technology. Scania have a very concrete mission of driving the shift, partly in order to build themselves a competitive advantage by being part of creating the ecosystem. Scania does as a result make heavy investments in the technology and the ecosystem.

Scania acquire the technology from in-house development and through external partnerships. The partnerships are targeted at both hardware and services in the ecosystem, see Northvolt and EVbox as examples. From a managing perspective, Scania have decided to already from the beginning incorporate electrification in the organization as the new normal at Scania. Scania's modular strategy is also important from a managing perspective since incorporating electric components in the products is relatively easy. From an exploiting perspective, Scania electrify because it's anticipated to be beneficial to their customers and the technology is exploited through the solutions they provide. However, if the customer buys the transport service *uptime* instead of a vehicle, the exploitation of the technology can be regarded

as internal since the technology is used as a way for Scania to in a more reliable and cost-efficient way offer the customer transport solutions. Replacing the technology may hence imply that solution-based business models become more viable since electric powertrains offers a more robust technology which leverage on high utility rates. The analysis of Scania's technology strategy can be seen in table 10.

Table 10. Analysis of Scania's technology strategy.

Strategic aspects	Adopted strategy
Acquire	• External partnerships • In-house development
Manage	• Incorporate electrification as an everyday process from the beginning • Build electrification on the contemporary modular platform
Exploit	• Through solutions based on the new technology

To conclude, a technology shift changes the core technology of a company, and they likely have to rethink their technology strategy. They need to find ways to acquire the new technology through inhouse development or external partners, they need to understand how to incorporate the new technology through internal capabilities without cannibalizing on the contemporary technology in the meantime and may have to reevaluate how to exploit the technology through their offer and business model.

6.4 Analysis of the consequences to Scania and general consequences

6.4.1 Consequences to the offer

6.4.1.1 Core customer value

When studying the consequences to the offer, it is prevalent that the previous life-time economy core value will become even more important to the customer. The relationship between initial cost, operational cost and earning potential is a major difference to the product. The vehicle cost more to purchase but is anticipated to have lower maintenance needs and to be more energy efficient in return. Many customers will also likely electrify as a consequence of their customers demanding green transports, which makes

sustainability a valid reason to buy the electric trucks from Scania. To guide customers regarding the TOE and sustainability, Scania will need to provide them with more on-boarding.

To conclude, the consequences to the core customer value are that the lifetime-economy becomes even more important, and sustainability becomes a new core to some customers. From a general perspective, customers may want to buy the same or additional cores.

6.4.1.2 Actual product

Externally, there is no reason to make any major changes to the vehicle, but the diesel combustion powertrain is replaced by an electric powertrain with electric engines and batteries as a consequence of the shift. The powertrain provides better system effectivity, lower emissions and improved robustness. However, the electric vehicles have initial challenges regarding loading capacity, range and refueling. Tailoring battery needs and understanding what services the customer needs around the battery becomes very important. The modularity is therefore still a strategic component to create solutions. Furthermore, the PTO will no longer be energized by the engine or gearbox, but through the battery. Lastly, as the technology matures it will be as good if not better than its predecessor due to its robustness.

To conclude, the actual product is externally likely very similar to its predecessor, but the technology shift has consequences to the traditionally most significant component of the vehicle, the powertrain. The new technology offers many better properties, but also come with challenges that have to be over-bridged by the augmented offer. However, the battery is anticipated to be an important part of the actual product, and most challenges are in consistence with the theory consequences of the battery. From a general perspective, a technology shift implies improvements to the actual product, or a shift would not be needed. However, the new technology may also imply challenges to how the actual product is designed or how it is used, and the most critical aspects of the actual product may change as a consequence of the shift.

6.4.1.3 Augmented product

The need for different services generally increases as a consequence of the shift. Since the ecosystem of eMobility involves more components than before, providing the customer with a full solution becomes very important. That may also imply providing some services from external partners. A solution provider in electrification is not the same as a solution provider in

the diesel combustion paradigm, it incorporates much more. The outcome however to the customer is the same, a transport solution. This is very closely tied to what it means to be premium in the electrified era. It is no longer about the engine; it's about offering operational efficiency to the customer (TOE) through a solution of vehicle and services. Since workshop hours are anticipated to be needed to a less extent, digital services become even more important. Digital services are also important to become a premium solution provider since they can harmonize the service ecosystem to make electric transports as easy as in the diesel paradigm and bridge the challenges of electrifying for the customers.

In conclusion, the shift implies an increasing service need due to the complexity of eMobility, and as a consequence the augmented offer becomes a key aspect in making electrification as easy and viable as possible to the customer. It is also primarily the solution that makes the offer premium, not the actual product alone. From a general perspective, the changes the technology shift implies means that these challenges have to be overbridged by the augmented offer. In that sense, technology shift may change the inbound importance of different aspects to the overall offer.

6.4.1.4 Summarizing analysis of the consequences to the offer

The analysis of the consequences to the offer have been summarized in table 11.

Table 11. Consequences to the offer.

Levels	Consequences to Scania	General Consequences
Core customer value	The consequences to the core customer value are that the lifetime-economy becomes even more important, and sustainability becomes a new core to some customers.	From a general perspective, customers may want to buy the same or additional cores.
Actual product	The actual product is likely externally very similar, but the technology shift has consequences to maybe the traditionally most significant technology of the vehicle, the powertrain. The new technology offers many improvements, but also come with its challenges to how the vehicle is designed and used. However, the battery is anticipated to be an important part of the actual product, and most challenges are also tied to the battery.	A technology shift implies improvements to the actual product. However, the new technology may also imply challenges to how the actual product is designed or how it is used, and the most significant component of the product may change as a consequence of the shift.
Augmented product	The shift implies an increasing need of different services due to the complexity of	The challenges of the technology shift have to be over-bridged by the augmented offer. In

	eMobility, and as a consequence the augmented offer becomes a key aspect in making electrification as easy and viable as possible to the customer. It is also the solution that makes the offer premium, not primarily the actual product.	that sense, technology shifts may change which part of the offer that is perceived as the most important.

6.4.2 Consequences to the business model

The business model can be regarded as a way to connect the technological core to the fulfillments of customers' needs and to describe how an organization creates, delivers and capture value. Radical changes in the company's environment may affect the business model. Technology shifts can therefore be a significant threat to especially mature companies. Heavy investments in the company's technical competence or transforming the value proposition will not be sufficient alone to handle a technology shift. Both technological and business model innovation is necessary. Scania's electrification started with the product technology but has now become a business model question as well. Many new business models become relevant as a consequence of electrification, especially as a result of the new relationship between initial cost, operational cost and earning potential as well as the ecosystem perspective. Scania have therefore not decided on one single business model and adapt the business model to customer needs. As a consequence, Scania explore a modular approach to business models with different levels of services included and different ways to pay for them. Generally, since the business model is used to connect the technological core to the fulfillment of the customers' needs, and a technology shift replaces the technological core, it is not surprising that technology shifts have consequences to the business model. In the preceding paragraphs, the consequences to the nine building blocks of the business model canvas will be analyzed.

6.4.2.1 Value proposition

The value proposition constitutes how the offer create value to the customer. Electrification is a fundamental ecosystem transformation and Scania as a consequence must include a bigger part of the ecosystem in its value

proposition. The system is also much more complex, and Scania's value proposition will be to harmonize the system for the customer. That implies moving deeper into the logistic systems and the customers' operations. However, the value proposition can be seen as an extension of the value proposition Scania already have. Scania have previously offered the best transport solutions to the customer, but now it's about offering the best solution based on new prerequisites and a new technology that is better for the customer in many cases. However, maintenance needs are anticipated to be lower and customer uncertainty may mean that Scania must take more risk and responsibility. Scania must therefore to an increasing extent sell uptime in their business model.

To conclude, the value proposition is an extension of the contemporary value proposition of offering the customer the best solution, but now with an additional technology at hand. Offering the solution imply harmonizing the transport ecosystem packaged as uptime. In general, shifts thus have consequences to the value proposition in the sense that offering the same value to the customer imply much more to the OEM, and what is sold is very different even though the job to be done is the same.

6.4.2.2 Customer segments

The customer segments consist of customers with similar needs, behaviors or attributes, and are considered unique if they require a distinct offer or are willing to pay for certain aspects of the offer. The customer segments of Scania's electric solutions are mainly anticipated to be a subset of the haulers they serve today. Many of the early electrifiers are larger customers with the capabilities to transform their transport system. However, Scania anticipate increasing interest from customers who chooses their electric solutions for their sustainability. Furthermore, some segments whose needs were previously not satisfied by Scania's offer may now with the new technology be targeted.

To conclude, Scania anticipate serving at least the same customer segments of haulers but may also serve extended customer segments with the electric offer where they have previously not been competitive. In general, the technology shift primarily serves a subset of the same market since the job to be done is practically the same. However, it may open up new opportunities with customer segments that the previous technology failed to satisfy or as a response to new core customer values.

6.4.2.3 Channels

The channels are the ways the company communicate with its customer segments. The contemporary channels of Scania are anticipated to still serve the customer segments that persist from the diesel combustion paradigm. However, the access to energy and charging that is now available to Scania through its extended value proposition can be regarded as a new channel to customers. On-boarding services are furthermore anticipated to becomes more important as a way to support customers to electrify.

To conclude, Scania will use similar channels to their contemporary customers, but may find additional channels through its extended value proposition. In general, the contemporary channels are not very affected by a technology shift. However, extending the value proposition may grant access to new channels and supporting customers in exchanging their technology becomes important.

6.4.2.4 Customer relationships

The customer relationships are used to acquire customers, avoid retention and sell additional services. In electrification, the customer relationships become much stronger. Electrification is new to the customers, and they must rely on Scania's expertise, especially during the early phases of the transformation. Scania must lead the customers through the transition and customers who electrify early become more reliant on Scania than previously. However, the stronger customer relationships can once again be seen as a natural step in the extended value proposition that accompanies electrification.

To conclude, the customer relationships grow stronger as the technology is new and uncertain to the customers, and Scania need to lead them through the transition. It is seen by Scania as a natural step in extending their value proposition. From a general perspective, technology shifts may make customer relationships stronger as customers feel uncertain in technology shifts and become more reliant on the OEM.

6.4.2.5 Key partnerships

Key partnerships consist of the network needed to successfully deliver value to customers. Key partnerships may have an important strategic role and can amongst other things be used to reduce risk and uncertainty, optimize business models or acquiring resources. The width of the transport ecosystem in electrification means it is no longer feasible for Scania to offer the full solution with in-house products and services. Therefore, partnerships become more important as a way to offer new components in the ecosystem without

the risk and the development time associated. Partnerships becomes particularly important around key aspects of the ecosystem such as charging infrastructure, battery and energy supply.

In conclusion, the changes to the value proposition that the technology shift imply have consequences to the partnerships in the sense that they become more important to create Scania a complete offer in a fast and risk mitigated way. In general, since partnerships is a way to acquire new technical and business model capabilities, partnerships increase in importance during technology shifts.

6.4.2.6 Key resources

The key resources describe the most important assets required to a business model. These resources allow the company to create and deliver the value proposition. The shift has many consequences to the key resources of Scania. Scania have previously relied on its competence in the diesel combustion powertrain as a key resource, but now they have to learn new competences around the electric powertrain. Especially the battery is anticipated to be very important to the electric offer and thus a key resource Scania wish to build. Scania therefore transfer a lot of resources to electrification. Furthermore, the 500 000 connected vehicles and the data base from their driving hours are anticipated to be key resources in the electric era. The data will be important for Scania to offer new and better digital services. Scania will also devote more resources to their larger clients since they are anticipated to be the first to electrify. The workshops that have previously been very important to deliver Scania's competitive workshop services will adopt a new role with new responsibilities in the electric paradigm. The owned retail network is also a key resource to Scania since it offers them the opportunity to push the new business models of electrification top down into the markets and to manage the risk implied. The increased relative importance of different services means the service organization of Scania become a key resource to an increasing extent. Lastly, to tailor solutions, Scania's modularity becomes even more important, and now has to be applied to services and partners' services as well.

To conclude, the shift imply that Scania must transfer resources to develop new competences around the electric technology, especially the battery, and to the segment that is anticipated to electrify early. Some of the previous key resources such as the connected fleet and modularity remains important, and some such as the workshops adopt a new role. Some of Scania's contemporary resources, like the owned retail network and the service

organization, grows to become very significant resources in delivering the value proposition with extended service needs and new business models. From a general perspective, the technology shift's consequences to the value proposition imply that the resources to create and deliver value also see consequences. As a consequence of technology shifts, key resources are transferred, adapted and built. Some resources already possessed may grow to become more important in the proceeding paradigm.

6.4.2.7 Key activities

The key activities are the actions the company must take to deliver value to the customers. The shift implies many consequences to the key activities of Scania. The consequences to the key activities are in many cases related to the battery, which is consistent with theory on the challenges of electrification. Tailoring battery needs and handling residual value becomes very important activities since batteries restrict electrification in terms of cost and capacity and may also offer a potential business opportunity. Scania must also actively work with risk sharing to deliver its value proposition where a lot of risk and uncertainty is transferred from the customer to Scania. Scania have also long developed top tier diesel combustion technology and development is traditionally important to the company. Now they will have to develop electric powertrains instead. Even though not explicitly said, developing services probably also becomes more important than it have previously been since services overall becomes a more important part of the offer. A key activity also becomes guiding the customer through the shift which is closely related to the delivery of the stronger customer relationships and the uncertainty of customers in the shift. It will also become important to position Scania in the value network since it is a crucial part in delivering the customer a complete solution. Lastly, it is also a key activity to be able to construct the complete solutions with all internal and external modules, services and products.

To conclude, Scania foremost see consequences to the activities related to the technology, such as tailoring battery needs and powertrain development. They also see consequences to activities targeted at delivering the business model, such as risk sharing, constructing solutions and guiding the customer. Furthermore, it is very important for Scania to build the ecosystem needed for delivering the value proposition. In general, it is evident that the technology shift has vast consequences to the key activities. Some of the consequences are related to developing the new technology, some are related to mitigating problems and capturing vale from the new technology, and some are related to delivering the extended value proposition.

6.4.2.8 Revenue streams and cost structure

The revenue streams are the ways the company generate money from the customers and the cost structure all the costs that goes into delivering the business model. All blocks in the business model are associated with costs and there may be various types of revenue streams in the business model. The new business models that are anticipated in electrification have consequences to the cost structure and the revenue streams of Scania. However, depending on the business model that is applied they may be very different. In general, transferring responsibility and risk to Scania, particularly in business models where a certain level of uptime or service is promised, has major consequences. As an example, service and maintenance becomes a cost to Scania rather than a revenue, which is favorable due to the anticipated lower maintenance needs. From this perspective, the quality level and the new more robust technology make service level business models presumably more profitable to Scania. Providing new services, such as charging solutions or residual value handling of batteries, may imply new costs to Scania, but may also imply new revenue streams. The payments are also anticipated to be more incremental, and investments are thus ensured by Scania over the lifetime of the vehicle rather than when it is purchased.

In conclusion, the technology shift's consequences to the business model imply new cost structures and revenue streams. Delivering the extended value proposition imply different costs, but also new business opportunities. In this case, the technology shift offers favorable prerequisites for a business model where Scania handle more parts of the ecosystem and the corresponding costs and revenue streams. Not adapting the business model could make electrification difficult for the customers. In general, technology shifts may change the business model to meet new prerequisites, and since the building blocks are associated with costs and revenues, changes to the building blocks of the business model have consequences to cost structure and revenue streams.

6.4.2.9 Summarizing analysis of the consequences to the business model

The analysis of the consequences to Scania's business model have been summarized in table 12.

Table 12. Consequences to Scania's business model.

Building block	Consequences to Scania	General consequences
Value proposition	The new value proposition is an extension of the contemporary value proposition of Scania, but with an additional technology base. Offering the new solution imply harmonizing the transport ecosystem and packaging it as uptime.	The shift has consequences to the value proposition in the sense that offering the same solution to the customer imply much more to the OEM, and the product sold is very different even though it does the same job to the customer.
Customer segments	Scania anticipate serving at least the same customer segment of haulers with the electric solutions but may also serve extended customer segments where they have previously not been competitive.	The technology shift primarily serves the same customer segments. However, it may open up new opportunities with customer segments that the previous technology didn't satisfy.
Channels	Scania will use similar channels to their contemporary customers but may find additional channels through their extended value proposition.	The contemporary channels are not affected by the technology shift. However, extending the value proposition may grant access to new channels.
Customer relationships	Scania's customer relationships grow	Technology shifts may make customer

	stronger as the electrification is new and uncertain for the customers, and Scania need to lead them through the transition. Customers will also for a time period be more reliant on Scania. However, it is seen as a natural step in extending the contemporary value proposition.	relationships stronger as customers feel uncertain in changing technology and need the help of the OEM. The customer also become more reliant on the OEM.
Key partnerships	The changes to the value proposition that the technology shift imply have consequences to Scania's key partnerships in the sense that they become more important to create Scania a complete offer in a fast and risk mitigated way.	Since partnerships is a viable way to acquire new critical technical and business model competence, partnerships increase in importance during technology shifts to acquire the competence the company doesn't possess and can't quickly build themselves.
Key resources	Scania must build resources to develop new competences around the electric technology, especially the battery, and to the segment in which they wish to sell electric solutions. Some of the previous key resources, such as the connected fleet and modularity,	A technology shift's consequences to the value proposition imply that the resources to create and deliver value also see consequences. As a consequence of technology shifts, key resources need to be built, transferred, adapted, and built.

	remains important, and some like the workshops adopt a new role and new responsibilities. Some of Scania's contemporary resources, like the owned retail network and the service organization, grows to become a very significant resource in delivering the value proposition with different service needs and new business models.	Some resources already possessed may grow to become particularly important in the new paradigm.
Key activities	Scania foremost see consequences to the activities related to the technology, such as tailoring battery needs and powertrain development. They also see consequences to activities targeted at delivering the business model, such as risk sharing, constructing solutions and guiding the customer. Furthermore, it is very important for Scania to build the ecosystem needed for delivering the value proposition.	It is evident that technology shifts have vast consequences to the key activities. Some of the consequences are related to developing the new technology, some are related to mitigating problems and capturing vale from the new technology, and some are related to delivering the extended value proposition.
Revenue streams and cost structure	Delivering the extended value proposition incorporates costs, but	Technology shifts may change the business model to meet new prerequisites, and

	also new revenue streams. The electric powertrain offers characteristics in benefit of the company in terms of costs, but also force changes to the business model to mitigate consequences to the customer. The payments may be more incremental.	since the building blocks are associated with costs and revenues, changes to the building blocks of the business model generally have consequences to costs and revenues.

6.4.3 Consequences to the resources and capabilities

The company can be seen as a set of resources that are strengths or weaknesses to the company and may play a major role in the company's strategic options. Resources must continuously be reevaluated to balance the exploiting of existing resources and the creation of new ones, especially in a technology shift like electrification that has major consequences to the company. By using the company's resources with the right competences, companies possess capabilities. From the interviews, Scania have anticipated the following consequences to their resources and capabilities:

- From a development perspective, the pace and uncertainty of development in the electric paradigm means that Scania must change the way they work towards a more agile development. That implies implementing agile value-streams, organizing in tribes, learning new ways to coordinate and to work hypothesis based. To be successful in adapting, it is also important to mix expertise with new perspectives. This capability is labelled as the *agile development capability.*
- From a hardware perspective, Scania must have the capability to develop hardware for electric vehicles. They have to build new competence by reeducating the contemporary development function and/or by recruiting new competence. Scania have identified the battery to be particularly important from a hardware perspective. Hence, battery capabilities become very important. Scania have invested in the sustainable battery cell manufacturer Northvolt and are building their own battery pack plant to build the battery capability. They are also anticipating building a competence in tailoring battery needs. These two hardware perspectives concretize into the *electric powertrain development capability* and the *battery capability*.

- Since services become more important to the overall offer, it is crucial to think both service and product equally much as a solution provider, which is practically challenging since the two are very different to develop, sell and deliver. From a development perspective, Scania have strengthened the service department with more resources, which likely involve new competence and resources from product development. From a selling perspective, Scania will have to build capabilities to sell solutions and offer the customer support as a consequence to the new value proposition and stronger customer relationships. This implies retraining the salesforce and new processes, tools and systems which are not in place today. Scania will also have to deliver solutions. In delivering solutions, customers expect a premium solution provider to offer a high degree of customization. The modular competence and platform thus become very important to offer tailor made solutions and to deliver them in a cost-efficient way. The modularity must also include modules from partners since Scania cannot offer the whole ecosystem with in-house services. However, the service modularity is not as mature as Scania's product modularity. Delivering electric solutions will furthermore also imply adapting the workshops to give them the capability to service electric vehicles. The solution perspective concretizes into the *service development capability, transformation support capability*, the *solution selling capability* and the *solution delivery capability.*
- Scania will also need the capability to deliver new types of business models. The new business models imply handling risk to mitigate the consequences to customers. Scania already possess a lot of competence from delivering service level agreements for many years. They also believe owning the retail network is a great capability for spreading risks. The new business models concretize into the *solution business model capability*.
- Scania must also have capabilities to create and monitor the electric ecosystem they use to deliver their value proposition. It incorporates the processes and systems to coordinate within the company and with the external parts of the ecosystem. The latter may involve forming partnerships, guarantee access to charging, participate in infrastructure development etc. This capability is labelled as the *ecosystem capability*.
- Lastly, Scania possess its installed base of connected vehicles. They have access to a data base with a significant amount of driving hours and possess a strong capability to extract insights from it. However, they must connect the electric vehicles and learn which insights that

are essential in the electric paradigm. This capability is named the *connected fleet capability*.

The identified capabilities have been listed in table 13 and attributed a letter for the purpose of further analysis.

Table 13. Electrification capabilities.

Letter	Capability
A	Electric powertrain development capability
B	Battery capability
C	Service development capability
D	Ecosystem capability
E	Agile development capability
F	Transformation support capability
G	Solution selling capability
H	Solution delivery capability
I	Solution business model capability
J	Connected fleet capability

6.4.3.1 Consequences to the capability types

The first step in analyzing the consequences of the shift to Scania's resources and capabilities is to see which capability type that see the most consequences. The capabilities can be physical, financial, human or organizational. From the capabilities that have been identified in the previous paragraph, the following capability types are identified:

- The electric powertrain development capability implies the physical capability of a competitive electric powertrain, a human capability of skilled engineers and a financial capability in the sense of allocated monetary resources.
- The battery capability consists of the battery and the software around it which is a physical capability. It also consists of the competence necessary which is a human capability. Furthermore, Scania's battery plant is a physical resource tied to the battery capability and the partnership with Northvolt is a human resource.
- The service development capability consists of financial resources that are transferred to the service organization and the human

competence that is built. Service will also have to be more coordinated with product development which is an organizational capability.

- The ecosystem capability implies human capabilities, such as partnerships, as well as organizational structures and processes to monitor the ecosystem.
- The agile development capability imply that new human capabilities are built or recruited and also consequences to the organizational processes at Scania.
- The transformation support capability implies both consequences to the human resources in the form of recruitment or retraining as well as physical resources in the form of new systems and tools for them to work with.
- The solution selling capability imply new knowledge and training, or in other words human resources, but also new organizational processes to sync the solutions and physical systems and tools to craft the solutions.
- The solution delivery capability implies the human competence and the physical platform to make services modular in the same way that products are modular. It is also about adapting the physical workshops and their human capability of the workshop staff to handle electric vehicles.
- The solution business model capability implies risk capabilities of human competence to assess risk and an organizational capability of risk sharing. It also implies financial capabilities of managing cash flows. The capability is also about the physical products of extended product coverage and predictive models, as well as the organizational capability of a strong quality process.
- The connected fleet capability consists of the physical data base and the connected fleet as well as the competence to get insights, which is a human capability.

The capability types identified have been listed in table 14 by listing the letters associated with the identified capability once if they are connected to a capability type. That is anticipated to give an indication towards which capabilities that see the most consequences from the shift.

Table 14, analysis of the shift's consequences on different capability types.

Capability type	Occurrence
Physical	A, B, F, G, H, I, J
Human	A, B, C, D, E, F, G, H, I, J
Financial	A, C, I
Organizational	C, D, E, G, I

It becomes evident that the technology shift has the most significant consequences to Scania's human and secondly physical capabilities. Every capability is tied to human competence in some way. The shift does have consequences to organizational capabilities as well, and the least consequences to the financial capabilities. In general, technology shifts hence primarily have consequences to the competence of the company, and how the human resources are allocated. It also has consequences to the company's products, systems and facilities and how they are used. It does also have consequences to how the company is organized and how different parts of the organization interact. The shift has least consequences to how financial resources are allocated and managed other than that they are transferred to the new development and to manage new revenue streams and cost structures.

6.4.3.2 Consequences to the dynamic capabilities

Capabilities are dynamic, and changes to the company's environment such as a technology shift can make resources less valuable over time. The company's dynamic capabilities are the company's abilities to address rapid changes in the company's environment. It is therefore relevant to investigate if the shift has any consequences to Scania's ability to sense, seize and reconfigure. It is also interesting to see which capabilities from the previous paradigm that is of particular value during the shift or in the next era.

Electrification implies a major consequence to how Scania have to work with development to meet volatile and uncertain customer needs. The industry has been stuck in a way of working due to the absence of revolutionary technology for a very long time, which according to theory make mature companies vulnerable to technology shifts (the success syndrome). However, as a consequence of the shift, Scania have begun a transformation of their development process to find new ways to sense, seize and reconfigure faster and under uncertainty by adopting an agile work process approach.

The shift doesn't just change the development process though. The ecosystem perspective and the increasing emphasis on the service offer imply that the organization has to adapt by transferring resources and build new competences in service. Scania therefore particularly need to have reconfiguring capabilities. It can also be anticipated that an organizational preparedness of services implies Scania's capability of sensing and seizing service trends becomes better. Such a capability may be important since Scania must be as good at developing services as they are at developing the products to be true solution providers.

In theory it is stated that a company may have advantages in a time period as a result of investments in a previous. Scania's data base of connected vehicles' driving hours give them a great starting point to understand transport flows and create new digital services. Even though most of the data is based on diesel vehicles, it's nevertheless an opportunity to adapt to new circumstances, and the inbound capabilities concerning connected vehicles is likely useful to quickly gain advantages in the electric era. It is therefore a reconfiguring capability and could also be a way to seize new opportunities by in this case using the data to provide services for electric vehicles. Scania also identify their development resources as a capability since having financial resources and a skilled development organization helps them to quickly transform to create competitive electric solutions, which is a reconfiguring capability.

The analysis of the dynamic capabilities has been summarized in table 15. The other capabilities are assessed to not offer any dynamic capabilities.

Table 15, Analysis of the shift's consequences to the dynamic capabilities.

Capability	Sensing	Seizing	Reconfiguring
Agile development capability	x	x	x
Service development capability	x	x	x
Connected fleet capability		x	x
Electric powertrain development capability			x

To conclude, the fast development and uncertainty force Scania to rethink their work methodology. The agile development capability will not only equip Scania with better dynamic capabilities for the shift to electrification but also improve the company's dynamic capabilities in general. Furthermore, Scania's increasing emphasis on the service offer equip them with dynamic capabilities to adapt to changes in the service environment as well. It is also evident that some of Scania's previously built resources will be important from a dynamic capability perspective. Scania anticipates that data from their connected vehicles and development resources will be important to seize opportunities and to quickly reconfigure in the shift. The

general findings from a dynamic capability perspective are therefore that technology shifts have consequences to the company's dynamic capabilities, at least for those who manage to adapt to the new circumstances. The ability to adapt may not only be beneficial in the contemporary shift but may equip them with a better capability to handle change overall. Furthermore, capabilities that were built in previous paradigms may turn out to be important dynamic capabilities in the contemporary shift.

6.4.3.3 Consequences to the distinctive capabilities

For capabilities to be distinctive and thus offer sustained competitive advantage they must be valuable, rare, inimitable and have organizational support. Each capability and their competitive implications will be described below:

- The capability to develop outstanding powertrains doesn't offer the same competitive advantage as it did before. The engine is no longer the primary premium component and there are likely competitors with longer experience in electric machinery who can supply electric engines to other OEMs. However, the electric powertrain is still an important part of the vehicle and it is still valuable to develop the electric powertrain in-house for Scania who have a tradition of in-house development. Scania have a strong development department who are anticipated to adapt to the new technology, which means the organizational support is anticipated to be in place. Developing electric powertrains is undeniably valuable but is not assessed to offer any competitive advantage as such.
- The battery capability however, if distinguished from the powertrain, may be a sustained competitive advantage. Combining a good battery with the proper software is valuable in the electric paradigm. Scania's own battery factory and co-ownership in Northvolt also access rare resources which can be anticipated to be hard for competitors to imitate. With the partnership in place and the battery factory in the making Scania are assessed to have sufficient organizational support as well.
- The service development at Scania will be valuable as different service becomes a more important part of the offer. However, Scania need to strengthen the service organization and make service as important as products in the development process to have full organizational support. Regardless, nothing points towards the service development being anything rare or inimitable. Every competitor will likely need to create services to accompany the vehicles in the new ecosystem, and it is a general trend to servitize for OEMs. Thus, the

service development capability does not offer Scania a competitive advantage.

- The ecosystem in a similar fashion is something important to build, but nothing that competitors will not also possess. Depending on how well the ecosystem is executed it might offer some competitive advantage. With that said however, the ecosystem capability cannot be anticipated to be a competitive advantage generally speaking. Regarding the organizational support Scania are aware of the ecosystem that has to be built, but many parts are not fully in place yet (such as the charging infrastructure).
- The agile work process of the agile development capability is a necessity to handle development in the electrified era. However, other competitors will likely have to adopt a similar development process and may even be further ahead in the process. Scania have started creating an organization that is more influenced by the agile work method with tribes, value-streams etc. and hence show an organizational support for it. However, it just offers a competitive parity in the market.
- Since Scania have long had the ambition to be solution providers, they might have an advantage relative to their competitors from the perspective of being relatively unique in selling solutions already today. However, it is not inimitable, and competitors alike will probably understand that it is necessary to offer the customer more or less complete solutions in the electrified era. A lot of systems and processes also has to be built for Scania to be able to sell the new more complex solutions implying that the organizational support is not there yet. The solution selling capability may however offer Scania a temporary competitive advantage.
- The transformation support capability is probably not going to be anything unique to Scania since on-boarding and support is anticipated to be needed to sell electric solutions. Scania does not either have the organizational competence and systems to fully possess the capability yet. Hence, it does not offer a competitive advantage.
- At least on the product side, Scania's modularity may offer them a competitive advantage through the solution delivering capability. The modularity is a unique aspect of Scania and they have built the competence for many years, which makes it rare and inimitable in a foreseeable future. It is also valuable since modularity makes it relatively easy for Scania to incorporate the new electric technology in the contemporary platform. It is also reasonable to argue that some

of the competence can be transferred to create a similar modularity in services, which will be necessary to craft tailored solutions with Scania's and its partners' services. That might give an even better competitive advantage. However, until the service modularity is in place, the organizational support is not there yet.

- Solution business model capabilities require the ability to handle risks and incremental revenue streams. Scania are likely not unique in their experience with service level agreements, however owning the retail network is fairly unique in the industry and offer good opportunities to both push new ways of selling vehicles and to share risk in the organization. Furthermore, building a similar network would likely take the competitors a long time and a lot of resources. That makes this capability both rare and hard to imitate. Organizationally, it is supported by competence in risk management and financing, the retail network, as well as a few key capabilities that are important for Scania to deliver such models efficiently (EPC, predictive models, quality process). It does therefore likely offer them a sustained competitive advantage.
- The connected fleet capability is also something more or less unmatched to Scania and can be used to build the new digital services. However, it is likely that more competitors will understand that it is important to start monitoring their fleet. With that said, Scania regardless have an advantage from historically building the capability to collect and analyze data which will give them an advantage. Since Scania are fairly unique in this sense, it is rare, and since it is hard to gather the same amount of data and build the competence, it is also inimitable. The organization is also equipped for it already, it's just about asking the right questions and connect also the electric vehicles. This thus likely give Scania a sustained competitive advantage.

The capabilities and their competitive implications can be seen in table 16.

Table 16. VRIO analysis of the electrification capabilities.

Capability	Valua-ble	Rare	Inimitable	Organi-zational support	Competitive implication
Electric powertrain development capability	x			x	Competitive parity
Battery capability	x	x	x	x	Sustained competitive advantage
Service development capability	x				Competitive parity
Ecosystem capability	x				Competitive parity
Agile development capability	x			x	Competitive parity
Solution selling capability	x	x			Temporary competitive advantage
Transforma-tion support capability	x				Competitive parity
Solution delivering capability	x	x	x		Sustained competitive advantage
Solution business model capability	x	x	x	x	Sustained competitive advantage
Connected fleet capability	x	x	x	x	Sustained competitive advantage

To conclude, the capabilities that are consequences of electrification does not automatically offer Scania a lot of competitive advantage. Many of the capabilities are just necessary for a competitive offer. However, the battery as a strategic bet might offer sustained competitive advantage. Scania's solution business model capability and connected fleet capability as well. The

solution delivering capability may also offer a sustained competitive advantage but does not have organizational support yet. Being at the early phases of the shift, there are a lot of capabilities that lack the necessary organizational support, but in many cases, Scania are aware, and they are in the process of being built.

From a general perspective, the shift mainly has consequences to the capabilities that are needed just in order to have a competitive offer. However, some capabilities may offer temporary or even sustained competitive advantage. Most of the competitive advantage is created from capabilities that in one way or another originates from strategic choices in the previous paradigm. However, it is evident that critical capabilities often lack organizational support initially in technology shifts, which is not surprising given that much is new to the company.

6.4.3.4 Consequences to the service capabilities

It is evident that service capabilities grow more important as a consequence of the more service intensive electric solution. To understand how Scania can leverage its resources from a service perspective the framework presented by Kowalkowski and Ulaga (2017) will be used. According to them, certain unique resources often possessed by manufacturing companies can be leveraged into competitive advantage in servitized markets through distinctive service capabilities. The truck market will likely be servitized as a consequence of electrification since eMobility is more service intensive.

The unique resources are *installed base product usage and process data*, *product development and manufacturing assets*, *product sales force and distribution network* and *field service organization*.

- Scania have an installed base of more than 500 000 connected vehicles with tremendous amounts of data. Even though most of the installed base initially consist of diesel vehicles, with the right questions Scania themselves believe a lot of the answers for electrification are embedded in the data.
- Scania possess many product development and manufacturing assets. They have first of all formed a partnership with the sustainable battery cell manufacturer Northvolt, they have also a strong in-house development team, and they are furthermore building their own battery manufacturing plant. Scania's competence and platform in product modularity can also be seen as a product development and manufacturing asset to Scania.

- Scania own its retail network and sales force, which is a unique aspect in the market. The retail network and salesforce are key to deliver electric solutions. However, according to one interviewee Scania don't extract the full potential from possessing such a unique resource today. Furthermore, they are not yet equipped for selling the new services and solutions in terms of knowledge and tools.
- The field service organization of Scania consist of Scania Technical Support, Scania Global Assistance and the workshop network. These are the ones closest to the customer and therefore very important to offer the customer great service – which is core to Scania.

Scania obviously possess some of the unique resources that the framework brings forward as important but can definitely improve on them as well. According to the framework, these unique resources can be leveraged into competitive advantage through distinctive capabilities. The distinctive capabilities are the *data processing and interpretation capability*, *execution risk assessment and mitigation capability*, *design-to-service capability*, *services sales capability,* and the *services deployment capability*.

- Scania have data processing and interpretation capabilities. They own the right to use the data they collect for improving the offering and have data scientist, analysts, and systems to process data in-house. It is important however to extract the right data, and to start gathering data from electric vehicles early to fully leverage the resource.
- Scania have long worked with service level agreements, and hence have capabilities to understand, sell and deliver those kinds of contracts that will likely increase in important in the electric era. They are therefore anticipated to possess the execution risk assessment and mitigation capability. It is important to be able to assess risks and mitigate it to be able to deliver performance-based contracts. According to Scania themselves, especially Financial Services possess those kinds of capabilities. Owning most of the retail network is also something Scania identify as an important resource to share risk in the organization.
- From a design-to-service perspective, Scania do not think services as much as they think product today. Even though they communicate between the product and service development organizations, it is still organized as two separate departments which is likely a relic from a more product centric paradigm. To deliver true solutions, the mind set must shift towards finding solutions of optimal combinations of services and products and not products that are accompanied by services to make them more attractive. Scania are however starting to work in value-streams by developing services as an end-to-end

process, which makes it easier to find cost reductions, increase end product quality and streamline the whole procedure.

- The service sales capability has to improve to leverage the product sales force. Selling solutions will imply training, systems and processes to support the salesforce to offer the customer a complete optimal solution through one sales representative. That is something that is unnecessarily difficult today. The retail network as such is neither used to its fullest potential, and one interviewee points out that with better central support it could be leveraged to offer even more value to Scania. To leverage the sales force and distribution network, they need to develop the right selling capabilities meaning training and the right tools and supporting systems from Scania centrally.
- Lastly, the service deployment capability is about balancing giving customers what they need and keeping the delivery process profitable. This is a key capability to a solution provider, especially in the extensive electric ecosystem. Scania strive to give the customer the best solution, but it has to be at reasonable cost. A critical part in that is to make modularity in service and business models just as developed as the modularization in the physical product, which have been identified as a unique resource to Scania. Even services offered by partners must be available as modules to form a complete electric solution for the customer. The modularity at the same time offers Scania the opportunity to find economy of scale and faster development in the products, and the same rationale could be applied to services. According to theory, it is also important to standardize the "back-office". The interviewees explain how it is important to have a common base but allow digital services and workshops to make adaption to local flavor or individual customers. To leverage this capability, modularity is particularly important close to the customer, which is in the retail and field service organization. However, the majority of the service base should be standardized at Scania centrally. In that way, it is possible to make cost reduction in the service delivery without making the solution lose its competitive edge, and thereby make Scania fall victims of the service paradox. Furthermore, the field service organization, primarily workshops, create much of Scania's competitive advantage today. However, it is important to find the workshops' new role in the electric business model to extract their full potential as the ones closest to the customer.

By leveraging these resources into distinctive service capabilities, Scania can enjoy competitive advantage in a more servitized market by offering the best solution. Since Scania are anticipating offering a premium solution in the

electric truck market, customers will expect them to offer the most tailor-made solution available. Therefore, when looking at the last part of the framework, it is evident that is it relatively more important for Scania to pursuit a differentiation advantage than a cost leadership advantage. The analysis has been summarized in table 17.

Table 17, Scania's service capabilities in the electric paradigm.

Unique resources	• Connected fleet • Battery partnership, battery pack factory, development team, modularity platform and competence. • Owned retail network and salesforce. Not used to their fullest potential. • Technical support, Scania Assistance and workshops.
Distinctive capabilities	• Own data rights and possess data analyzing capabilities. Need to equip electric vehicles and understand new insights • Possess capabilities to assess and mitigate risks. The own retail network and financial services are particularly important from a resource perspective. • Must be better at thinking services as much as products. Work in agile value streams. • Will have to improve service selling capabilities with training, processes and systems. • Must use competence in modularity for both products and services.

Competitive advantage	• Being a premium solution provider, customers expect a high level of customization. Differentiation advantages is therefore more important than cost leadership advantage.

To conclude, partly as a consequence of the shift, the solution becomes more important. The companies that have or create themselves unique resources can therefore leverage them into competitive advantage in electrification. With that said, Scania have since long had a solution strategy, and it is probably advantageous to already possess some of the critical resources needed to be a solution provider. Scania hold unique resources in every of the framework's aspects and have many of the distinctive capabilities as well. However, to fully leverage the unique resources in the electric paradigm, Scania has to connect the electric vehicles and understand which insights that are important to the customers. Scania must also be better at thinking services as much as products and improve the systems for selling solutions to extract the full potential of the retail network. Since Scania is a premium solution provider, the customer expects a high level of customization, and the competitive advantage that service capabilities can give Scania in the electric paradigm is to differentiate themselves in the market with the most customizable solution.

The general conclusion is that the company may have or build themselves unique resources which they can leverage into competitive advantages in the new paradigm through its distinctive service capabilities.

6.4.3.5 Summarizing analysis of the consequences to the resources and capabilities

The analysis of the consequences to the resources and capabilities have been summarized in table 19.

Table 19. Consequences to the resources and capabilities.

Analyzed capability	Consequences to Scania	General consequences
Capability type	The technology shift has the most significant consequences to Scania's human and secondly physical capabilities. Every electrification capability is tied to human competences in some way. The shift has the least consequences to the financial capabilities.	Technology shifts primarily have consequences to the competence of the company, and to how the human resources are allocated. It also has big consequences to the company's products, systems and facilities and how they are used. The shift has least consequences to how financial resources are allocated and managed other than that they are transferred to the development of the new technology and to manage new revenue streams and cost structures.
Dynamic capabilities	The fast development and uncertainty forces Scania to rethink their work methodology. Working more agile will not only equip Scania for the contemporary shift but improve the company's dynamic capabilities in general. Furthermore,	Technology shifts have consequences to the company's dynamic capabilities, at least for those who manage to adapt to the new circumstances. The ability to adapt may not only make companies succeed in the contemporary shift,

	Scania's increasing efforts towards service equip them with dynamic capabilities to adapt to changes in the service environment as well. It is also evident that some of Scania's previously built resources will be important from a dynamic capability perspective.	but also equip them with a better capability to tackle changes in their environment overall. Capabilities that were built in the previous paradigm may turn out to be important dynamic capabilities as well.
Distinctive capabilities	The capabilities that are consequences of electrification does not automatically offer Scania competitive advantage. However, the battery as a strategic bet might do so. Scania's solution business models and connected vehicles as well. The solution delivering capability may also offer a competitive advantage but does not have organizational support yet. Being at the early phases of the shift, there are a lot of capabilities that lack the necessary organizational support	The shift mainly has consequences to the capabilities that are needed just to offer a competitive offer in the new paradigm, however some capabilities my offer temporary of even competitive advantage. Most of them are capabilities that in one way or another have been built during the previous paradigm but that become increasingly important in the new one. However, it is evident that critical capabilities initially often lack organizational support.
Service capabilities	Scania have an advantage from already possessing unique resources that can be	The general conclusion is that the company may have or build themselves unique

	leveraged into distinctive service capabilities, however they must improve some capabilities to fully leverage the unique resources they possess. In that way they could enjoy competitive advantage by being able to differentiate their offer by better tailoring the solutions to customers' needs.	resources which they can leverage into competitive advantages in the new paradigm through its distinctive service capabilities.

6.5 Summarizing analysis

With the purpose in mind, the technology shift steering wheel framework have been used to analyze the consequences of the technology shift. The analysis started in the contemporary offer, went via the technology shift and the company's adopted technology strategy, and ended by analyzing the three perspectives of offer, business model, resources and capabilities.

Scania's contemporary offer is in many ways based around Scania's diesel combustion engine, which due to many years of engineering efforts offer the customer fuel economy and uptime, which is connected to the highly valued TCO and TOE. It is also the engine and its high quality that makes the vehicle premium today. Some customers also choose Scania since their vehicles' comfort and driving experience is appreciated by the drivers. The offer covers practically every application in its class through modularity and PTOs. The vehicle is accompanied by an extensive service offering, mainly targeted at maintaining the properties of the vehicle. Many of the services are enabled through the connectivity that is fitted to each new vehicle. Many of the services also improve the uptime and therefore also the TOE. Along with the reliable engine, the services also contribute to the trust and peace of mind through warranty, support, and assistance.

It is evident that the industry is experiencing discontinuous innovation, that the diesel paradigm will stagnate, and that electrification soon will be the superior alternative for most applications. Electrification offers the transport industry many improvements to the technology but is hindered by challenges

such as insufficient charging infrastructure and customer anxiety. As a result, Scania has formed a technology strategy for electrification to both capture the benefits and address the challenges. The technology strategy controls the direction of the offer, business model, resources and capabilities. The technology strategy Scania have decided to pursuit is about being first and building the ecosystem that is so desperately needed for electrification to take off by balancing partnerships and in-house development. They also believe in making electrification the new normal at Scania already from the beginning. They plan to exploit the technology by exchanging the powertrain and offer the customer a complete transport solution around it.

It is evident that from the perspective of the offer, the shift is anticipated to have many consequences to Scania. The customer will still want to buy TOE. Since the vehicle cost more than its predecessor initially, but has lower operating costs, the TOE becomes even more important. Sustainability to an increasing extent becomes a core value that electric vehicles can satisfy. Electric vehicles are from a sustainability perspective a much better solution than its predecessor. The electric powertrain furthermore offers better robustness and lower maintenance needs. However, electric vehicles are initially restricted by their range and capacity, and charging is a complex and time-consuming task. The service around the electric vehicle therefore becomes more important to mitigate the challenges and complexity of eMobility and to keep the vehicle's uptime high in order to leverage on operating economy. It is furthermore the solution that makes the electric offer premium, not primarily the powertrain anymore. In more general terms, the shift changes the technical core which means that the physical product may see changes to how it is used and designed. However, the customer essentially wants to buy the same thing. The technical changes offer improvements, that's the driver to change core technology, but also imply challenges which are mitigated by the services around the product. Which part of the overall offer that is the most important may change as a consequence of the shift.

It is evident that the technology shift has consequences to Scania's business model. From an offer perspective, even though the new value proposition is an extension of offering the customer the best available solution, it entails a lot more to do so with an electric core technology. The offer has to be packaged as a solution and must incorporate all the necessary aspects if the eMobility ecosystem. However, since the job to be done is practically the same, the major customer segment is a subset of the haulers that are customers today and would benefit from electrifying. Some new customers might however also find electric solutions valuable, mainly since they are more sustainable. Since the haulers are contemporary customers of Scania, the

channel to them is anticipated to be the same. However, accessing charging and batteries may provide new channels to Scania's customers that were not within scope in the previous paradigm. The customer relationships also see consequences and become much stronger due to the ambiguity that a shift imply to customers. The stronger relationship is also anticipated to be a natural step in extending Scania's value proposition. From an infrastructure perspective, offering the whole ecosystem in a solution imply that partnerships become increasingly important to acquire necessary competence. The key resources and the key activities also see consequence since Scania need to do new and possess new things to deliver the wider solutions at a certain service level with stronger customer relationships than before. Some new resources have to be built or acquired, some resources from the previous paradigm evolve to become key resources, and some previous key resources take on a new role in the business model. Key activities are also important in delivering the extended value proposition and does hence see consequences. Foremost, Scania see consequences to key activities related to the technological core, the business model and building the ecosystem. Lastly, from the financial viability perspective the changes to the business model have consequences to the cost structures and revenue streams. Transferring risk and committing to more services imply different revenue streams and cost structures. The difference to the initial cost and operational cost also implies that Scania might have to offer business models where investments are recovered more incrementally than before. Furthermore, more parts of the ecosystem now become part of Scania's cost structure, but they may also offer Scania new revenue streams. In general terms, technology shifts have no consequences to the job to be done. Delivering the business model however can become heavily influenced by changing the technological core. On that remark, practically all aspects of the business model see consequences. Since the job to be done is practically the same, the new offer will likely serve the same customer segment but may also appeal to new segments. The contemporary segments will likely be reached with the same channels, but additional channels may be accessed or needed to new customer segments. As technology shifts are uncertain to customers, the relationships grow stronger. Furthermore, since the company have to acquire new competence, partnerships are identified to increase in important during technology shifts. The key resources and key activities also see consequences since the company need to know and possess new things to deliver the new business model. Lastly, the consequences to the other building blocks of the business model imply that the cost structure and revenue streams also see consequences in a technology shift.

Scania anticipated a few consequences of the technology shift to their resources and capabilities. All of the consequences were connected to human competence, and some to physical products, systems and facilities. The shift is anticipated to have the least consequences to the financial capabilities of Scania. However, the uncertainty and speed of development connected to electrification imply that Scania have to transform their development process, which will likely equip them with better dynamic capabilities both going forward in electrification, but also in addressing upcoming changes to their environment. Building stronger service capabilities and recognizing the value of resources built during the previous paradigm are also identified to improve Scania's dynamic capabilities. From a competitive perspective, the shift may offer Scania some competitive advantages in the electric era, mainly as a result of previous strategic bets that turns out to be favorable in electrification. Many of the capabilities, however, are simply necessary to offer a competitive solution. Furthermore, Scania lack organizational support for many of the capabilities identified as important. Lastly, Scania have over the years built unique service resources that with proper distinctive service capabilities could be leverage into competitive advantage in the electric paradigm. Some of the resources are not used to their full potential, and improving the corresponding capabilities is very important. Being a premium solution provider, the competitive advantage Scania could achieve by doing so is offering the most customizable solution in the market. In general terms, the shift has the most consequences to the human and physical resources. Many of the capabilities that the company have or build to tackle the shift, is something that improves their ability to handle changes in their environment in general. Some of the resources built in the previous paradigm may also have significant impact on the company's ability to adapt to changes in their environment. Furthermore, technological shifts don't necessarily offer competitive advantage, it is about being equipped with the capabilities to even have competitive offers in the new era. In the cases when they do, it is generally capabilities that the company already possess that becomes more important as a consequence of the shift. The capabilities that the company need however often lack organizational support initially. Lastly, the company may possess or build unique resources that they can leverage into competitive advantage in the new technological era. From a servitization perspective, manufacturing companies can use their unique resources and distinctive service capabilities to find themselves service based competitive advantage that may give them an advantageous position in the new technological era.

It is important to emphasize that the three perspectives are not separate, but part of the same system as showcased in the technology shift steering wheel framework. Scania today have an offer centered around the diesel combustion technology. The offer's core technology is now replaced as a consequence of an ongoing technology shift in the industry. Replacing the technology doesn't just imply changes to the product, but the whole ecosystem surrounding it. Scania, being a solution provider, therefore form a technology strategy of building and offering the whole ecosystem around the new technology. Such a strategy involves ways to acquire the technology and the ecosystem, ways to manage it internally, and ways to exploit the technology in the market. To do so, Scania must extend its value proposition to include the ecosystem and find ways to harmonize it for the customer by constructing a new business model that supports it. They must therefore create an offer that embodies the value proposition in which they can exploit the technology. They must also build all capabilities necessary to deliver the new responsibilities, which is a direct consequence of the resources and activities that goes into delivering the business model. The technology shift steering wheel hence connects the dots to help the company identify which consequences they will encounter from the three perspectives. In general, a technology shift in the company's industry substitutes the core technology of the company. In response, they form a technology strategy to acquire, manage and exploit the new technology. They do, as a consequence, make changes to their business model to connect the new technological core to the customers' needs. They must then construct an offer around the new core technology that embodies the new value proposition. They will furthermore need to build or possess the necessary resources and capabilities to deliver the desired business model. The consequences are implications of each other, and the technology shift steering wheel help the company steer through the ambiguous alleys of a technology shift by identifying the consequences and help them understand how to respond.

7. Conclusions

As mature manufacturing companies face a technology shift, it is important to anticipate what consequences it may imply to their offer, business model, resources and capabilities. Otherwise, they may not manage to adapt. The purpose was hence to describe and analyze a mature manufacturing company's current offer and anticipate the consequences of a technology shift to the company's future offer, business model, resources and capabilities.

From the perspective of the company's offer, the shift changes the technical core which means that the physical product may see changes to how it is used and designed. However, the customer essentially wants to buy the same value. The technical changes offer improvements, that's the driver to exchange the core technology, but also imply challenges which are mitigated by the services around the product. The augmented offer is used to over-bridge the challenges of the shift. Depending on the shift's consequences, the relative importance of different aspects of the offer might change.

From the perspective of the business model, the technology shift has no consequences to the job to be done. Delivering the business model however can be heavily influenced by changing the technological core. All aspects of the business model see consequences. Since the job to be done is practically the same, the new offer will likely serve the same customer segment but may also appeal to new segments. The contemporary segments will likely be reached with the same channels, but additional channels may be accessed or needed to new customer segments. As technology shifts are uncertain to customers, the relationship grows stronger. Furthermore, since the company quickly have to acquire new capabilities, partnerships are identified to increase in important during technology shifts. The key resources and key activities also see consequences since the company need to know new things and possess new things to deliver the new business model. Lastly, the consequences to the other building blocks of the business model imply that the cost structure and revenue streams also see consequences in a technology shift.

From the perspective of the resources and capabilities, the shift has the most consequences to the human and physical resources. Many of the capabilities that the company have or build to tackle the shift, is something that improves their ability to handle changes in their environment in general. Resources built in the previous paradigm may also have significant impact on the company's ability to handle change. Furthermore, technological shift doesn't necessarily offer to many competitive advantages, it is more about being

equipped with the capabilities to even have competitive offers in the new era. In the cases when they do, it is generally capabilities that the company already possess that becomes more important as a consequence of the shift. The capabilities that the company need often lack organizational support initially which has to be built. Lastly, the company may possess or build unique resources that they can leverage into competitive advantage in the new technological era. From a servitization perspective, manufacturing companies can use their unique resources and distinct service capabilities to find themselves service based competitive advantage that may give them an advantageous position in the new technological era.

The three perspectives are not separate, but part of the same system. A technology shift in a company's industry substitutes the core technology of the company, and in response they form a technology strategy to acquire, manage and exploit the new technology. They do, as a consequence, make changes to their business model to connect the new technological core to the customers' needs. They must then construct an offer around the new core technology that embodies the new value proposition. They will furthermore need to build or possess the necessary resources and capabilities to deliver the desired business model. The consequences are implications of each other, and the technology shift steering wheel hence help the company steer through the ambiguous alleys of a technology shift by identifying the consequences and help the company understand how to respond.

As a concluding remark, even though technology shifts imply risks and challenges to mature manufacturing companies, they also offer opportunities. To reach the full potential of electrification as a mature manufacturer in the transport industry, it is critical to master an ecosystem of products and services far beyond the traditional boundaries of OEMs. Even though it is still important to offer a competitive vehicle, it is critical to possess capabilities to offer the transport solution as a whole, not just the hardware. Since electrification offer a technology that leverage on high utility rates, offering the transport as a service rather than a product can be a very viable business model. Electrification is not initiated by the customers; they will follow when the solution is the equal or better option. Manufacturing companies in the transport industry should therefore prioritize building the necessary ecosystem, where their products go hand in hand with internal and external services, packages as solutions. That means, apart from developing a competitive technological core (foremost battery) they also have to develop solution capabilities with the adequate organizational support. To succeed in the shift, OEMs in the industry must furthermore learn to work more agile to be successful in a faster and more uncertain environment.

From a more general perspective, it is crucial to understand the consequences a technology shift imply and use the knowledge to construct a business model with an offer and the capabilities that are identified to be important to deliver that business model. If prioritizing, it is important to apart from the new technological core understand which part of the offer that becomes the most important in the next era and build a business model which reflects that. First, it is important to build capabilities that are needed to have a competitive offer in the next paradigm with the corresponding organizational support, then it is important to identify which capabilities that will provide competitive advantage and use them to construct a unique offer. Often, the augmented offer has to be extended to mitigate the consequences of the technology shift, therefore servitizing can be a valid way to stand out from the crowd already during the shift. To be successful, companies should furthermore consider changing their work process towards a more agile one to be equipped for the volatile and uncertain nature of technology shifts.

8. Contributions and reflections

8.1 General contributions

The main contribution is the technology shift steering wheel which is a framework that could be used for similar studies both from an academic and an industry perspective. The framework could from an academic perspective be useful in studying other companies and other shifts to increase the knowledge base about the phenomenon. The framework could also from an industry perspective be used to provide companies facing a shift with the consequences they will encounter.

To some extent, the findings in this report could be seen as a contribution in the studying of electrification of the transport system. However, one should be restrictive in generalizing the findings of one particular case. Nevertheless, the findings could give an indication of the consequences to similar companies, i.e., mature manufacturing companies in the heavy vehicle transport industry.

According to one of the cited reports, few studies address the intersection between servitization and technology shifts. It is therefore an academic contribution to provide the academia with further theory and insights regarding this relatively unexplored research field.

8.2 Contributions and recommendations to Scania

The contribution to Scania is the insights towards the consequences of electrification to their offer, business model, resources and capabilities. The author hopes that Scania will find the conclusions useful to their continued path of electrification and that they will use the recommendations as a basis for discussion on how to be better solution providers in the electrified era.

The author makes the following recommendations to Scania:

- The services and products must be devoted equal consideration, and Scania thus must integrate them more from an organizational perspective. Therefore, Scania is recommended to organize as a solution provider and not in “products” and “services”.
- Scania are recommended to create the necessary systems and tools centrally to support the retail network in selling and delivering customized solutions in a profitable way.

- Scania are therefore also recommended to create the same modularity in their services as they have in their products to offer the most customizable solution at the lowest cost.
- Scania are recommended to give the workshops new responsibilities to extract their full vale as a resource very close to the customer.
- Scania are recommended to leverage their service resources to offer the most customizable solution in the industry and make that their unique selling point.
- Scania are recommended to build organizational support for the new important capabilities, especially the solution delivery capability that can offer competitive advantage.
- Scania are furthermore recommended to be proactive in the development of the charging infrastructure, as it is a bottleneck for the adoption of electrification.
- Finally, a solution provider offers the customer the best solution available, which in electrification imply offering the whole ecosystem to make electric transports as easy as diesel combustion transports. To be a solution provider becomes very valuable in the electric era, and Scania already possess many valuable capabilities due to their history as solution providers. That gives Scania an important advantaged over the competition that they should built upon. By building on the capabilities that Scania already possess and package the new technical core in an uptime service solution, Scania have a great chance of being very successful in the electrified era.

8.3 Reflections

Even though electrification have consequences to the aspects discussed in this report, it is important to emphasize that the consequences may not be exclusively related to electrification. As an example, electrification imply new ways to work at Scania, but so does the digital transformation and other megatrends in the industry such as ACE (autonomous, connected, electric).

In terms of generalizing the results, selecting a case company in the same industry with roughly the same size and market position would in the authors opinion likely give similar results. As an example, Swedish truck manufacturer Volvo are also facing electrification, are part of the premium segment, and are similar in terms of size. However, the two case companies may have different technology strategies or different approaches to solutions, and it would therefore be interesting to see if that would impact the conclusions.

8.4 Further studies

To test the robustness of the framework, it would be interesting to test it on other similar transport companies undergoing the same shift. Furthermore, the framework could also be applied on other industries or other shifts to create new knowledge in the research field of technology shifts. Furthermore, adapting the framework or improving it is very welcomed by the author. As an example, when the offer doesn't consist of a physical product, some other model more targeted towards service would be preferable to analyze the offer. See as an example Grönroos (2000) *the augmented service offering* (Grönroos, 2000).

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