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SCHOOL OF BUSINESS, ECONOMICS AND LAW

A useful set of tools or a heavy backpack?

A case study of Volvo Trucks during the shift from fossil fuels to electricity.

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Preface

We would like to thank everyone who participated in helping us finish this study. First off, we would like to thank our tutor Jon Williamsson who provided invaluable guidance throughout the entire process, helping us make sense of it all. Jon has provided feedback on our written material and thoughts through countless meetings whenever we needed it. We would also like to extend our deepest gratitude to our interviewees who took time out of their days to talk to us.

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Abstract

Since the discoveries of the externalities caused by the combustion of fossil fuels, a more sustainable alternative has been sought. One such solution that has gained increased attention from both the public and the manufacturing industry is Battery Electric Vehicles, BEVs. However, for the vehicle production industry, this technological shift is not unproblematic due to heavy investments in the development and production of Internal Combustion Engines, ICEs. The aim of this study is hence to try and identify the main considerations of a mature producer, Volvo Trucks, because of the company's size and the sister company's already developed battery electric busses, through a literature review and interviews. The results show that Volvo Trucks are aiming to educate their customers on the benefits of BEVs, help handle the customers' perceived risk, as well as to create a more agile organisation.

Keywords: Innovation management, Technological innovation, Service innovation, Management innovation, Electromobility, Battery electric truck, Electric vehicle, Disruptive innovation, Volvo.

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1. Introduction

This part will present a brief background and discussion of the problem examined in this study. It will also present the aim, delimitation and outline of the study.

1.1 Background

Throughout history, mankind has been an innovator. She has created tools, machines and organised herself with others to solve her problems. Since the discovery of the practical uses of oil as an energy source in the beginning of the 20th century (Tongur & Engwall, 2014), technological innovation has developed many usages for it. One of the business sectors that has depended heavily on oil use is the automotive industry, which has relied on Internal Combustion Engines, ICEs, using gasoline and diesel as its energy source (Tongur & Engwall, 2014).

Since the advent of combustion engines, scientists have discovered externalities, such as smog in the local environment and climate change on a global scale, caused by the burning of oil and fossil fuels (Bae, Sarkis & Yoo, 2011). Even when not taking these factors into consideration, the fact that petroleum is 'a very volatile commodity whose available inventory as a natural resource is rapidly depleting' should be taken into account (Bae et al., 2011, p.793). At the same time as the political pressure to reduce pollution is rising (Tongur & Engwall, 2014), the customer demand for vehicles is shifting towards lower carbon alternatives (Volvo Group, 2017, p.16).

1.2 Discussion of problem

This increased interest in more environmentally sound transports has led to the development of new fuels made from renewable sources. While resulting in noticeably lower emissions of carbon than conventional fossil fuels, most of them fail to reach zero emission, and the only way to attain no emissions at all would be to go fully electric or use fuel-cells (European Commission, 2016). Electric and fuel-cell vehicles share many advantages, but the biggest disadvantage of fuel-cells is that they use hydrogen, which is complicated and expensive to produce (Larminie & Dicks, 2003). As a result, the popularity of electrical passenger vehicles has grown among the public (European Environmental Agency, 2016, p. 48), and there are more than 500 battery electric buses in the EU (European Environmental Agency, 2016, p. 39).

A shift towards battery electric vehicles is not without problems for the producers however, especially since their extensive experience is, as previously mentioned, in the area of ICEs rather than electric

engines. In the face of technological shifts, Tongur & Engwall (2014) suggest that innovation research has two different strategies; technology innovation, where the firms can invest in research and development, R&D, 'to radically transform the firm's technological core competence', or service innovation, where the product is embedded in 'functional sales and product service systems' (p. 525). One problem that emerges when considering which strategy to pursue, is that the development of new technologies and services is expensive, and due to technological discontinuities, the technology desired by the customers might change (Porter, 1985), which creates an uncertainty of what technology should be developed to meet the future demand.

However, when striving towards innovation, facing competition and rapidly changing technologies, it is important not to forget that 'the challenge is not only offering new products and services, but also changing the nature of management within organizations' (Vaccaro, Jansen, Van Den Bosch and Volberda, 2012, p. 28). Management innovation is a process that can lead to increased competitiveness for organisations, and even redefine entire industries (Vaccaro et al., 2012).

On the one hand, the shift has already started for passenger vehicles and busses, as shown by the increased popularity, but on the other hand, fully battery electric trucks are not yet commercially available (European Environment Agency, 2016). Trucks need to carry heavy loads and travel far, making it hard to find suitable batteries (European Environment Agency, 2016). For a business sector as heavily dependent on the use of fossil fuels as the truck manufacturing industry, a shift to battery electric vehicles, BEVs, poses a big challenge for many established actors. The truck industry is considered 'mature and characterized mainly by incremental technical innovation' (Tongur & Engwall, 2014, p. 529), and when adding the industry's capital and knowledge invested into the production of ICE vehicles, one realises that a technology shift as big as this could prove difficult or even 'lethal to many manufacturing companies' (Tongur & Engwall, 2014, p. 525).

While it is difficult to undergo technological changes of this magnitude because of the difficulty of transforming the technological core competence (Tongur & Engwall, 2014), one of the companies that has started exploring this upcoming shift is Volvo Group. They have shown interest in technology innovation through the electrification of their vehicles, and have developed several different electrified buses, spanning from hybrids to all-electric (Volvo Group, 2017a, p. 38). The company also engages in service innovation, providing services spanning from financing solutions, rental services and IT services together with the products sold, which 'helps to balance fluctuations in the sales of new products' (Volvo Group, 2017b). With Volvo Group being such a large organisation with just shy of 95 000 employees worldwide (Volvo Group, 2017a), management innovation may become more difficult as organisation size grows while it still is 'an important source' to remain competitive (Vaccaro et al., 2012, p. 28).

However, Volvo Group's largest business area by net sales is trucks (Volvo Group, 2017a, p. 2), so the transition of Volvo Trucks towards BE technology could have a large impact on Volvo Group. Taking this into consideration, as well as Volvo Truck's competence in BE technology through the sister company Volvo Bus, and the move towards expanding the value proposition by including services into the products, makes Volvo Trucks relevant for this study. Finally, since Volvo Trucks is the second largest heavy-duty truck manufacturer in the world (Volvo Group, 2017a), it makes the company an interesting case study to further understand the difficulties that established truck manufacturers may encounter during the shift towards BE technology.

1.3 Research question

How is the uncertainty of future demand for BEVs dealt with, by Volvo Trucks, and what are their main considerations during the shift from ICE to BEV?

1.4 Aim and Scope

The purpose of this thesis is to identify what Volvo Trucks considers to be the critical factors to take into account when undergoing the technological shift from ICE trucks powered by diesel to battery electric trucks. It also aims to map how Volvo Trucks is dealing with the uncertainty factor of future customer demand for a product not yet available commercially.

By fulfilling the purpose, the thesis will provide evidence for innovation management in practise during radical shifts in a Swedish context. In addition, upon fulfilling the aim of the study, a deeper understanding will be provided of the problems encountered by mature established truck manufacturing companies during the shift towards BE technology.

1.5 Delimitation

There are several ways to electrify a vehicle, spanning from electric road systems and hybrids to fully-electric battery technologies. The focus of this study is BE trucks because of the superiority of BEVs in terms of low environmental impact (European Environmental Agency, 2016), in relation to the technological feasibility to commercialise BE trucks in a not too distant future (Feng & Figliozzi, 2012). This study is excluding all other technologies, such as alternative fuels for ICEs, hybrid electric vehicles and electric road systems, and will only explore the use of BEV technology in the shift away from ICE technology.

1.6 Outline

First, a frame of references is provided, where relevant information and theories on technology, service and management innovation are presented. After which a description of the methodology used to conduct the study follows, and how credibility, transferability, dependability and confirmability were ensured. The next section presents the results from the empirical study, followed by an analysis and discussion where theory and empirical findings are compared and analysed. Finally, a conclusion of the study's findings follows and recommendations for future research.

2. Frame of references

This section will present three kinds of innovation which are used in this study to examine the problem, followed by basic information about BE trucks and the studied company. The theoretical material will then be summarised.

2.1 Innovation Theory

Innovation can be found in different alterations and this study examines three different kinds of innovation and how they are described by the literature. The three kinds are technological innovation, service innovation and management innovation. These are used to analyse the empirical material later in the study.

2.1.1 Technology Innovation

There are two different types of innovation according to Abernathy & Clark (1985), incremental innovation, which leads to enhanced performance within its technological paradigm, and radical innovation, which is innovation in areas where the organisation does not have prior knowledge. Incremental innovation can make processes or products more effective and attractive by utilising existing resources within the firm. Radical innovation can also bring with it change that makes a process or product more attractive but it does it in a way that the existing resources within the firm 'satisfy poorly or not at all' (Abernathy & Clark, 1985, p. 6). To summarise, the difference in effect between incremental and radical innovation is that incremental innovation is 'enhancing and strengthening' while radical innovation instead 'disrupts and destroys' existing competence (Abernathy & Clark, 1985, p. 6).

When industries are forced to undergo radical technological change, companies within these industries are likely to face problems because they cannot react fast enough. This is especially true for mature companies facing technological shifts where they struggle to see what needs to change and how it should change before it happens (Abernathy & Clark, 1985). According to Tongur & Engwall (2014), the reason they run this risk is because they 'tend to focus too much on their existing customers' (p. 526) and not pay enough heed to new emerging technologies which are viewed as 'less profitable or under-performing' (p. 526).

Thus, radical innovation can be hugely impactful on mature companies that suddenly find themselves losing their market position to new entrants. When radical innovation is more extreme, 'where disruption is both deep and extensive, such innovation creates new industries.' (Abernathy & Clark,

1985, p. 6). There are many ways that established actors can try to prevent this grim outlook and among them is, according to Tongur & Engwall (2014), to invest in R&D and try to maintain their technological position of their existing products by continuing to invest in incremental innovation. This should be done while not ignoring new and more radical technology by doing both types of innovation at once (Tongur & Engwall, 2014).

2.1.1.1 Being the first mover on a new market

When looking at whether to invest in new emerging technologies or not it should be a conscious choice according to Porter (1985). It is an important decision in whether the company wants to position itself as a technological leader, to reap the potential benefits of first-mover advantages, or to be a technological follower to avoid the potential pitfalls of first-mover disadvantages. The decision on this matter 'can be a way of achieving either low cost or differentiation' (Porter, 1985, p. 68).

The first-mover advantages are the benefits a company gains by being one of the first companies to exploit a new technology and can offer a wide range of perks. One of the potential upsides, as described by Porter (1985), of being a technological leader can be lasting reputational benefits, by being regarded by stakeholders as unique because of perceived technological superiority, even after the technological gap has been bridged by competitors. Also included in the list of potential benefits of being the first-mover is the ability to raise the switching costs for the firm's stakeholders so that they refrain from switching to a competitor as they arrive. Another advantage of being early with adopting new technology is that 'a first mover can define the standards for technology or for other activities, forcing later movers to adopt them' (Porter, 1985, p. 72).

While there on the one hand certainly are possible benefits to get by being a first-mover, it should not be forgotten that it on the other hand are potential risks in being unable to avoid the first-mover disadvantages. These 'stem from two broad sources, the costs of pioneering and the risk that conditions will change' (Porter, 1985, p. 73). The pioneering costs include, but are not limited to, educating the buyers so that they realise what they want and how to use it. Also among the pioneering costs is that early in production, the cost per product is high because of 'scarcity of supply or small scale of needs' (Porter, 1985, p. 73). Another risk factor that becomes important is the demand uncertainty, because a first mover 'bears the risk of uncertainty of future demand' when it needs to take the first step and provide a product or service before there is demand for it so that demand has a chance to materialise (Porter, 1985, p. 73). Future demand is hard to predict and another aspect that is volatile and hard to predict is technological discontinuity, where an emerging technology is deemed promising and investment into it follows. A risk here is that the technology suddenly meets an insurmountable barrier which renders the technology and all the investments into it obsolete. First-movers have to take great care to not find themselves in situations where they are in the middle of

‘major shifts in technology that a first mover may be ill prepared to respond to given its investment in the old technology’ (Porter, 1985, p. 73-74).

It should here, however, be kept in mind that models of firm competitiveness such as Porter’s have been described to be oversimplified with the assumption that all firms within an industry ‘are identical in terms of the strategically relevant resources they control and the strategies they pursue’ (Barney, 2000, p. 205). Another criticism of Porter's frameworks is that they are static and do not take into account 'the dynamic environments within which many firms operate' which makes them age poorly (Huggnd & Izushi, 2012, p. 10). On this, however, Porter's response was that his work is not examining trends within businesses, instead it is dealing with 'something that is an underlying fundamental. It will be about something like the switching cost, and not, for example, an IT variable' which, he claims, makes it independent to the current state of the industry (Huggnd & Izushi, 2012, p. 10).

2.1.2 Service Innovation

In the face of innovation, instead of focusing on technological innovation, firms can try to expand their value proposition by adding services to their product. This is called ‘servitization’ and often manifests itself with ‘the move by manufacturers to generate greater returns by providing through life support for their products’ (Ng, Parry, Smith, Maull & Briscoe, 2012, p. 417). Mont (2002), suggests that the service economy should be referred to as the ‘functional economy’ because ‘both product and technology are mere modes of providing function’ which is absolutely central to the satisfaction of the customers (p. 238). The shift to services is among the main points in Mont’s view on servitization where for instance customers ‘are buying mobility instead of cars’ (Mont, 2002, p. 238). Another shift is the shift of research focus, according to Tongur & Engwall (2014), towards the notion that ‘disruptive innovation may present opportunities to generate new services’ (p. 526)

To sell an entire system of products and services as a solution to the customer’s needs is called a ‘product-service system’, or PSS for short, and is categorised by a few trends according to Mont (2002). One of the trends is when rather than selling a product, the customer is sold the use of the product and all the surrounding services that are required to gain utility from it. Another trend that is identified is the change from selling products with an initial payment towards leasing the product during the lifetime of the product to the customer (Mont, 2002, p. 239).

2.1.3 Management Innovation

Management practices have changed significantly through history, lean production being one well-known example (Vaccaro et al., 2012, p. 29). These changes can be defined as 'management innovation' if they are new either to the world or to the organisation implementing them, depending on viewpoint (Birkinshaw, Hamel & Mol, 2008, p. 828). In this study, management innovation is viewed as the 'generation and implementation of a management practice, process, structure or technique that is new [to the organisation] that is intended to further organizational goals' (Birkinshaw et al., 2008, p. 829), and can be detected through 'how managers set directions, make decisions, coordinate activities, and motivate people' (Vaccaro et al., 2012, p. 30). Management practices are, for instance, the setting of objectives, arranging tasks and developing talent, whereas management processes are the routines the manager is keeping to in her work, and management structure refers to the organisation of communication and aligning of contributions from the employees (Vaccaro et al., 2012). One example of management innovation within an organisation, lifted by Vaccaro et al. (2012), is self-managed teams that are 'responsible for their own internal functioning, setting of priorities, and decision making' (p. 31), thereby affecting the management practices, processes, and structures.

Birkinshaw et al. (2008) further lifts the importance of 'change agents' to management innovation. There are two types of change agents - internal and external. The internal change agents are employees who are 'creating interest in, experimenting with, and validating the management innovation', and the external change agents are 'independent consultants, academics, and gurus' outside the organisation who bring legitimacy, credibility and expertise to the management innovation process (Birkinshaw et al., 2008, p. 832).

Moreover, Vaccaro et al. (2012) emphasise the importance of leadership, stating that a leader 'has the ability to greatly influence management innovation' (p. 28). Their study finds that a big organisation, would benefit from 'transformational leaders' for their management innovation setting to be successful, because of the complexity of a large organisation. A transformational leader is one that is 'admired, respected and trusted', challenges her followers, encourages creativity, and shows appreciation 'for each of the followers and their ideas' (Vaccaro et al., 2012, p. 32), and she is in the position to create 'an organizational context conducive to experimentation with and introduction of new processes, practices, or structures' (p. 31).

2.2 Battery Electric Trucks

As mentioned in the delimitation, there are more than one way to electrify a vehicle. The most suitable way depends on how the truck will be used. Medium-duty trucks are lighter, and often operate in an urban environment with low average driving speed rather than long-hauling across the country, making them suitable for electrification (Lee, Thomas & Brown, 2013).

One of the advantages of the BE truck is its 'far lower life-cycle environmental impacts' than fossil fuel trucks, if the electricity used to charge it is generated from renewable energy sources (Sen, Ercan & Tatari, 2017, p. 119). Another advantage is that a BE truck has a lower total maintenance cost than its conventional counterpart 'due to the absence of engine and transmission-related maintenance' and the use of regenerative braking (Lee et al., 2013, p. 8025).

A disadvantage of the BE truck is its limited range related to its battery. Large batteries provide longer driving range, but they are also heavier. The full-electric Swiss 'eForce one' truck weighs 18 tonnes and has a range of 300 km, but its battery weighs 2,6 tonnes - reducing the truck's loading capacity (European Environmental Agency, 2016, p. 38). Also, even though the urban setting has the potential of 'higher density of recharging stations' (Feng & Figliozzi, 2012, p. 703), 'the current widespread unavailability of fast recharging stations is likely to hinder to massive adoption of commercial electric trucks in urban areas' (p. 710). Furthermore, the attractiveness of the BE truck also depends on other factors, like the battery's life expectancy and price, and the diesel fuel price in comparison to the electricity price (Lee et al., 2013).

However, one of the biggest issues in the commercialisation of BE trucks today is that they have a high initial cost. This high price prevents their competitiveness, and would 'have to decrease between a 10 and 30% for these vehicles to become competitive' (Feng & Figliozzi, 2012, p. 710). For this decrease to be realised, the manufacturers would need to attain 'economies of scale due to mass production or less expensive batteries', something that should be possible in the near- to mid-term future (Feng & Figliozzi, 2012, p. 710).

2.2.1 Range anxiety

The limited range of the BE truck in combination with the current unavailability of recharging stations leads to a phenomenon called range anxiety (Feng & Figliozzi, 2012). This is when the driver's worry to run out of power causes 'a reduction in the utilized range by as much as 50%' (Feng & Figliozzi, 2012, p. 704), hence leading to the truck's full potential not being used.

2.3 Volvo Trucks

Volvo Trucks is, as mentioned, the second-largest heavy-duty truck brand in the world, selling trucks in more than 140 countries (Volvo Trucks, 2015a). The company is a subsidiary to Volvo Group that was created in 1927, and produces medium-, heavy-duty and construction trucks (Volvo Group, 2017a). Its core values are Quality, Safety and Environment, the latter expressed through a strive towards energy efficiency (Volvo Trucks, 2015b).

Volvo Trucks continuously focus on improving energy-efficiency as a way to lower carbon emissions (Volvo Trucks, 2015b), but states that 'there is no single fuel to meet all needs' (Volvo Group, 2017a). The company's research and development thus focus on several energy sources with different applications depending on the purpose of the vehicle, e.g. methane, dimethylether and electricity (Volvo Group, 2017a).

Furthermore, the Volvo Group annual and sustainability report for 2016 lifts the development of electromobility for busses and medium-weight trucks (Volvo Group, 2017a, p. 38). All-electric busses are already a reality in Volvo Group, and customer testing is ongoing for medium-weight trucks.

2.4 Summary of frame of references

The radical shift from ICE to BE technology necessitates innovation in different forms and in this case namely technological, service and management innovation. All three forms of innovation are responses to change in the firm's environment.

Technological innovation can be of two kinds: incremental and radical. The former is enhancing competence within the existing technological paradigm. The latter is innovation that is in, to the firm, new areas and thus makes existing competence obsolete (Abernathy & Clark, 1985). Mature companies often struggle with radical innovation and risk losing their position on the market to new smaller competitors due to this. There are some ways mature companies can try to keep their position on the market, for instance investing in R&D for their existing products (Abernathy & Clark, 1985 ; Tongur & Engwall, 2014). In technological shifts, actors on the market should decide whether to pursue first-mover advantages by being a technological leader or to try to avoid first-mover disadvantages by being a technological follower (Porter, 1985). The first-mover advantages could be to set standards for technologies that later actors have to adjust to, or to get reputational benefits by being early. First-mover disadvantages come from two sources: pioneering costs and the risk of conditions changing. The latter can manifest itself as technological discontinuity where a new technology is invested in but is then forced to be abandoned because of new conditions (Porter, 1985).

If not by technological innovation, the radical shift can be dealt with by service innovation by incorporating services into the product offered to customers. Also, a trend among manufacturing companies is the move to the functional economy where the use of a product is sold rather than the product itself (Ng et al., 2012 ; Mont, 2002). One step further towards integrating services with products is what Mont (2002) refers to as product service systems where the customer is sold a system solution to their needs.

Last but not least is management innovation which is by Birkinshaw et al. (2008) explained to be the changing of three components: management practices, management processes and management structures. These changes are only considered to be part of management innovation if they are new to the organisation (Birkinshaw et al., 2008). The drivers of management innovation are referred to as 'change agents' and a possible change agent could be leaders, due to the fact that leaders usually have the ability to affect management practices, processes and structures (Birkinshaw et al., 2008 ; Vaccaro et al., 2012).

These three kinds of innovation will be used as categories to sort the empirical material into. The categories will then be used in the analysis to compare the empirical findings with the theoretical frame of references.

3. Research method

This section will explain how the research was approached and how the study was conducted in general. It will also describe how the subject was chosen, the frame of references created and how the interviews were done, transcribed and analysed.

3.1 Research approach

The research approach in this study was a case study looking into Volvo Trucks' shift towards electromobility. To do this, the study used interviews, i.e. a qualitative source, as its primary source of information because of a qualitative study's ability to generate rich data on the subject (Bryman & Bell, 2013). For a deeper understanding, the study also used secondary sources, such as articles and books.

There are three types of case studies according to Stake (1995); intrinsic, instrumental and collective. Intrinsic means that there is a particular case that needs to be studied, without it providing understanding to other cases or any general problem (Stake, 1995). Instrumental means that there is a research question, and a need for general understanding, where a specific case could provide deeper insight (Stake, 1995). Collective means that a set of instrumental case studies are combined (Stake, 1995). This study is an instrumental case study where one specific case was examined in-depth as a way to reach deep understanding on the subject. Flyvbjerg (2006) explains that contrary to what the conventional wisdom says about case studies 'one can often generalize on the basis of a single case, and the case study may be central to scientific development via generalization as supplement or alternative to other methods' (p. 228). Flyvbjerg (2006) also writes that even though generalisation is possible from case studies, context-dependent knowledge is both useful and underestimated for research and that the case study is 'especially well suited to produce this knowledge' (p. 223).

3.2 Method for developing the theoretical frame of references

The first step of this research process after a subject had been chosen was to lay a foundation of knowledge around it. This was mainly done by reading articles to gain a general understanding of the subject. The concept of innovation in different forms came up early in this initial research process and thus it was natural to build a frame of references incorporating this.

3.2.1 Databases

In order to find relevant material, online bibliographical databases were used as they are ‘an invaluable source of academic journal references’ (Bryman & Bell, 2015, p. 112). Primarily, the database search engine, SuperSearch, of Gothenburg University Library was used because of its ability to find not only academic articles but also references in books that could be available to loan at the library or access online (Gothenburg University Library, 2017). In order to find specific subjects Boolean Search Logic was employed, and to exclude irrelevant hits ‘operators’ were used such as ‘ “innovation management” ’ which would include hits that had only the exact wording of the search and not only ‘innovation’ and ‘management’ separately (Massachusetts Institute of Technology Library, n.d.). This part of the research was explorative and in each article that was deemed relevant, the keywords of that article were used to continue the search process further.

3.2.1.1 Keyword search history

- Electromobility
- Electric truck
- Electric AND truck AND technology
- Technology shift AND truck
- Future demand uncertainty
- “Game theory” AND “green technology” AND truck
- Technology AND “first mover advantage”
- "Innovation management" technology
- Management innovation
- Fuel cell truck

3.2.2 Articles

The articles that are used in this research are almost exclusively from academic journals and thus peer reviewed as a way to ensure their credibility. Peer reviewed articles are anonymously reviewed by experts in the field and rejected if they feel that the article is lacking in any way. The process of peer reviewing is a rigorous one where in some prestigious scholarly areas ‘it is common for more than 90 per cent of articles to be rejected’ (Bryman & Bell, 2015, p. 101). The extensive use of such academic articles adds to the credibility of this study.

3.3 Method for empirical material collection

Here the way that the interviews were planned, carried out, recorded and then transcribed is explained in detail.

3.3.1 Choice of interviewees

As a complement to the secondary sources on the subject of BE trucks, a primary source was used. In order to get such a primary source, contact was established with the department that is responsible for traffic in the City of Gothenburg. The subject was then briefly explained, and a request for someone that had the knowledge and time to participate in an interview was made. After being redirected a few times such a representative was found at Lindholmen Science Park. This representative was a person that was well-read on the subject of BE trucks, and the conversation with the same made sure that we reached a higher level of understanding of the complexity of the subject at hand.

Magnus Karlström is a former researcher at the University of Chalmers, who works as a project manager at Lindholmen Science Park. He is also the editor-in-chief since seven years back of a newsletter about electric vehicles, financed by the university of Chalmers and the Swedish Energy Agency.

When choosing interviewees at Volvo Trucks, a contact person at Volvo Trucks was asked for recommendations on who that could be contacted that might be able to answer the interview questions. Contact with the recommended people was made by e-mail, explaining the subject briefly and they were asked if they had the knowledge and time to answer the questions, or if they knew someone else that would be better suited for the interview. After being redirected a couple of times, a final list of interviewees was reached.

Niklas Thulin works at Volvo Group Trucks Technology as a researcher and product development manager for the Volvo Group's Electromobility unit. He has previously worked at Volvo Powertrain as software developer and as engineering manager for alternative fuels and powertrains, and he has over 15 years of experience from 'applied automotive research and product development' (Thulin, n.d.).

Daniel Heimer is a part of Volvo Group Trucks Technology, as the manager of project management and purchasing in the newly established Electromobility unit. Within Volvo Group he has worked with electromobility in different parts of the company since 2005. He previously worked at purchasing at Volvo Powertrain where he had responsibility over hybrids, and he has worked with electromobility at Volvo Group Trucks Operations. (Heimer, 2017)

Jessica Sandström is the Senior Vice President of City Mobility at Volvo Bus Corporation, and coordinates the Electromobility unit. She has worked with electromobility for 10 years, 'starting with product development, product planning and now [...] sales and business development' (Sandström, n.d.).

Fredrik Cederstav is a project manager of research projects at Advanced Technology & Research at Volvo Group Trucks Technology since 2011, with focus on 'urban transport solutions, autonomous vehicles, noise in refuse solutions, electromobility (ePTO) telematics projects'. (Cederstav, n.d.)

3.3.2 Structure of interviews

The interviewees were given an identical summary of the research focus at the initial contact which was over email in all the cases. The interviews used semi-structured questions as to adapt to unexpected but interesting turns during the interviews (Bryman & Bell, 2013). The interview method allowed for interview questions not previously thought of to be asked in order to reach interesting insights that would not have been reached otherwise (Eriksson & Kovalainen, 2008). If there was any confusion of what the interviewee had said, validation was sought through asking follow-up questions.

Even if the interviews were not strict in their structure, a base of questions was used for all interviews which can be found in Attachment 1 in the study's appendix. These questions were conceived through initial studying of the research field while trying to identify what kind of aspects to look for during the interviews. Theory was thus used as a foundation on which the questions for the interviews were based (Bryman & Bell, 2013). However, due to the interviews being semi-structured, not all questions were asked and others were added.

3.3.3 Interview form

The interviews were conducted face-to-face in order to reduce the risk of confusion between interviewer and interviewee. The interviews were conducted in Swedish to limit language barriers, which are described by Bryman & Bell (2013) to be inhibiting if interviews are conducted in another language than a person's first language. On the case of face-to-face interviews, Bryman & Bell (2015) summarises the findings of research into online interviews versus face-to-face interviews. The added benefit of face-to-face interviews was among other things the fact that the interviewees' answers are 'often more detailed and considered' than when interviewed over the internet (Bryman & Bell, 2015, p. 674). Because of the geographical proximity to the organisations from which the representatives came, it was not an issue to meet them in person for the interviews. Four of the interviews were held

at the representatives' workplaces as to reduce the risk of the interviewees declining due to time constraints. One of the interviews was conducted at the School of Business, Economics and Law at the University of Gothenburg by the wish of the interviewee.

3.3.4 Recording, transcription and summarising

All interviews were recorded digitally with an external microphone connected to a computer which per Bryman & Bell (2013) brings with it the advantage of superior audio quality. When initial greetings had taken place the recording process was started and it was not turned off until the end of the interview upon which the meetings ended as well to limit the risk of the interviewees saying important things after the recording had been stopped as recommended by Bryman & Bell (2013). During the interviews, notes were taken on subjects of particular interest and would be suited for a follow-up question at a later point in the interview. However, to be able to listen more carefully, the general content was only recorded and not written down during the interview.

All the interviews were transcribed in order to get a more thorough analysis of the answers of the interviewees as per Bryman & Bell (2013), and these transcriptions were then used as the basis for the analysis later on. To get an initial draft of the interviews the technique of 'voice-to-text' programmes was employed because of its speed (Bryman & Bell, 2013). The process through which this was done was by listening to the recording with headphones and then repeating what was heard into an external microphone as suggested by Bryman & Bell (2013). This technique of repeating what was said during the interview is attractive according to Bryman & Bell (2013) because it removes the issue of teaching the 'voice-to-text' programme how different interviewees pronounce different words by allowing it to only process the researcher's voice. The digital audio files from the interviews were then listened through at least twice in order to get the exact wording right as to not miss quote the interviewees. In order to get a get an overview of the empirical findings a summary with timestamps was written of each interview, to find quotes at a later point. All relevant direct quotations from the empirical data were translated from Swedish to English in a manner that attempted to retain the meaning rather than the structure of the sentences, such as the case of idioms which loses some of their meaning if literally translated (Bryman & Bell, 2013). These interview summaries were used extensively during the analysis part of the research.

3.4 Method for analysis of empirical data

This section describes how the interviews were first analysed individually, then compared to each other and finally to the theoretical framework of the study. The section is then followed by a description of how validity and reliability was taken into consideration.

3.4.1 Interview analysis

All people are individuals and no one is exactly like the other, and since an organisation can be defined as made up of 'a group of people who form a business, club, etc. together in order to achieve a particular aim' (Hornby & Turnbull, 2010, p. 1074), there will be different and sometimes conflicting opinions and perceptions within the organisation. This means that the answers of the interviewees are representations of that individual's perceptions and assumptions, and might therefore differ between the individuals. This can be explained by how people make sense of the situations they encounter in different ways.

Sensemaking is a theory or frame of reference pioneered by Weick (1995) that can be used when doing qualitative studies of organisations (Manning, 2013, p. 695). Sensemaking is, among other things, linked to the individual performing it, it seeks to retrospectively rationalise people's decisions and actions, and it 'addresses the question of how actors feel attached to the organization and how the organization presents itself to those who work there' (Manning, 2013, p. 695). Within the organisation, the individual creates, through Sensemaking, a picture of said organisation through 'routines, tasks, and communications' (Manning, 2013, p. 696), while the organisation itself tries to sustain its 'identity, image or "who are we as an organization" ' (p. 696). Manning (2013) further explains that 'organizational imagery, stated core values, and the organizational culture' are connected (p. 696), which leads to change to any of these being problematic. If the changes feel too far from how the individual perceived the organisation, 'its role, its history, and even its future', said individual could lose their 'sense of connectedness' with the organisation (Manning, 2013, p. 696).

Notable about the process of Sensemaking is that what is important is not how accurate the new view of the world is when it is updated with the new information, but how closely it fits the person's current view of the world (Weick, 1995). In other words, it is more important how plausible the explanation is, without conflicting with the person's current world view, rather than how closely it resembles the truth. Because of this, small details could be blown out of proportion, as a result of trying to make the new information make sense, without it conflicting with the person's current world view (Weick, 1995). This is why something can hold true according to one individual, and not according to another, while both are describing what they perceive as the truth.

In this study, Sensemaking provides a way to analyse the underlying problems of introducing technological and organisational change, i.e. the potential conflicts among stakeholders in their perception of the organisation, and the consequences of said conflicts. Furthermore, even if Sensemaking is not the focus of the study, it is worth remembering that it is not only the interviewees, but also the interviewers, and the interaction between the two, that are affected by Sensemaking

(Weick, 1995). Sensemaking is something everyone does, all the time, thus everyone will have their own perception of what is the truth (Weick, 1995).

3.4.2 Comparison between theory and empirical data

The summaries from the interviews together with the transcriptions creates the base upon which the empirical analysis is built. The analysis of the empirical data was largely done by comparing it with a theoretical frame of reference as well as comparing the answers from the different interviews with each other. Because this is a qualitative study, the theories and the empirical data are continuously interacting with each other and more theory has been added as the need for it has been identified. The first thing that was done when the analysis of the empirical material was started, was to categorise it into the same categories as the theoretical framework: Technological Innovation, Service Innovation and Management Innovation, in order to build a structure that would be easy for the reader to follow. This was also done to examine the data and the theories to discover discrepancies and similarities upon which to found the analysis.

3.5 Credibility, transferability, dependability and confirmability

Many researchers that use qualitative research methods argue that the same measures that are used on quantitative research is not applicable to qualitative research according to Bryman & Bell (2013). Instead of using validity and reliability to gage the study, Bryman & Bell (2013) describe four similar but, according to some researchers, more specific criteria that can be used on qualitative studies; credibility, transferability, dependability and confirmability.

Credibility is how well the results match with the truth, even if truths are subjective. Bryman & Bell (2013) explain that credibility is a substitute for the measurement internal validity. One good way of increasing the credibility, according to Bryman & Bell (2013), is respondent validation where the researcher maintains a dialogue with the participants of the study to corroborate the findings in order to make sure that her interpretation of the participants' experiences was correct. Because the interviewees were contacted with the summaries from the interviews to let them respond if something was wrong with the interpretation of it, the credibility of the empirical data increased. Also, to increase credibility, the empirical data was as previously mentioned both recorded and transcribed in order to not miss important details.

Transferability is whether the findings of the study are applicable in another context than the one studied in the case (Bryman & Bell, 2013). Transferability is described by Bryman & Bell (2013) to be a kind of external validity measurement. Because the study examines specific factors within a specific company, high transferability is not the main concern for this research. The company that is

examined in this study, is however, an influential actor on the market and it is not unlikely that some of the conclusions drawn in the research can be applied to other mature actors within the business sector.

Dependability is the matter of how trustworthy a study is and plays the same role as reliability would within quantitative research (Bryman & Bell, 2013). Dependability is increased when researchers keep records of the entire research process as to let external actors, if they desire it, audit the research project. Extensive records have been kept from this study, including original audio recordings from all interviews, but no external auditing has been requested and due to time constraints, it has not been initiated by the researchers. Bryman & Bell (2015) acknowledge these limitations of auditing and highlight the problem of it being very demanding for the auditors as a reason that this has not become 'a pervasive approach to validation' (p. 405).

Confirmability, is the issue of the researchers remaining objective while conducting their study, thus it is similar to the measurement objectivity (Bryman & Bell, 2013). While it is considered, as per Bryman & Bell (2013), impossible to conduct completely objective research, it is important for the confirmability of the study that the researchers are not found to have been acting in bad faith and knowingly and willingly let personal opinions affect the results of the research. In this study, the authors have tried, to the best of their ability, to maintain an objective view on the gathered empirical material. It is important, though, to lift the fact that 'the case study contains no greater bias toward verification of the researcher's preconceived notions than other methods of inquiry' (Flyvbjerg, 2006, p. 237).

4. Results from empirical studies

Here selected empirical data from the conducted interviews is categorised and presented to ease the analysis later on in the study.

4.1 Interviews

The answers from the interviews are here divided into the three kinds of innovation used by this study; technology innovation, service innovation and management innovation.

4.1.1 Answers regarding Technology Innovation

From the interviews with the representatives from Volvo Trucks there were aspects that were brought up on the subject of technological challenges. Among the main concerns and problems with implementing BE trucks were battery related issues. During all the interviews, the current problems with the battery's relatively high price in relation to the total price of the vehicle was brought up as a big deterrent for its competitiveness. On the high price of batteries for heavy BEVs, Sandström highlighted that 'it is the most expensive component we have ever put on a vehicle, and the life expectancy is uncertain' (Sandström, 2017). Another problem with the batteries that was also identified as a deterrent was the fact that the technology is moving so fast in the battery sector, where Sandström (2017) explained that 'the chemistry in the batteries has to be changed every third year, or you risk falling behind' your competitors. This leads to that the would-be customer is scared of the possibility of there not being spare parts available to the battery within five years of purchasing a BE truck (Thulin, 2017). The risk of radical change in the battery sector is not something that only the customers have to deal with, according to Heimer (2017), instead this is something that Volvo is looking into continuously. He explained that one reason why Volvo Group does not have battery production in-house so far is that the production of batteries is still too small to gain economies of scale and that the issue of volume plays a central role in this dilemma (Heimer, 2017). Heimer (2017) also brought up the issue of unpredictable technology development in the battery technology where 'you want to know where the technology is heading before you commit to building your own industry infrastructure'.

The problem of customers being tentative towards new technology can manifest itself as 'range anxiety' but Thulin (2017) explained that for EVs, 'range anxiety is only an issue until you have tried it', and that the way to combat this problem is to make sure that there are products available for testing to interested potential customers (Thulin, 2017 ; Heimer, 2017). Cederstav (2017) had a different view on the problem of range anxiety and also the solution to it as being to bring extra

capacity and to have the option to recharge during the day if need be. Not only the batteries themselves provide areas of uncertainties, the way that the owners of the vehicles can recharge the batteries is also source of concern. During the interviews, the problem of coordination between all actors of the industry and all customers was brought up as a big obstacle to standardisation of the recharging infrastructure and the quick implementation of the it. Sandström (2017) went on to say that they, Volvo Buses, could not wait for standardisation to be implemented by another actor, instead they took matter into their own hands and created their own standard for recharging infrastructure, 'OppCharge'. They then contacted their competitors to try to get them to join the project where Sandström (2017) explained that 'there were no patents, nothing that could hinder anybody from incorporating OppCharge as their standard, all parties had to sign a contract where they agreed upon this'. Sandström (2017) continued to say that this was because they, Volvo Group, believe that 'the most important thing is that there is only one solution' in order to get as many customers as possible to risk investing in BEVs. Another aspect that can be discouraging for customers to try BE trucks is illuminated by Thulin (2017) to be the fact that since the recharging infrastructure is not widespread yet, the customer who is willing try the BE truck also has to be willing to pay for the recharging infrastructure.

Within the company Heimer (2017) explained that the technological shift from ICE to EVs brings with it the consequence that 'certain areas of competence will not be needed in the future' within the organisation, and that this could consequently lead to the worry of some within the organisation. Sandström (2017) recalled that they had taken the decision to completely abandon production of city buses that are propelled solely by diesel back in 2012, they did this because they decided that 'we are going to excel in this area, this is our best chance to get a big market share'. Heimer (2017) lifted the fact that BE trucks can be used in new ways that conventional ICE trucks cannot, such as delivery trucks being used during night hours where engine noise from an ICE would disturb the inhabitants in the neighbourhood. This is also the case with BE buses according to Sandström (2017) where they can be utilised indoors and in other areas where pollution is forbidden. Taking this into account, Heimer (2017) explained that because the customers and end-customers are often not yet 'mature' enough to realise these benefits compared to ICE trucks, Volvo Trucks so far often needs to push the new technology unto the customers and educate the customers on these benefits. Also an effect of the low maturity of the technology, is that the customers all want very different things, which Sandström (2017) explained that they try to counteract by 'trying to push the customers in the same direction' to limit the amount of unique demands put on Volvo.

Thulin (2017) explained that this large shift in technology from ICE vehicles to EVs 'will open up the market to new competitors who do not need to support a "diesel backpack", they can go straight for EVs' which will make them more agile. This is seen in the BE bus segment where Thulin (2017)

summarised the extent of the difference between the big actors from the ICE vehicle days and the new actors; 'the companies that sell the most electric buses today are companies that we previously did not even consider to be competitors'. Sandström (2017) described another part of the problem with immature demand that big organisations face being that 'as long as there is no real market, we have to invest before we can see a good business case' and she went on to say that this is not how big organisations work, the structure for the entire firm is rooted in business case estimation. Also among the factors that can be hard to predict that impact the business case, Sandström (2017) explained, are unexpected factors that affect the old technology that you are phasing out. She recalled that when they had just taken the decision to abandon pure ICEs in their city buses in favour of hybrids and BE buses, the oil price plummeted, 'the entire business case we had built relied on the fact that it would be cheaper to go electric, that just did not work anymore' but that the price of batteries now has caught up with the price of oil. Sandström (2017) summarised how the shift from the production of ICE vehicles to EVs will affect Volvo Group by saying that 'it will affect our industry system, our after-market, our sales organisation, our logistics. In short, it will affect everything, by a lot'.

4.1.2 Answers regarding Service Innovation

Volvo Trucks has undergone a transition where they have started focusing more and more on providing services, such as maintenance and spare parts. This is heavily affected by a transition to EVs as the need for those kinds of services is drastically lower according to Thulin (2017). Another big difference between ICE trucks and BE trucks is the perceived economic risk that buyers of BE trucks would undertake, this due to the high initial cost of a BE truck, but this is something that Volvo Group is well aware of according to Thulin (2017). One possible solution to this is to lower the initial price of the vehicle by, for instance, offering a discounted price for the truck and then leasing the battery of the truck to the customer over a few years. This also, Thulin (2017) explained, has the added benefit of counteracting the problem with lower cash-flows over time that the reduction in need for service and maintenance would lead to. Another strategic change that selling BE vehicles brought with it is that it opens up the possibility to sell the recharging infrastructure and vehicle together, this 'provides the opportunity to transition into selling entire systems' (Sandström, 2017). Thulin (2017) also considered this transition a possibility to move into the area of selling transport solutions; 'to sell zero-emission on a per kilometre basis, that would be an attractive deal, would it not?'

On the topic of moving into other kinds of cash-flows, Heimer (2017), brought up three areas that Volvo Group focus on currently; Electromobility, Connectivity and Autonomous drive and how they can be used in synergetic systems to sell add-on services from, for example, software optimisation. Heimer (2017) mentioned such an example where connectivity aids electromobility when the vehicle will learn the topography of the route it is driving and warn the driver if she needs to recharge the

battery to be able to manage a steep climb towards the end of the trip. Another example of where connectivity adds additional services is brought up by Cederstav (2017) to be wireless monitoring of components, this could be used to 'actively monitor the lifetime of the battery' to reduce the perceived risk of range anxiety or battery failure.

4.1.3 Answers regarding Management Innovation

The interviews brought up signs of management innovation as well as technology and service innovation. To face the challenge of new and agile competitors the company is turning to management innovation to become more agile (Heimer, 2017; Sandström, 2017).

As already stated within the frame of references, Volvo Trucks is a large organisation within Volvo Group, with extensive experience in ICEs. During the interview, Heimer (2017) explained that Volvo has had long development processes, up to five years, while the new battery technology changes about every third year. If this does not change, he continued, it will lead to Volvo not staying competitive. To deal with this risk, Volvo Group has chosen to create a smaller department independent project group, the Electromobility unit, to tackle the challenge of developing battery electric vehicles (Heimer, 2017). He explains that this unit gathers electromobility resources from different divisions within Volvo Group, for example product development, purchasing and marketing from Volvo Busses who already has experience with electromobility.

Furthermore, Sandström (2017) describes the unit as consisting of about 100 employees and using a, to the company, new management framework. The framework was originally developed for software development, but is now implemented for the entire Electromobility unit (Heimer, 2017). It is new for the company to work this way in both software and hardware development, but Heimer (2017) believes the framework could be implemented outside the Electromobility unit later on. On the one hand, he explained that the framework has the advantage of much shorter development processes than what is customary in the company, weeks rather than years, thereby capturing and implementing ideas quicker. On the other hand, he pointed out that a competitor with only 20 employees could still be quicker. Today, Volvo's backpack with 'muscles […] and knowledge' is beneficial but could potentially also make the company slow in comparison to those smaller competitors, and the Electromobility unit is, according to Heimer (2017), one way of coping with new and agile competitors.

Sandström (2017) also pointed out that the Electromobility unit has, and encounters, fewer levels of hierarchy in the development process, thus easier cherishing the individuals who dare try new things despite the risk of failure. This, she emphasised, is crucial for the development of electromobility. On

that note, she continued by highlighting the importance of having the right people in leading positions, that if the leader does not dare to try and error, and backs off of an idea when encountering obstacles and hardships, this would hinder the development and innovation. She explained that Volvo Group has had three different CEOs since the decision to start developing electrical hybrid busses, all of them promoting the development of electrical vehicles, and that Volvo has been lucky to have had this support from top management (Sandström, 2017). She described how the leaders kept encouraging creativity and the development of BE busses even when the idea was challenged, both from within and outside the company, due to its novelty and a sudden fall in oil prices. On that note, Sandström (2017) concluded that she believes the shift to electrical vehicles 'wouldn't have worked' without this supportive leadership.

5. Analysis

This section will explore any connections between the frame of reference and the empirical findings as well as examining any similarities or differences within the empirical material, it will also attempt to point out any lack of connection between theory and empirical data that is found.

5.1 Innovation Theory

The empirical data from the corresponding categories is in this section analysed by comparing it with the frame of references and each other.

5.1.1 Technology Innovation

From both the empirical findings and theoretical background, namely pioneering costs as per Porter (1985), it can be concluded that the issue of initially high costs on emerging technology, in this case chiefly battery technology, plays a central inhibiting role. The empirical material strongly suggests that the battery's and consequently the entire vehicle's currently high cost compared to conventional ICE vehicles makes it less competitive. The empirical findings suggest that not only the price is high for the batteries used in the BE trucks but also that the evolution of the technology is very unpredictable. This makes it a risky endeavour to invest in the production of batteries as described by Heimer (2017). This is also illuminated by the literature as a risk during 'major shifts in technology' by Porter (1985) which he calls technological discontinuity. The theoretical background brings up the first mover advantage of being able to set the standard for technology in a way that suits the pioneer and then forcing later actors to adapt to their standard (Porter, 1985). The empirical findings suggest that Volvo Group did just that in creating the recharging standard OppCharge. The data then tells us that they then asked the other actors on the market to join their standard to make the standard as universal as possible. The empirical data and theoretical background stand in stark contrast with each other at one point however. What Volvo Group did when they shared their technology, OppCharge, for free with their competitors is something that Porter (1985) would consider to lessen their technological superiority.

It could be seen that Volvo Group, despite being a mature company that has been around for 90 years, does not fall into the pitfall that Tongur & Engwall (2014) describes as focusing too much on existing technology and customers when it comes to BE trucks. In the empirical data, it can be seen that although Volvo Group is focusing on the area of BEVs, there are relatively new actors on the market that are surpassing the mature producers of BEVs in market share, as summarised by Sandström (2017). The theoretical literature suggests that when faced with radical innovation, mature companies

can find themselves losing a previously strong position on the market to new entrants (Abernathy & Clark, 1985). Thus, from both the theoretical and empirical material it is found that losing a previously strong market position to new entrants is a real risk. The empirical data suggests that what Heimer (2017) explains to be the risk of existing competence losing its usefulness in the near future due to a technological shift, could be a symptom of radical innovation where existing competence is destroyed, according to Abernathy & Clark (1985). From both the literature and empirical material it can thus be concluded that the shift from ICE vehicles to BE vehicles is driven by radical innovation.

In the empirical material, Heimer (2017) lifts that the risk of competence becoming obsolete could bring worry to some within the organisation as some positions diminish in numbers while others grow. However, the employees that remain would also be affected. As described by Manning (2013) in the Sensemaking framework in the methodology section of this study, a radical change to the company's image, stated core values or culture could affect the employees' sense of connectedness. If an employee sees Volvo Trucks primarily as a major producer of ICE trucks, and the company decides to switch to producing BE trucks, it risks conflicting with the employees' perception of the company, thus creating a feeling of distance towards the organisation.

In the theoretical background, it should be noted that the literature (Porter, 1985) touches upon the subject of pioneering costs in educating the customers in order for them to fully realise the benefits of new technology and how to take advantage of these new benefits. In the empirical findings, the issue of 'range anxiety' is brought up frequently during the interviews as a substantial barrier to quick adoption of BE trucks. The empirical findings, (Thulin, 2017 ; Heimer, 2017), indicate that this barrier is greatly diminished if customers are able to try BE vehicles and thus it is considered to be an example of a first-mover disadvantage. On this issue the empirical data was not agreeing, the solution to the issue of range anxiety was brought up by Cederstav (2017) to be to 'make the battery hold more energy than it needs to complete its route' and to have backup systems for quick recharging. The empirical material lifts another problem with trying to sell BEVs currently, chiefly the unawareness of the new added uses of a BE vehicle as opposed to an ICE vehicle. A couple of examples of this, as indicated by the empirical findings, would be to operate the vehicles indoors or during night hours due to no pollution from the engine and limited noise levels (Heimer, 2017; Sandström, 2017). These issues are considered to be disadvantages of the nature that can be amended by teaching the customers the whole range of new benefits provided by the new technology, thus they are considered first-mover disadvantages as per Porter (1985).

There are obstacles to introducing new technology to customers not only in the sense that they have to be taught how to utilise it but also because it can be technology that the customers do not associate with the company. Just as a switch from ICE to BE technology could affect the employees' sense of

connectedness to the company due to Sensemaking, it could also affect the relationship with the customers. When educating customers on the new technology, the company needs said customers to accept it and participate in the process. But if they do not support the change made by the company and the new technology proposed, they could be inclined to resist the change. As described by Weick (1995), it is important to an individual that the new information fits the person's current view of the world in a plausible way. If the customer would not find the new image of Volvo Trucks as a BEV producer to fit with their current view of the company, it could create dissonance and possibly distance between the two.

The empirical material suggests that Volvo in the case of Volvo Buses deciding to focus on the new technology and abandoning the old one for city traffic did not do what the theoretical material (Tongur & Engwall, 2014) explains is common for established actors to do. That is to continue to develop their existing product with R&D while exploring the new emerging technology, instead they abandoned their existing technology in order to focus completely on the new one.

From the theoretical frame of references, it can be noted that mature actors often struggle in major technological shifts due to their investments in old technology that is rendered obsolete (Porter, 1985). The empirical material suggests that the issue of having a lot financial capital invested in the production of combustion engines plays a central role among the difficulties identified during the shift from ICE technology to BE technology. From this it can be concluded that the by Thulin (2017) referred to 'diesel backpack' is playing a part in the difficulties encountered by the mature actor Volvo Group.

5.1.2 Service Innovation

In the theoretical framework it can be discerned that not only technological innovation is a response to technological shifts but also to add services to their product, often referred to as service innovation or 'servitization', in order to increase the value it provides. The empirical material suggests that Volvo Group are partaking in both technological innovation and service innovation in order to manage this technological shift. The theoretical framework brings up the concept of 'product-service systems' where a package of both products and services are bundled together to satisfy all the needs of the customer (Mont, 2002). The empirical data suggests that this is something Volvo Group is interesting in transitioning into providing as per Sandström (2017) when she explained that they are now selling not only the BE bus but also the recharging infrastructure together. Mont (2002) explains that the customers are sold the use of a product instead of a product on its own in a PSS and Thulin (2017) lifted the potential of selling 'zero-emission on a per kilometre basis' instead of only selling vehicles as attractive.

The theoretical framework, namely Tongur & Engwall (2014), discusses how 'disruptive innovation' can produce new services. The empirical material suggests that new services are indeed created as a result of this technological shift, Cederstav (2017) explained that as vehicles are turning electrical they are also getting more connected. This, he continued, brought with it the possibility for new services such as wireless monitoring of the battery. Heimer (2017) also explained that services such as topographical analysis of the routes the BE vehicles will take allows for a new kind of service as well. While not an entirely new service, the practise of leasing the vehicles to customers is something that the empirical material indicates will become more prevalent with BEVs (Thulin, 2017 ; Heimer, 2017). The theoretical frame of references also suggests that leasing is becoming more and more common (Mont, 2002). Thus, from both the empirical and theoretical material trends of service innovation taking place in Volvo Group can be noticed.

5.1.3 Management Innovation

Both the theoretical framework and the empirical material lifts the need to renew the organisation as part of the challenge in the shift towards BE Trucks. The empirical material suggests that the shift requires organisational changes for the company, and points out the importance of management innovation to increase speed in the development process and to become more agile (Thulin, 2017; Sandström, 2017; Heimer, 2017).

The Electromobility unit is one way Volvo Trucks is attacking this issue (Heimer, 2017), and since the unit is separate from any other division (Thulin, 2017), it is a bit like the self-managed team mentioned in the frame of references (Vaccaro et al., 2012). The unit also uses a new management framework, as described by Sandström (2017) and Heimer (2017), with shorter development processes and fewer levels of hierarchy. This leads to the conclusion that this unit fits the theoretical definition of management innovation as described in the frame of reference (Birkinshaw et al., 2008), through its changes to management practices, processes and structures.

6. Conclusion

This section will summarise the study and attempt to answer the research question: 'How is the uncertainty of future demand for BEVs dealt with, by Volvo Trucks, and what are their main considerations during the shift from ICE to BEV?'

6.1 Conclusion

This thesis has used a theoretical frame of references made up of existing literature on the areas of technological innovation, service innovation and management innovation to analyse the technological shift from ICE technology towards BE trucks. The empirical data has been gathered through interviews with representatives within Volvo Group and Lindholmen Science Park. The purpose of this study was to illuminate what the main considerations in this technological shift are and to see how the uncertainty of future demand is dealt with, inside Volvo Trucks.

As concluded in the analysis, the technological shift from ICE trucks to BE trucks is a radical shift which brings with it several challenges for the producers in the industry sector. From the empirical material and analysis some considerations have been identified as important.

6.1.1 Technology Innovation

The analysis of the empirical material leads to the notion that because this technological field is full of radical change. One of the considerations from the representatives of Volvo Trucks is the fear that new competitors without 'diesel backpacks' will enter the truck market with BE trucks on par or superior to those of Volvo Trucks, but priced at a lower level, and take a large part of Volvo Truck's market share. Another consideration is the choice of which component to produce in-house, and which to purchase externally. If the wrong emerging technology is developed, large costs will be born due to technological discontinuity, making this choice a difficult one with great importance. From the empirical data, it can be concluded that especially the battery represents one such big uncertainty because of its technological immaturity.

From the analysis, it can be seen that the issue with the lack of standardisation for the recharging infrastructure is brought up time and time again by the representatives, with the risk of both producers as well as customers of BEVs ending up with vehicles that cannot be recharged with ease. Additionally, it can be discerned that the tentativeness of customers regarding this new emerging technology of BE trucks presents a substantial challenge for Volvo Trucks. The results of this study suggest that one of the ways that Volvo Group are trying to deal with the customers' perceived risk of

switching to BEVs, is by trying to spearhead the standardisation process of the recharging infrastructure. This is done through the development and sharing of OppCharge, in order to get one widespread solution adopted.

This study also implies that the uncertainty of future demand is dealt with by attempting to get the customers to demand what Volvo offers in terms of BE trucks. The empirical material, once again, suggests that the market is immature, and therefore the customers do not know what they want and are afraid to try the new technology. The empirical data suggests that one of the ways that this issue is handled is by educating the customers on the benefits of Volvo's BEV offer. This is done by exposing them to BEVs, which is done at the expense of Volvo Trucks. This is considered to be one of the first-mover disadvantages.

6.1.2 Service Innovation

From the analysis, it can be concluded that by selling entire systems, with products and services combined to satiate the needs of the customer, the company is not only lowering the perceived risk of the customer, but also expanding Volvo Trucks' value proposition.

Another aspect that the empirical material suggests is limiting the perceived risk of trying BE trucks for the customer is to lease the battery, since this stands for a substantial part of the total price for the vehicle. Volvo could also let the customer lease the entire vehicle as a way to lower the perceived risk even further. From the analysis, it is concluded that this could play an important role in replacing lost cash flows over time from maintenance and spare parts which would decrease with a switch to BE trucks.

6.1.3 Management Innovation

Another consideration that the empirical findings brings up is the worry that the organisation Volvo Trucks is too big with too many levels between decision and action, which could make them too slow to adapt to sudden technological shifts in the field of BE trucks. The results of this study suggest that this problem is, to some extent, dealt with by the creation of the Electromobility unit.

As explained above, uncertainty of future demand leads to uncertainty of what should be developed in-house, and as seen in the empirical material, the development process within Volvo Trucks is slow. The analysis considers the technological shift to be of a radical nature, and the technological innovation section of the frame of references explain that during such a shift speed of the essence as one needs to be agile to be able to adapt to changes in the development. The analysis poses this to be a severe challenge for a large organisation, where decision making and implementation can end up far

apart, slowing down innovation and adaptation of technology. At the same time, as lifted in the empirical material, competitors are getting a chance to enter the market, and quickly attain market shares. To handle this, the analysis of this study suggests that Volvo Group turned to management innovation, creating the Electromobility unit, where a concentrated group of experts, with less hierarchy and shorter development processes, can move faster than the rest of the organisation, allowing them to compete with the new smaller entrants.

6.1.4 Summary of conclusion

Once again, the research question of this study is as follows: *How is the uncertainty of future demand for BEVs dealt with, by Volvo Trucks, and what are their main considerations during the shift from ICE to BEV?* To answer this, the study has used theories of technology innovation, service innovation and management innovation together with empirical data collected through interviews.

First off, the main considerations gathered from the analysis include the fact that Volvo Trucks is a large organisation, with extensive investment in ICE technology and slow development processes. This makes new smaller competitors a serious threat because of their agility. Another consideration is the choice between purchasing or producing the batteries for the BEVs. Yet another consideration is the issue of lacking standardisation of recharging infrastructure and the uncertainty that it brings to both customers and producers. This in combination with the current high price of the vehicles leads to a tentativeness among the customers regarding investing in the BE technology.

Furthermore, the uncertainty of future demand derives from technological discontinuities and immaturity in the BE market, and is dealt with by Volvo Trucks in three main ways. Firstly, by reducing the customers' perceived risk. This is partly done through the development and sharing of the recharging system OppCharge, providing the BEV market with a possible recharging standard. It is also done by sharing the economic risk with the customer, either through leasing agreements or through the purchase of entire systems. Secondly, Volvo Trucks is trying to get the customers to demand what is offered. This is done through educating the customers on the benefits of the technology, and through exposing them to it through showcasing. Thirdly, the innovation process has been sped up, to mitigate the technological discontinuities, by the creation of the Electromobility unit. This is a way in which the company tries to become more agile to respond quicker to new competitors.

6.2 Transferability and scientific contribution

The issue of technological immaturity is not something that is unique to Volvo Trucks. Both existing studies in this area, per Tongur & Engwall (2014), as well as the empirical data of this study indicates that this problem is likely shared by other actors within the BEV manufacturing sector. Flyvbjerg (2006) maintains that it is not impossible to generalise on the basis of one case, and because of Volvo Trucks' size and position among other heavy-duty truck manufacturers, the issue with lack of agility compared to new entrants on the market could be one that is common to other established actors within this business sector.

This study has, through a case study, provided new empirical data on how a Swedish established manufacturing company, Volvo Trucks, attempts to deal with radical technological change. The study has provided insight into what the company considers to be critical factors during the technological shift, and into how the company attempts to deal with the uncertainty of future demand. In addition, the study has contributed to the field of innovation management by comparing empirical findings with existing theories.

6.3 Critique of method

To increase the quality of the study, further preparations before the interviews could have been made. Bryman & Bell (2013) presents challenges for first-time interviewers that could have been beneficial to be aware of before encountering them in the interview setting. Some of these includes how unexpected problems in the surroundings or surprising answers can make a first-time interviewer lose focus (Bryman & Bell, 2013, p. 487). Also, during one of the interviews the recording device stopped recording so that a few minutes of the interview was lost. This was however noticed and remedied somewhat by asking the respondent to repeat the answer to the lost question. Finally, during the respondent validation, one of the interviewees did not answer before the first submission of the study, due to the person being out of office during that period. The information used was cross-referenced with another interviewee within the same organisation to make sure the information retained was correct, but minor changes to the exact wording has been made.

6.4 Recommendations for future research

During the research into this particular area several interesting aspects were brought into light that could not be investigated further due to time constraints. Some of them include the substitutes to fossil fuels, such as HVO and Biodiesel, that are emitting significantly less greenhouse gases than conventional diesel but fail to reach zero-emission (Perstorp, 2013 ; Ecobränsle, n.d.). When

examining these briefly, the possibility that these kinds of substitutes, that can be used with existing infrastructure, could potentially delay the advent of fully electric vehicles.

Another important factor that the study was unable to expand upon was the role of leadership during radical technology shifts, and the importance of the personal conviction of the leaders regarding certain emerging technologies being 'the right choice' no matter any contemporary evidence of the contrary. This was brought up by Sandström (2017) during the interview, when she described the importance of having support from the CEOs of Volvo Group during the shift, even though an objective business case evaluation would deem BEV development a poor investment. Sandström (2017) even goes as far as to say that it would not have been possible without their support. However, this could not be analysed through the frame of references, and was thus omitted from the analysis of the study. The role of leadership during radical technology shifts would because of this be interesting for future studies to examine further.

Finally, this study examined only one company, albeit a big one, thus it would be interesting for other studies to examine other companies in this industry sector. The results could then be compared with those of this study in order to reach deeper insight on the subject of innovation management in technological shifts.

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8. Appendix

8.1 Attachment 1: Interview question base

1. Vad är innovation?
2. Ellastbilar
    a. Var är ellastbilar nu?
    b. Var är ellastbilar om 10 år?
3. Största fördelen med att övergå till ellastbilar?
    a. För omvärlden?
    b. För Volvo?
    c. För kunderna?
4. Största utmaningen vid skiftet från ICE till EV
    a. För branchen?
    b. För Volvo Trucks?
    c. För avdelningen?
    d. För kunderna? Hur hanterar Volvo kundernas tveksamhet?
5. Utvecklingsprocessen.
    a. Vem bestämmer vad som ska utvecklas? Vems idé är det? Hur beslutar man?
    b. Vad läggs mest tyngd på vid utvecklingen av EV trucks? Hur gör man för att fånga upp kundernas önskemål och åsikter? Vet man vad kunderna vill ha?
    c. Hur fångar man upp och bearbetar nya idéer i organisationen?
        - Inom electromobility-projektet
        - Generellt på företaget
6. Är det främst nya kunder som lockas in av EVs eller är det existerande kunder som övergår från ICE till EV?
7. Batterier står i nuläget för så stor del av kostnaden vid framtagandet av ellastbilar, men de inte produceras in-house.
    a. Varför har man valt att göra så idag?
    b. Har man råd att inte ha batteri-kompetensen in-house från början?
    c. Blir "den gamla kunskapen/kompetensen" obsolet i och med utvecklingen av EVs?
    d. Vill man i framtiden ersätta den förlorade konkurrensfördelen i växellåde- och motorfabrikerna med t.ex. Batteritillverkning?