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Identifying B2B Customer Needs with Electrification in the Industrial Sector

A study on how a lithium-ion battery manufacturer can meet the needs of their customers with digital solutions

Master's thesis in Management and Economics of Innovation

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Abstract

As the pressure for green solutions increases and the costs for li-ion batteries decrease, producers find more and more viable business cases for its applications. Consequently, li-ion battery producers are entering new markets and engaging with new customers, for example within the industrial sector. Customers in the industrial sector will likely have different needs and face different challenges than those in existing markets, and to understand these is crucial to offer a relevant product. Thus, in order to best support the process of li-ion battery electrification of the industrial sector, it is of interest to understand what needs industrial companies have related to this.

The purpose of this study is to investigate what needs and challenges industrial customers face in electrification with li-ion batteries of their machines. The study will also discuss how these needs could be met by digital solutions. The focus will lie on industrial customers within material handling, construction equipment and marine. The study is mainly based on semi-structured interviews with employees at organizations that are, existing or potential, customers to a li-ion battery producer, the case company.

The study identifies seven parameters along which li-ion batteries need to perform in order to meet customers needs and challenges. These are productivity, availability, energy density, cost, emission, precision and security. In addition, industrial organizations are challenged to renewing their business model when electrifying their products. Further, there is a vast knowledge gap within industry on li-ion batteries, both with equipment producers and end-users. The study concludes that digital solutions could be used to increase li-ion batteries performance along the identified parameters, but as for business model renewal and knowledge gap, alternative solutions might have a larger impact. However, to outline these solutions in greater detail, further research needs to be conducted.

Keywords: Lithium-ion batteries, energy storage systems, digital solutions, industrial, electrification, technological innovation, complementary assets, organizational adoption, performance parameters, customer needs

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Ella Dehn

Louise Larsson

Gothenburg, May 2022

List of Acronyms

Below is the list of acronyms that have been used throughout this thesis listed in alphabetical order:

B2B	Business to Business
BMS	Battery Management System
CAPEX	Capital Expenditure
ICE	Internal Combustion Engine
Li-ion Batteries	Litium-ion Batteries
OPEX	Operative Expenditure
TLC	Technology Life Cycle

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1 Introduction

One of the most permeable challenges of our time is to break the reliance on fossil fuels. However, while alternatives are emerging, emissions of carbon dioxide continue to increase (Keramidas et al., 2020). Electric energy is frequently discussed as an alternative to move away from fossil fuels, but such a transition is still hampered by several factors of, for example, economic and political nature (Keramidas et al., 2020). Alignment of economic and political factors will play a crucial role for a potential transition, however so will also the technology's ability to deliver on the expectations of potential customers and users (Geels, 2004). In other words, the technology for energy storage solutions needs to be continuously developed in a direction that can align it with market needs.

This thesis will seek to investigate industrial customers' existing and future challenges and needs, and how those could possibly be met by digital solutions from the energy storage industry, more specifically the li-ion battery industry. By identifying what digital solutions might be requested in the near future, the ambition is to shed light over one aspect of making electric power a more attractive alternative.

1.1 Background

One third of all energy worldwide is used by industry, where heavy industry is the biggest driver of greenhouse gas pollutants (Wei et al., 2019). As the world is searching for alternatives, there are huge incentives, and pressure, for industry to transition into more sustainable ways. As mentioned above, one such option is electric energy and already today there are deemed to exist strong business cases for electrification in several parts of industry. Aspects that are particularly highlighted as advantageous with electrification are lower total costs of ownership and higher precision and reliability for some applications. Moreover, this transition is also predicted to have strong synergies with employment of digital technologies, such as automation and connectivity. (Forsgren et al., n.d.)

As an important part of the electrical chain, li-ion battery producers will be concerned with the opportunities that spur from digital solutions within electrification. Digital solutions entail a wide range of digital applications that are typically aimed at, for example, improving customer experience or reducing costs. Digital solutions are often focused at more short-term goals and targets where time-to-market and rapid returns are prioritized. There is a close connection between digital solutions and operations and the solutions are typically developed to solve or facilitate an existing problem or issue (Hemon-Laurens, 2018). Production of li-ion batteries is continuously rationalized, prices steadily decrease, the market is quickly expanding and the number of viable business cases are on the rise (Zhang, n.d.). These circumstances create a fast-moving and changing industry with expanding opportunities and intense competition. This puts companies in a position where they cannot rely on their current offers to provide cash flow for the future. Bower and Christensen (1995) describe the dilemma of how companies' greatest resources suddenly can become their biggest problem. This is because leading companies rely heavily on their existing offers and customers and thus fail to capture value as their industry changes. By listening carefully to the needs of the customers, paradoxically, they fall behind as others find ways to solve problems the customers never knew they had (Bower and Christensen, 1995).

In 1942 Schumpeter introduced the concept of creative destruction which has become central to innovation theory. Creative destruction refers to the destruction or elimination of old markets and actors to make room for new ones that can better answer the needs of the market. Still, competition does not only originate from the focal market, but companies can also be challenged by companies competing for seemingly different customers. (Schumpeter, 1942) The ability to merge seemingly different industries and put companies that were previously meeting different needs head-to-head, has been one of the peculiarities of digital technologies (Yoo et al., 2012). Yoo (2012) brings up the example of how a software development company, Skype, has come to directly compete with traditional telecommunications actors. As digital technologies are becoming more and more pervasive in industry (E. M. Porter and Heppelmann, 2015) it would be wise for energy storage providers to be anticipatory of opportunities that can be leveraged to assure value capture also in the future. Digital technologies can create value in many different ways for an energy storage solution. To be able to understand and analyse this, this thesis will analyse the data gathered trough looking at li-ion batteries in industrial applications as an innovation and the digital solutions to this as a complementary asset.

Due to the issues outlined above, it is crucial for battery storage companies to focus on developing their solutions for the future market as circumstances rapidly change. By taking the dynamic industrial and digital environment in consideration, it is important for a company's development and competitiveness to understand what opportunities and customer needs will evolve within the energy systems industry and how these can result in new products and services. In other words, it is of interest to study the role that energy storage systems hold for electrified industry and in what ways they can create value, specifically related to digital solutions.

This leads to the research question of this thesis; What needs and challenges do, and will, industrial customers to li-ion battery producers have, that can be met by digital solutions?

1.2 Research Gap

When researching possible applications and business cases for batteries within industries, it becomes clear how this area of research is still fairly underdeveloped. There exist macro analysis of the potential for electrified industry (Wei et al., 2019), but literature on certain applications is scarce. An area that is better researched is the electrification of the automotive sector. This is not surprising, as development has come further in the automotive sector than in the industrial, resulting in more reachable cases and situations. Searches of combinations of keywords such as *energy storage, electrification, industry, industrial, construction, material handling, commercialization, application, customer preferences, digitalization* and *battery* renders results mainly either on technical aspects of batteries or on cases from the automotive industry.

While it might seem that the automotive and industrial sectors are similar, they have one fundamental difference that makes it unsuitable to draw conclusions on the industrial sector based on learning's from the automotive. The automotive sector is mainly working with B2C transactions and the industrial sector is focused on B2B, which implies that there are differences in customer behaviour (Lilien, 2016).

Consequently, there is little research on the specific topic to build on. Instead, more general theories on B2B marketing, business models and technological innovation will make up the foundation that this thesis is built on.

1.3 Aim

The purpose of this thesis is to identify industrial customer's, current and future, needs and challenges of going electric, and if they can be met by digital solutions from producers of li-ion batteries. This will be investigated in this study by approaching li-ion batteries as the core innovation for electrification of industry, and digital solutions as complementary assets. This perception is the product analysis conducted by the authors, and is motivated below in the theory section.

1.4 Limitations

Due to the number of resources at hand, mainly in terms of time, this thesis will be limited in terms of scope. Firstly, the study is designed to examine the situation of one li-ion battery producer and its ecosystem, which is assumed to provide a deeper understanding of the needs and challenges that arise with electrification within industry. Secondly, the study's aim is to investigate industrial needs, but due to limitations of resources all parts of industry have not been looked into. The study is primarily based on data collection from material handling, construction equipment and maritime and to some extent also from the forestry and energy storage solution sectors. Furthermore, it does not focus on digital solutions for products that are not li-ion batteries or products that are not linked to these. Neither is the aim to describe technical aspects of batteries or digital solutions. The study will neither try to outline functionality of the digital solutions brought up, they will merely be matched with the need or challenge that they can support. A distinction is made between digital solutions and digital transformation where the latter one, which refers to a large-scale transformation involving large parts of an organization, will not be dealt with.

2
Theoretical Framework

The following chapter is dedicated to give a theoretical foundation for understanding the studied issue. In order to understand the research area and question, different relevant theories have been put together to form a framework to conduct analysis of the data. As the study is framing the li-ion battery in the industrial context as an innovation, and digital solutions as a complementary asset, this section seeks to cover the backgrounds and theories for this. But pervasive innovation is about much more than just supply, the innovator must also know who the customers are and what challenges they face. Thus, the chapter will also set the foundation for understanding the user side of technology, how innovations are perceived by customer- and user organizations, and how to find and reach the market.

2.1 B2B Marketing

The term B2B marketing has come to more often replace the earlier concept of industrial marketing. While the latter focuses on transactions of raw materials and equipment used in operations, the former is a broader term that also includes the relationships that are value generating such as between businesses, non-profit organizations and governmental agencies. Yet, an additional aspect of the theory is that there are vast differences in B2B and B2C relationships; the B2B relations are in general more heterogeneous regarding performance requirements and customer size. (Lilien, 2016)

The different performance requirements and expectations in such a business setting is important to be aware of, in order to take the right actions. A definition of the marketing process offered by the Chartered Institute of Marketing describes it as:

> "the management process responsible for identifying, anticipating and satisfying customer needs profitably" (McGivern, 2009)

The two cornerstones to this are the internal and external analysis, which are central in creating a marketing plan and setting marketing objectives. The analysis of the internal environment is concerned with the focal company's resources and capabilities - the ability to capture value from its situation. A common marketing tool for analysing the internal environment is the SWOT analysis. The external environment on the other hand, concerns political, social, economic, legal and technical aspects that influence the firms situation. Some of the most well established tools to analyze the firms external environment are the PEST analysis (McGivern, 2009) and the Porter's Five Forces Model (Porter, 1979). Good market research requires the collection of large amounts of data that can be transformed into information (McGivern, 2009). McGivern (2009) also states that market research is of value if, and only if, it manages to create information that can support an organization in successful decision-making. Factors that are brought up as possible problem sources are poor understanding and definition of the studied problem or situation as this will likely guide data collection in the wrong direction. (McGivern, 2009)

To analyse the data into useful information is often complex. Common tools such as the mentioned above; PEST, SWOT and Porter's Five Forces, have received criticism on their ability to offer a good understanding of the external environment. There are several established quantitative tools and methods for conducting market research, but these typically require large sets of data from existing markets (McGivern, 2009), which makes them less suitable when a market is emerging or even non-existing. The PEST analysis has the shortcoming of being inexhaustible and requires the ability to sort the vital from the unimportant, otherwise the organization might face high costs and information overload (Grant, 2018). Porter's five forces model has been criticised for regarding the environment as too static (Grundy, 2006) and focusing on the situation of large firms and organizations (Isabelle et al., 2020). Since the framework was first presented, much about the general business environment has changed and scholars have suggested to include additional forces to the framework, such as globalization, digitalization, deregulation and level of innovativeness. (Isabelle et al., 2020) Further, complements could be regarded as an additional force (Grant, 2018).

The factors of innovation and digitalization have been strong forces in rapidly changing industries and markets, hence they are suggested as additions to the above framework. The changing circumstances puts companies in a situation where they must be anticipatory of changes coming that can overturn their markets or industry (Bower and Christensen, 1995). Further, it is important to understand what factors enable and inhibit organizational innovation adoption (Frambach and Schillewaert, 2002). Thus, the following sections are dedicated to outline on the one hand aspects that influence customer needs and innovation adoption and on the other how a fast-changing environment can be understood.

2.2 Technological Innovation

Innovation is commonly defined as the result of an exploited invention, that is the application of something novel with the purpose to capture value (Roberts, 2007). The invention does not need to be novel to the world, merely to the context into which it is brought(Utterback, 1971). Further, there are different types of innovation; it can be social (Cajaiba-Santana, 2014), institutional or technological (Hargrave and Ven, 2006). Within industry, the concept of innovation is a process that entails high degrees of uncertainty paired with creativity and simply chance, thus its potential is a result of the firm's organization and technology as well as the competitive advantage and strategic decisions. (Utterback, 1994) On the account of technological innovation, Roberts (2007) argues that:

> "Technological innovation can alter the competitive status of firms and nations"

More scholars agree on the potential implications of technological innovation (Foster, 1986)(Bower and Christensen, 1995), but there exist several views of what exactly technological innovation is. In their literature review, Garcia and Calatone (2002) refer to a definition of technological innovation by the OECD as being the most suitable;

> "Innovation is an iterative process initiated by the perception of a new market and/or new service opportunity for a technology-based invention which leads to development, production, and marketing tasks striving for the commercial success of the invention."

The appropriateness of this definition originates from it bringing up two important aspects of technological innovation; it is the combination of technological development and market introduction of that invention; and the iterative nature of innovation (Garcia and Calatone, 2002).

2.2.1 The Technology Life Cycle

Innovation follows different phases, and in order to conduct an understanding of the technology life cycle, there are mainly two different perspectives that distinguish themselves as of special interest and importance. These are the macro view and the technology S-curve, and will hence be outlined in the following sections.

2.2.1.1 The macro View

The macro view describes a cyclical pattern where each cycle is initiated by a technological discontinuity. A technology's evolution and progression within an industry is studied and complemented with investigations of industry evolution and technological trajectories. Each cycle begins with a phase called the *Era of Ferment*. This is characterized by technical uncertainty and unclear customer needs, that are still mainly potential, together with intense competition among a high variety of different solutions. Following this is the *establishment of a dominant design*, which allows for an industry standard to emerge. As a consequence, uncertainty for both consumers and producers is reduced and the diversity of solutions is reduced. Settling for a dominant design allows the technology to enter the *Era of Incremental Change*, which shifts focus towards retention and continuous, incremental innovation. Rather than developing the technology, focus lies on developing processes to enable meeting customer demands at lower costs. Eventually, the cycle reaches it's last part where the established technology is outperformed by a new technology, causing a *technological discontinuity.*(Taylor and Taylor, 2012)

Yet another macro perspective is explained by Utterback (1994), who outlines the dynamics of innovation as illustrated in Figure 2.1. This model is identified by three phases; the *fluid*, the *transitional* and the *specific*, and illustrates how product and process innovation alter over the life cycle of a technology. (Taylor and Taylor, 2012) During the fluid phase, innovation is heavily focused on development of products with high concentration of firms' competing with different solutions. Due to the novelty of the technology, manufacturing is reliant on skilled labor and organizations are characterized by an entrepreneurial culture. A further feature of the fluid phase is a fragmented and unstable market where fast feedback is central to survival. Eventually, the technology enters the transitional phase where product innovation starts declining while process innovation starts to increase. This coincides with the emergence of a dominant design and spreading market acceptance for the new technology. To meet the growing demand focus is directed at developing large scale efficient production to support the technology. As production of the technology becomes highly efficient, it enters into the specific phase.(Utterback, 1994) With efficiency comes rigidity and strong inter-links that makes it costly to make changes to the product or process(Taylor and Taylor, 2012). Where the fluid phase saw a fragmented market and skilled labor, the specific phase implies a commodity-like technology with little differentiation produced by low-skilled labor. The entrepreneurial culture has been replaced by a hierarchical mechanistic organization and the intense competition between many firms has become an oligopoly. (Utterback, 1994)

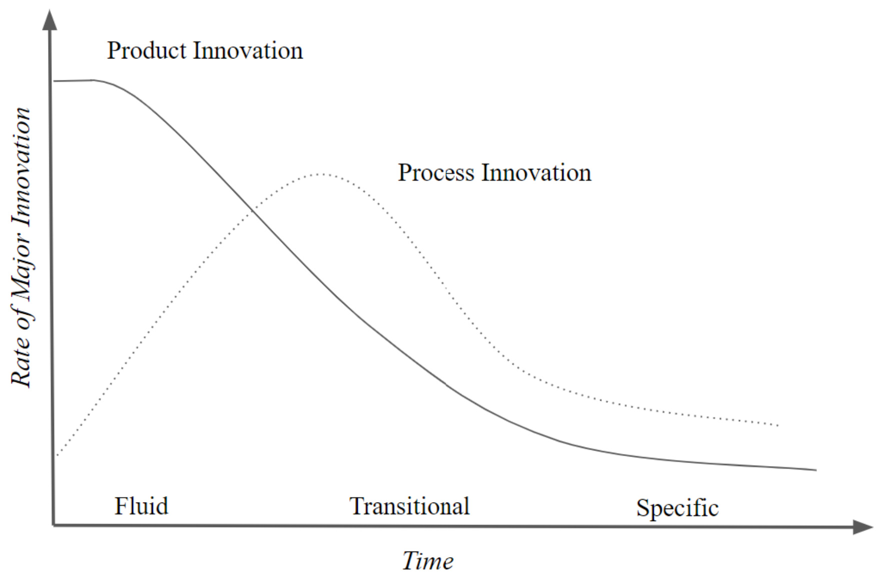

Figure 2.1: Adoption of Utterback's model of the "Dynamics of Innovation"

2.2.1.2 The Technology S-curve

In contrast to the macro perspectives, another model that has been proposed to describe the life cycle of technology, is the Technology S-curve, as outlined in Figure 2.2. The name derives from the shape that a technology's progression or adoption creates when mapped over time or effort. At the beginning, development of a new technology is slow but eventually gains momentum before it inevitably decreases as technological limits are reached (Foster, 1986). This is because technological uncertainty is high in the early life cycle, but are with time and effort overcome (Taylor and Taylor, 2012). Foster (1986) highlights the concept of this:

> "As technological limits are reached, it becomes increasingly expensive to make progress. At the same time, the possibility of new approaches often emerges - new possibilities that frequently depend on skills not well developed in leader companies."

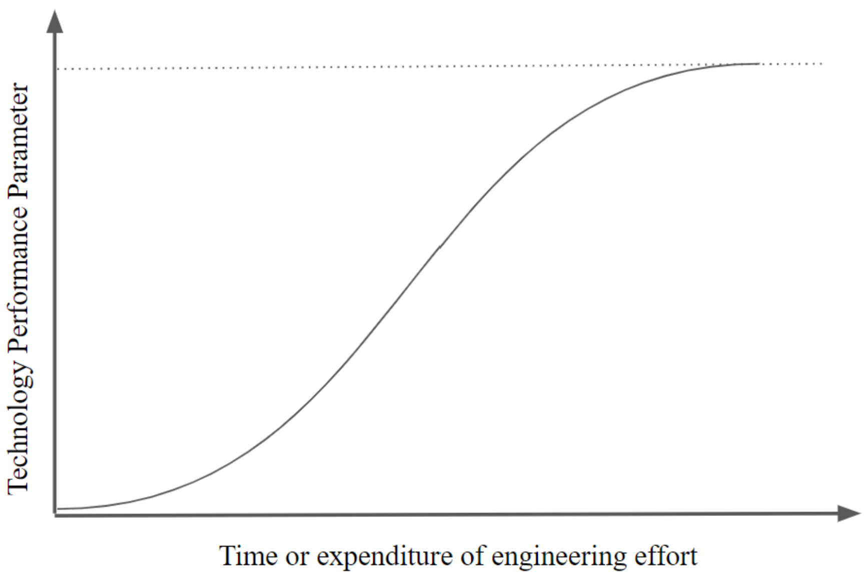

Figure 2.2: A typical technology S-curve over performance parameter development

In order to prioritise efforts accordingly to the right time and place, the innovative company needs to be aware of the external environments and markets. Marketing in established companies is mainly concerned with the needs of existing customers as these provide the recurring cash flow that established companies rely on. This can become problematic at the emergence of a new technology. Due to low performance and high uncertainty in the early life of the technology, it is not of interest for customers. Companies that listen to their current customers, will then miss the opportunity to early invest in the new technology. Once development starts taking off, they will hence lag behind. To avoid such a situation, technologies should be mapped along their performance trajectories to predict if and when a new technology will out-compete the old. (Bower and Christensen, 1995)

The emergence and evolvement of the various phases outlined above take different long time depending on factors such as industry and sector. A study on the development and commercialization of new technologies in the energy sector found that full commercialization of innovations often takes three to four decades from the point of invention (Gross et al., 2018). The development of li-ion battery cells has been rapid in the past decades, and performance has been greatly improved. Prices have fallen with 97 percent since 1991, and in response the market for li-ion batteries has experienced heavy growth. Technological improvement rates prove even better when also including energy density. Zeigler and Trancik (2021) argue that currently, it might be other performance parameters than cost per energy capacity that restrict further price reductions. The performance rates imply that applications that are less restricted in terms of volume and mass, might experience faster cost reductions. (Ziegler and Trancik, 2021)

Foster (1986) outlines a four step analysis on how to assess technologies - either one's own or a competitor's.

- Step 1: Identify and list existing and potential alternatives to present approaches without yet evaluating them.
- Step 2: Identify what are the performance parameters for customer groups. Each group may have different needs and thus different performance parameters.
- Step 3: Calculate the limit for each performance parameter.
- Step 4: Draw the S-curves based on historical development and estimated limits.

This methodology can be used in order to understand and investigate how to act and reason when taking strategic decisions. In addition, organizations can use it to understand what kind of technological innovation(s) they are facing.

2.2.2 Types of Technological Innovation

Innovation can span from almost being unrecognized to drastically changing entire industries and overturn firm's competitive advantages. Two types of innovation have been particularly central in innovation research; incremental and disruptive. Incremental innovation is associated with smaller changes to products and leverages the potential of the existing design. Since firm's can apply there existing competencies to exploit incremental innovation, it often leads to a reinforcement of established firms. Radical innovation, on the other hand, can swiftly eradicate the dominance of established firms as it changes the engineering principles that the product is built on. Another common consequence is the emergence of entirely new markets and possible applications. This puts established firms under pressure as they have to reconsider their competencies and problem solving methods (Henderson and Clark, 1990). Henderson and Clark (1990) further argue that incremental and radical innovation require different organizational skills and that this is why they have such alternate implications for firm's competitive advantage.

However, not all innovations follow this pattern. Even small technological changes have shown to have dramatic consequences for firms' competitive advantages. To categorize innovation as either incremental or disruptive is incomplete for understanding the implications of technological innovation. (Henderson and Clark, 1990) Rather, innovation should be mapped along two dimension where the first represents the innovation's impact on linkages between the components within a product and the other the impact on the components themselves. This results in a categorization with 4 types of innovation as showed in Figure 2.6. (Henderson and Clark, 1990)

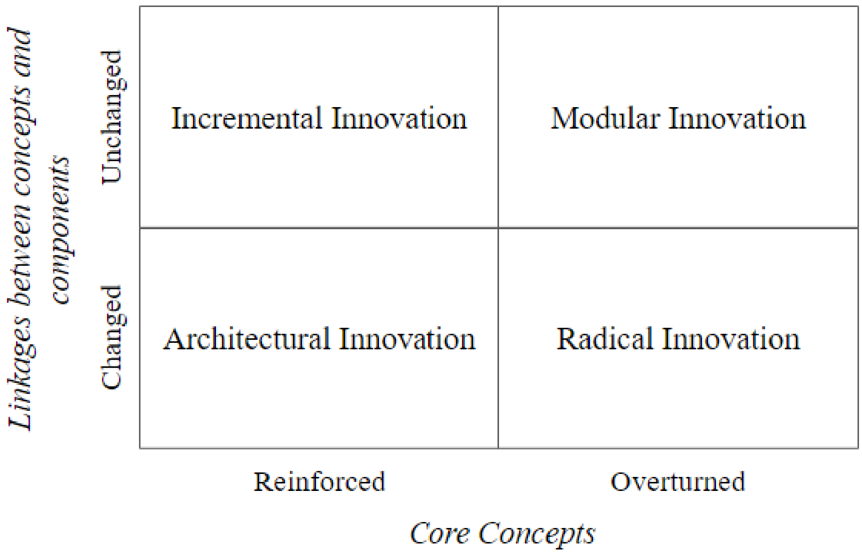

Figure 2.3: An illustration of the types of innovation as outlined by Henderson and Clark (1990)

Architectural innovation is, in short, changing linkages between components to reconfigure them in a new manor. Such innovation is often spurred by changes on component level, smaller size or lighter weight, that enables the system to take another form. It is important to distinguish the nature of such component change, core component design and associated knowledge needs to be the same for it to be architectural innovation. As products become locked into dominant designs and organizational knowledge and learning is built up around the existing architecture, even small changes in product architecture can be a challenge. These challenges show themselves both in engineering where new knowledge needs to be acquired but also in the organization and its patters of communication, information filtering and problem-solving strategies. (Henderson and Clark, 1990)

Modular innovation also requires new learning and knowledge on the component introduced, but the organizational impact is less as linkages between the core concepts, and thus between organizational members, remain the same (Henderson and Clark, 1990). But modular and architectural innovation are not always separate. Rather, these types of innovation are part of a process where the introduction of new modules can come to reconfigure existing architectures and result in new architectures. (Habib et al., 2020) If modular innovation introduces large changes to a component it will likely also change the interfaces and types of flows to the rest of the product. This implies that linkages between components are changed and that architectural innovation can be the outcome of modular innovation. (Habib et al., 2020)

2.2.2.1 Complementary Assets

In order to leverage innovations in the most efficient way, organizations can use complementary assets. The concept of complementary assets are described as the resources, assets and capabilities that a firm requires to profit from an innovation. A successful commercialization of an innovation or product requires not only the product itself, but also other functions such as marketing and after-sales support. (Teece, 1986) Other than influencing a firms ability to appropriate value, complementary assets have shown to have potential influence on the future strategy of a firm (Teece, 2006). Theory on innovation implies that if these complementary assets are novel to the context into which they are brought, they can also be defined and viewed as innovations.

Teece (1986) proposed a taxonomy that categorizes complementary assets into three groups; generic, specialized and co-specialized. A generic complementary asset is one that requires no customization to the product or innovation in question. For specialized assets, there is a one way dependence between the complementary asset and the innovation, either of the asset on the innovation or vice versa. The co-specialized asset shows a bilateral dependence between the complementary asset and the innovation, in other words, they are tailored to one another. (Teece, 1986) The introduction of new technologies and innovations that eradicate the value of existing complementary assets is likely to strongly challenge incumbents. In contrast, technologies and innovations to which existing complementary assets can still be applied will rather let incumbents retain their position. (Tripsas, 1997).

2.2.3 Digital Technology Innovation

As this study investigates digital products and services as a complementary assets to li-ion batteries, this section seeks to explain the background behind this theory. Digitization has had major impact on the nature of innovation and the products and services that it results in. (Nambisan et al., 2017). Digital technologies have become incorporated in many objects that were earlier only physical, adding new characteristics to these objects. According to Yoo (2012), digital technologies have two fundamental properties; re-programmable functionality and data homogenization. These properties allow for a flexible environment with open-ended product development meaning that a product is not finalized even when brought to market. A further consequence of the properties of digital technologies, is that innovation is characterized by convergence and generativity. (Yoo et al., 2012)

Convergence is the phenomenon of fusing user experiences or industries that were previously separate and can be illustrated by the integration of previously separate products serving separate markets into a smartphone. Genereativity, is the ability or capacity of a technology to create unexpected and unplanned changes, initiated by large and distributed groups. This ability of digital technology is driven by three factors. The first is the procrastinated binding of form and function, which allows for a more open-ended product design to which changes can be made and features added. The second is called wakes of innovation, which refers to the consequential changes that are enabled by digital innervation. The last is that digital innovations will leave traces of data that can be leveraged in new innovations. (Yoo et al., 2012)

2.3 The Customer Side of Innovation

Understanding of how a technology behaves and develops over time is central to successful innovation. It can, for example, guide a firm in understanding when and where to invest more and give confidence to believe in a technology that is still only in the beginning of its development. But still, no innovation will succeed without customers that perceive the product as valuable. A common, and potentially fatal, misconception about innovation is that a perfect product will be enough to succeed and yield great success in the marketplace. But, even the perfectly designed product is entirely worthless if it does not solve a problem that the targeted customers have and most importantly - would be willing to pay to solve. (Christensen et al., 2016) In other words, it is just as important to understand the customer and its situation as it is to understand the technology's prospects. This section will look into what aspects guide whether an organization decides to adopt an innovation or not, and what consequences such a decision might get. Even after an innovation is adopted, customers might face challenges as changes to their product might require changes in their business model. However, before going further into this, it is of interest to understand the nature of industrial buying.

2.3.1 Industrial Buying

Lilien (2016) states that industrial buying can differ in its character, depending on if the market is emerging or existing and business should strive to understand the character of the market in which they are present. Furthermore, relationships and markets change over time, for example due to digital development. This implies that the character is not static and that the market needs to be reevaluated, which can be challenging. (Lilien, 2016)

Vowels et al. (2011) highlight that from a producing company's point of view, an innovation might be very interesting and radical. However, it is the perception of the adopters on the market that set the context on how valuable the innovation actually is. Knowing this, the innovators must be aware of who the early adopters in the market will be, to set the innovation in a best context as possible, from a perception point of view. In addition, the presence champions in the adopting environment can have a catalysing effect on the adoption process. (Vowles et al., 2011)

Besides knowing where to best place the innovation for successful adoption, it is crucial to know that most innovations need a number of complementary offers, besides the main product, such as services and processes, to successfully meet the needs of the customer. (Vowles et al., 2011) Lilen (2016) adds that B2B buying relationships includes a range of stakeholders, and such make the relationships and network more complex. The stakeholders, both internal and external, might have different goals, be involved in different processes, have different time perceptions and value different things. The complex nature of transactions between companies often makes them require more time and resources compared to transactions with consumers. The transactions that a firm go through are thought to have strong influences on the organizations structure, for example according to the resource dependence theory, which states that the external environment is the primary determinant of firm structure (Cohn and Turyn, 1984) and goals (Fligstein, 2021). Many transactions between firms are recurring, but innovation will naturally involve a first time transaction of its kind for at least one of the involved firms. Thus, it is of interest to understand what factors guide an organizations decision to adopt a technology or not, which will be covered in the following section.

2.3.2 Organizational Adoption

To successfully bring an innovation to the market, it is important to understand what factors guide the adoption decision within the customer organization. (Frambach and Schillewaert, 2002) Frambach and Schillewaert (2002) propose a framework for understanding organisational adoption, presented in Figure 2.4, in which the decision to adopt is influenced by several factors. The adoption decision is primarily influenced by the adopting organizations characteristics - its size and innovativeness - how the adopting organization perceives the innovation and what external influences are at play. How the adopting organization perceives the innovation is in turn under influence of the supplier's marketing efforts and the actions of other actors within the adopting organization's network. The conditions for adoption can also change due to competitive pressures, for example if a competitor chooses to adopt the innovation.

How the customer perceives the characteristics of an innovation is critical for its decision to adopt or not (Frambach and Schillewaert, 2002). As non-incremental innovations introduce new elements, either in components, architecture or even how value is created, customers will likely be uncertain about what benefits they could draw from the innovation. Consequently, it will be challenging for the innovator to communicate the benefits and define what attributes of the product correspond to the customer's needs (Bohlmann et al., 2013). An effective marketing effort from the innovator can influence the potential customer's perception of the innovation (Frambach and Schillewaert, 2002). Innovators that focus on reducing risks for customers and follow a marketing strategy that clearly shows the particular properties of the innovation, are more likely to have their innovation adopted. For service offerings, risk reduction, for example through low introduction prices, is particularly successful. This implies that suppliers can influence the customers decision to

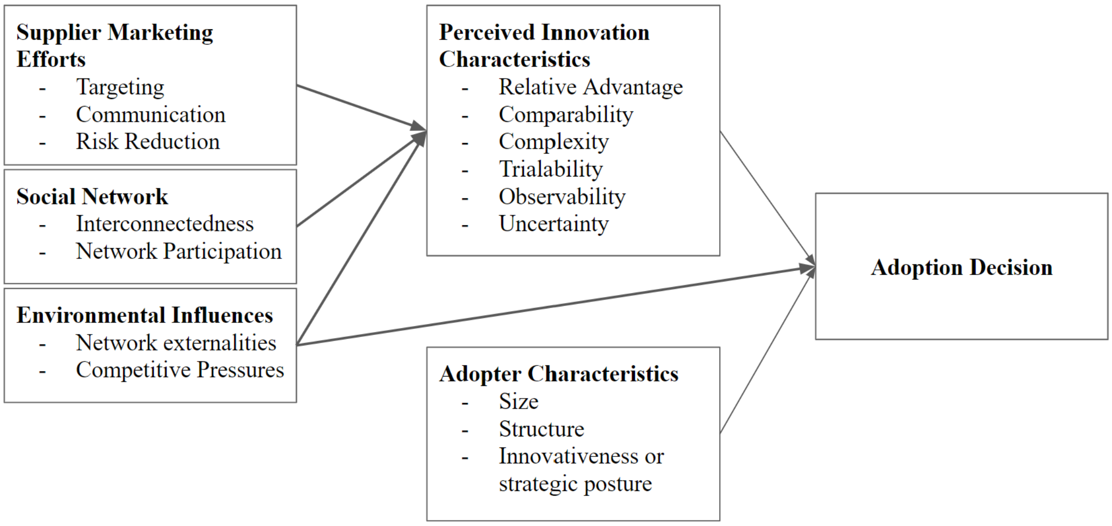

Figure 2.4: Factors that influence an organization's decision of whether or not to adopt an innovation, adopted from Frambach and Schillewaert (2002)

adopt. (Frambach et al., 1998) As customers learn about and experience the new technology their needs and preferences tend to develop and change. This implies that there is a dual learning process taking place, the innovator learns about the customers situation to improve their marketing and the customer learns about the product and its potential for the own business. Thus, communication of product benefits are central to reduce perceived shortcomings of the technology and to allow for customer learning. The more the customer learns about the product, the more value it is likely to see in implementing it.(Bohlmann et al., 2013)

Further, organizations are not working in isolation, but are interconnected with other actors (Frambach and Schillewaert, 2002). When striving to understand customers' needs, it is important to consider the entire buyer-supplier chain. Manager's are often concerned with technology and competitive issues regarding not only their own company, but also their customers and customer's customers. Needs and challenges can often be the result of changes happening further downstream, that have spread up the supply-chain. For successful innovation it is not only important to understand the supply and demand side of the technology, but also the interplay between them. (Bohlmann et al., 2013)

The adopting organization's characteristics will affect it's propensity to adapt an organization. Size is positively related to adoption, but a formal and centralized organizational structure is negatively correlated. Organizations that regard innovation as strategically important are also more probable to adopt an innovation. (Frambach and Schillewaert, 2002)

Adopting an innovation can influence an organization also long after the decision has been taken. Innovations that alter the product or service that the adopting organization sells, will likely require corresponding changes to the organizations business model (Sandström and Osborne, 2011). Required changes can range from small adjustments to complete reconsideration of the organizations raison s'être. The following section will be about business models and business logic and how this might need to change as a product changes.

2.3.3 Business Models

The term Business Model is wide, with numerous definitions throughout scientific literature. Ait and Zott (2001) defines it as:

> "The structure, content, and governance of transactions between the focal firm and its exchange partners"

In addition, Chesbrough (2007) claims that:

> "A better business model often will beat a better idea or technology"

The business model has two functions; value creation and value capture. Capturing value is crucial as a business must earn profit from their activities, or the activities cannot be sustainable over a longer period of time (Chesbrough, 2007). The value created can be applied on industry level, as well as on firm level. As an industry changes, the business models tend to change in parallel. (Schweizer, 2005) Sandström and Osborne (2011) explains that a business model is based on the interfaces of a firm, and its external stakeholders. Further, it includes the transaction models linked to those interfaces and relations. In addition they state that due to this, a firm has a limited power to control the business model fully. (Sandström and Osborne, 2011)

A framework that is commonly used by researchers as well as practitioners is the *Business Model Canvas* formulated by Osterwalder and Pigneur (2010), illustrated in Figure 2.5.

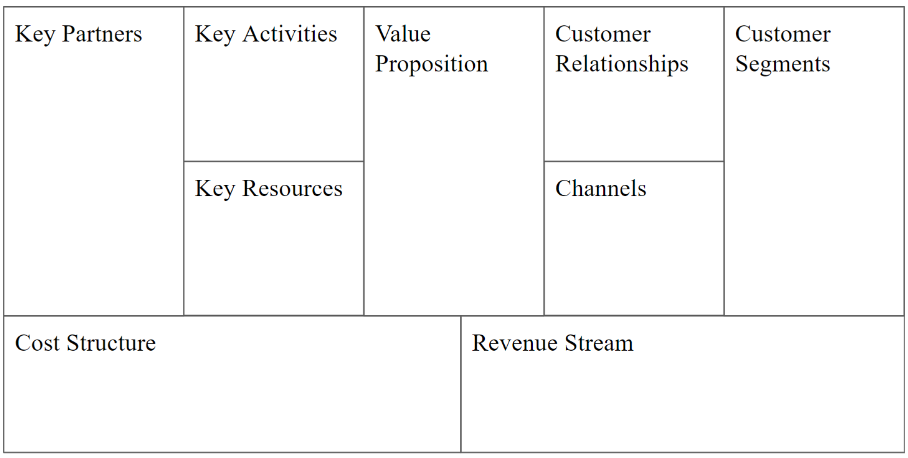

Figure 2.5: An illustration of the Business Model Canvas by Osterwalder and Pigneur (2010)

The Business Model Canvas is applied in many different areas connected to energy storage systems, however an example is shown by Yukselen et al. 2020. They apply the model to a hypothetical start-up company that works with salt water batteries. In addition, the study also looks into how this can be applied to lithium-ion battery companies. The results of the study shows that the energy storage systems is not yet affordable for the customers on the market investigated, hence the suggestion is that governmental incentives will play a large role in the commercialisation of the products (Yukselen et al., 2020).

Customer Segments Knowing who the customer is central to any business. The purpose of this building block, is to define and divide customers into segments based on their traits. Aspects that implies that customers belong to different segments are their needs and willingness to pay, how they are reached, what kind of relationship they require and what their profitability is. The organization then has to decide which segments to serve and which not to serve.

Value Proposition The value proposition describes how value is created for a customer segment and specifies what offers will serve that customer segments needs. A value proposition can also create a new need by showing customers offers that change their perception of what they need.

Channels In order to reach customer segments with the intended value proposition there must be ways of communication and distribution, which falls under the Channels building block. The channels building block is divided into five phases:

- Awareness - make potential customers aware of the offered products and services
- Evaluation - support customers in making an informed evaluation of the Value Proposition
- Purchase - make purchases of specific products and services possible
- Delivery - make sure the value proposition is delivered to the customer
- After Sales - identify how after-sales support can be offered to support customers

Customer Relationships Customer relationships can range from being based on personal connection, to being fully automated. For each customer segment, it should be defined what kind of customer relation ship is aimed for.

Revenue Streams Revenue can be generated in two ways; transaction revenues and recurring revenues. The first is the result of a one-time payment, for example an asset acquisition, and the other of rolling payments, for example through a usage fee, subscription fee och leasing.

Key Resources This refers to the resources that are vital for making a business model feasible. Key resources can be divided into four categories; physical, intellectual, human or financial. The key resources will depend on the business, but could for example be production facilities or competence.

Key Activities Any business model is reliant on suppliers and partners to be functional. Partners can be found in competitive or non-competitive settings, in joint ventures or in buyer-supplier relationships.

Key Partnerships The key partners are the relationships to other entities, non-customers, that a firm have that help their business, and therefore business model, to work.

Cost Structure This building block outlines the costs that appear from operating the business model.

2.3.3.1 Renewal of Business Models

Sandström and Osborne (2011) state that a product that calls for a change in distribution, relations and/or activities also requires the business model to change. However, this is often complicated due to the nature of the business model and its interlinks with the external environment, as explained above. This change requires a clear identification of all parts, internal as well as external, that would be affected of such a change. The effort in the change then lays in aligning the incentives throughout the different stakeholders and creating a new balance, which can meet resistance to change. (Sandström and Osborne, 2011) When a supplier organization adopts a new innovation that calls for a change in the business model, the down streams customers might also need to innovate their business model. In this way, innovations in one part of a network might have implications for the business models of other actors who are also part of that network. (Stone et al., 2021) The reasons for changing, or evolving, a business model can be of different characters, than just the product offer. Teece (1986) states that if the market doesn't work optimally, or imitation of the business offer is easy for other firms, then the business must make the earnings from complementary assets. One such can be the business model itself, or it can protect or enhance such assets in the organisation. (Teece, 1986) (Stone et al., 2021) As companies are busy serving current markets and customer needs, they risk to become obsolete and miss the opportunity to adapt their offer and business model for future needs. This is also one of the reasons that companies miss to evolve their business models, and can lead to misalignment within networks as it evolves. (Bower and Christensen, 1995)

2.4 Macro-level Demand and Regulations

The sections above have been focused on demand from an organization's perspective, but demand is also a result of factors acting on macro-level. On a macro-level, demand can be understood as a result of interdependent regimes, trajectories influenced by path-dependencies and lock-in effects. Together, the technical, science, user and market, socio-cultural and policy regimes make up the socio-technical regime. The prevailing socio-technical regime directs, for example, where technology development efforts are made and what customer needs look like. A destabilization of the regime, for example though institutional and regulatory changes, could potentially alter the conditions for customer needs. (Geels, 2004)

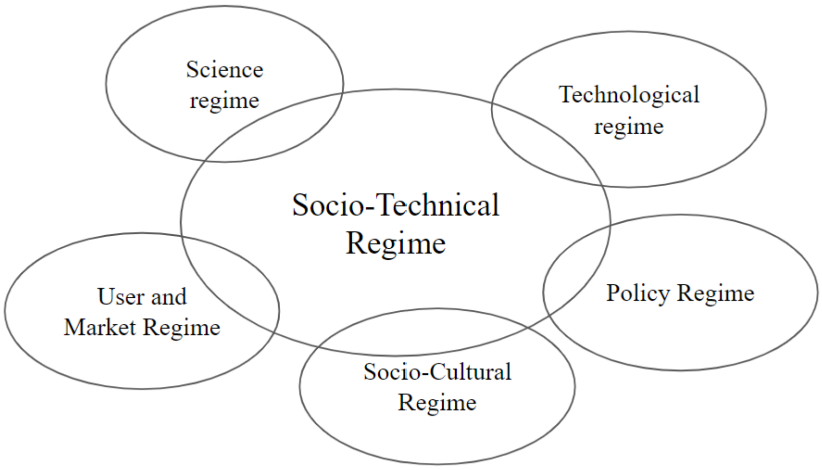

Figure 2.6: An illustration of the regimes making up the socio-technical regime, adopted from Geels (2004)

Theoretical Framework - Summary

To summarize the theoretical framework, for successful marketing of an innovation, it is as important to understand the customers and what they are willing to pay for, as it is to understand how technologies behave and develop over time. Due to the novelty that an innovation introduces, it can be misleading to rely too heavily on traditional tools for market analysis, such as Porter's Five Forces, SWOT or PEST.

Technological innovation is in its early phases typically surrounded by high uncertainties regarding performance and market size. Eventually, this uncertainty settles as customer needs become more crystallized and condense. In addition, the degree of uncertainty depends on what type of technological innovation is regarded - architectural innovations will likely be surrounded by larger uncertainties than modular innovations. Innovations can also be delivered and marketed together with complementary assets that help the innovator profit from the innovation. Digital technologies have a few traits that distinguishes it from other technological innovation - convergence of user experiences or markets that were previously separate, and generativity that allows the technology to develop in unexpected and unplanned ways.

Industrial customers are characterized by professional buying centers with multiple stakeholders, and are known to have heterogeneous requirements relative to consumers. Whether an industrial organization decides to adopt an innovation or not depends on how the innovation is perceived, what external influences are at play and also the adopting organization's structure and size. Needs that emerge at one level can be the result of needs expressed further downstream the supply-chain. A decision to adopt an innovation that alters the marketed product will require the adopting organization to renew their business model. Such renewal demands good knowledge of the current business models different parts and alignment of stakeholders throughout the organization and potentially within down stream customers. Finally, on a macro-level, demand is influenced by different regimes trajectories that make up the socio-technical regime. Such trajectories are, for example, the technological regime, the policy regime and the user and market regime.

3 Research Methodology

This section will outline the research methodology applied during the study. In short, the study has followed a qualitative strategy with an inductive approach with semi-structured interviews as the major technique for data collection. The study has been conducted trough the perspective of a Swedish energy storage company and its interlinks on the market. The semi-structured interviews have been held with internal employees as well as customer organization's employees, with a professional relation to electrification and/or digitalization. The data has then been analyzed in multiple turns, as suggested by the Gioia method (Gioia et al., 2012), to identify common and recurring themes.

3.1 Research Arrangement

The aim of this study is to identify both existing and emerging needs and challenges that come with electrifying with li-ion batteries. As emerging needs do not yet exist to be measured, it would be hard to provide data for a quantitative analysis. A qualitative research strategy, on the other hand, is common in business research and does not require prior qualitative data. Further, it allows for the researcher to engage with the subjects and can thus produce a more nuanced picture and allow unknown aspects of the researched issue to emerge. (Bell et al., 2019) Moreover, this thesis uses an inductive approach which, as opposed to the deductive, is not based on, or initiated by, theory, but allows concepts and theories to form and emerge from the data collected (Bell et al., 2019).

3.2 Literature Study

The literature study began early in the process and was continued throughout the data collection. The aim was on the one hand to produce a foundation that the thesis could be built on, and on the other to gain knowledge and understanding in the area. As the study includes the scope of industrial businesses interacting with each other and the mapping of how some of these adopt a technical innovation from others, the initial keywords that were used in the search were for example *B2B Marketing*, *Adoption* and *Technological Innovation*. The list of keywords was expanded and altered as the relation between the studied issue and theory unraveled. It became clear that studies of B2B marketing in fast-changing and innovative settings are quite rare. Thus, the literature study was built to cover more general aspects of technology supply and technology demand.

The Scopus database shows that few studies on organizational adoption, technology supply or technology demand have been made in a Swedish setting. Publications with these keywords start appearing in the second half of the 90s and the yearly number of publications has been growing since. Further, the combination of B2B Marketing and Innovation only gave 28 results worldwide, which implies that there is most likely a need for research on this.

Theory has been searched and found in scientific journals, books and reports from authorities. The majority of the research has been conducted through databases such as Google Scholar, Elsever, Emerald and Taylor Francis.

3.3 Data Collection

The data collection makes up the very backbone of the study, and its' quality is crucial for the resulting conclusions. Understanding of the context in which the study takes place, and more specifically the context as the involved perceive it, is central in qualitative research (Bell et al., 2019). In seeking to capture a representative image of the context of the case the data collection involved employees at the case company, as well as existing and potential customers to the company.

3.3.1 Interviews

It is common to talk about immersion in qualitative research, which means that the researcher interacts with the subjects of the study to learn about a social setting (Bell et al., 2019). One common method for such interaction is the semi-structured interview, as it allows the researcher to keep an open mind towards the research question and theory (Bell et al., 2019). An unstructured format would allow for even less preconception, but Bell et al. (2019) highlight how this lack of structure might negatively impact comparability if the study is conducted by several researchers. A further advantage with using semi-structured interviewing is that is allows the participants to go off script so that unknown themes can emerge. Thus, the semi-structured format was considered most suitable to achieve a balance between flexibility and comparability. According to the Gioia method, the interview should always be preceded by the creation of a research question which can guide the scope of the questions (Gioia et al., 2012).

For a start, a list of potential interviewees at the case company was given by the researchers contact at the focal company. These interviewees were selected based on their knowledge related to the thesis issue, and were conducted to gather a picture of the context within which the study was made. Based on this initial understanding of the context, appropriate questions for interviews with customer organizations were formulated. Some of the interviews were conducted face-to-face, and some online, depending on the availability and location of the interviewee. Since the purpose was not to produce data for analysis, the interviews were not recorded, however, extensive notes were taken at all. In some cases, as new information surfaced employees who had earlier interviewed were again contacted to clarify any thoughts or questions.

Table 3.1: Conducted interviews at case company

Position	**Date**	**Length**
Director of Business Development	08-02-22	62 min
Sales Manager ESS - Business Development	09-02-22	25 min
Application Engineer - Business Development	09-02-22	21 min
Manager Aftermarket Development	10-02-22	29 min
Director of Aftermarket	10-02-22	30 min
Senior Business Developer	11-02-22	31 min
Director Industrial Products	14-02-22	28 min
Digital Product Manager	14-02-22	32 min
Key Account Manager Automotive	16-02-22	27 min
Chief Security Officer	17-02-22	29 min
Senior Development Specialist	21-02-22	30 min

Further, interviews with employees at existing customer organizations were conducted to gain a deepened understanding of what needs and challenges exist and what are driving factors behind these. An initial group of potential interviewees was offered by the researchers contact at the focal company. These were contacted by email to set up a date for an interview. If there was no response, the researchers searched the potential interviewee by phone call. From this foundation of interviewees, the principle of snowballing was used, meaning that interviewees was asked for relevant referrals. Bell et al. (2019) writes that snowball sampling can be useful when it is hard to define a sampling frame or the notion of a representative population might not be applicable. This was the case for the study as only a small group of people was of interest based on the criteria of employer organization and relevant position.

To make sure that the data could be revisited, all interviews of this kind were recorded with the permission of the interviewee. Communication is made up by more than just spoken word - body language and intonation also carries a lot of information that is of interest in qualitative research (Bell et al., 2019). To capture these nuances, two researchers participated in every interview, allowing one to focus on asking questions and driving the interview, and the other to take notes of things that would not show in the recordings. All interviews were conducted online through video meetings, which made it harder to read and see the nuances of the interviews. Still, online interviews were regarded as the most suitable as it is a lot more efficient and allowed the researchers to hold more interviews over a larger geographical area. Further, participation by two researchers in each interview was regarded to reduce the degree of personal bias.(Gioia et al., 2012)

Contact with potential customers was established by phone calls as a first point of contact at which, if there was an interest to participate, a time for an interview was booked. Potential customers included companies that are similar to already existing customers in terms of operations and size, but also companies that differ from existing customers but for which the focal company's products are considered to provide some value. The design of the interviews followed exactly that for the existing customer organizations.

Table 3.2: Conducted interviews with customer organizations

Segment	Interviewee	Role	Date	Length	Recorded	Transcribed
Consumer tools	Participant A	VP Technology Management	25-02-22	58 min	Yes	Yes
Material Handling	Participant B	Control Systems Manager	03-03-22	43 min	Yes	Yes
Marine	Participant C	Manager Energy Storage	07-03-22	40 min	Yes	Yes
Material Handling	Participant D	Digital Director	08-03-22	36 min	Yes	Yes
Material Handling	Participant E	Technology Manager Electrification Mobile	08-03-22	39 min	Yes	Yes
Construction	Participant F	Global Product Manager Battery and Connectivity Systems	08-03-22	45 min	Yes	Yes
Energy Storage	Participant G	Battery Technology Engineer	15-03-22	41 min	Yes	Yes
Energy Storage	Participant H	Senior Battery Technology Engineer	15-03-22	41 min	Yes	Yes
Forestry	Participant I	Manager of Product Development	18-03-22	32 min	Yes	Yes
Marine	Participant J	Manager of Product Development	21-03-22	33 min	Yes	Yes
Construction	Participant K	Manager of Product Development	23-03-22	35 min	Yes	Yes
Material Handling	Participant L	Technical Director	24-03-22	44 min	Yes	Yes
Material Handling	Participant M	CEO	29-03-22	29 min	Yes	Yes
Marine	Participant N	Production Manager	31-03-22	45 min	Yes	Yes
Construction	Participant O	Sales Director	04-04-22	39 min	Yes	Yes
Construction	Participant P	Project Manager	06-04-22	31 min	Yes	Yes

3.4 Data Analysis

Qualitative research is often criticized for being non-systematic and data analysis is not an exception to this. This data analysis was based on two methods for analysing semi-structured interviews in an inductive study - the Gioia method, and the method outlined by Galletta - that both aim to provide a systematic way to conduct such studies. (Gioia et al., 2012)(Galletta, 2013) The Gioia method has been used by similar studies, for example in a study on how customer involvement can benefit or challenge the development of innovation. (Scaringella et al., 2017)

Even before the data collection was completed, early data analysis began. Directly after an interview, any core ideas identified or questions raised were written down. Next, the data generated by the interview was organized as to make it available for further analysis, in this case by transcription of the interview. Other than making the data more accessible, transcription was a way to engage in early analysis. (Galletta, 2013) Following, thematic patters and quotes that were clearly related to the research question were documented. In this 1st-order analysis, the terms and expressions of the interviewees were kept, as the purpose was primarily descriptive. (Gioia et al., 2012) It is important that the researcher considers the relevance of the collected data for the research question, is ready to iterate on assumptions and revisit data as the analysis proceeds (Gioia et al., 2012)(Galletta, 2013).

Based on the initial understanding of the interviews and the 1st-order concepts collected, the researchers started searching for patterns. This resulted in a number of in vivo categories to which the 1st-order concepts were matched. The purpose of these 2nd-order categories is to make the connection between the concrete result and the more abstract connection to the research question - what it is actually telling us. Another benefit is that it heavily reduces the number of concepts to a more manageable amount. (Gioia et al., 2012) These connections between the results and the larger narrative were made in common understanding of both researchers. As the data analysis expanded, new codes were constructed and overlapping or old ones that lacked proper support in the data set aside. This allowed the understanding of the study to develop as new information emerged (Galletta, 2013)

The analysis began in looking at the interview data, one by one, trying to understand the narrative and experience of the specific participant and to collect relevant concepts brought up. As the analysis continued, this single narrative was put in relation to other interviews. By contrasting and comparing, the meaning of codes could be extended which led to a categorization of codes. These categories of codes could subsequently be compared and contrasted to find more general patterns.

3.5 Methodology Discussion

This section is dedicated to discussing the quality of the study and the results generated by it. For qualitative research the most common quality criteria are

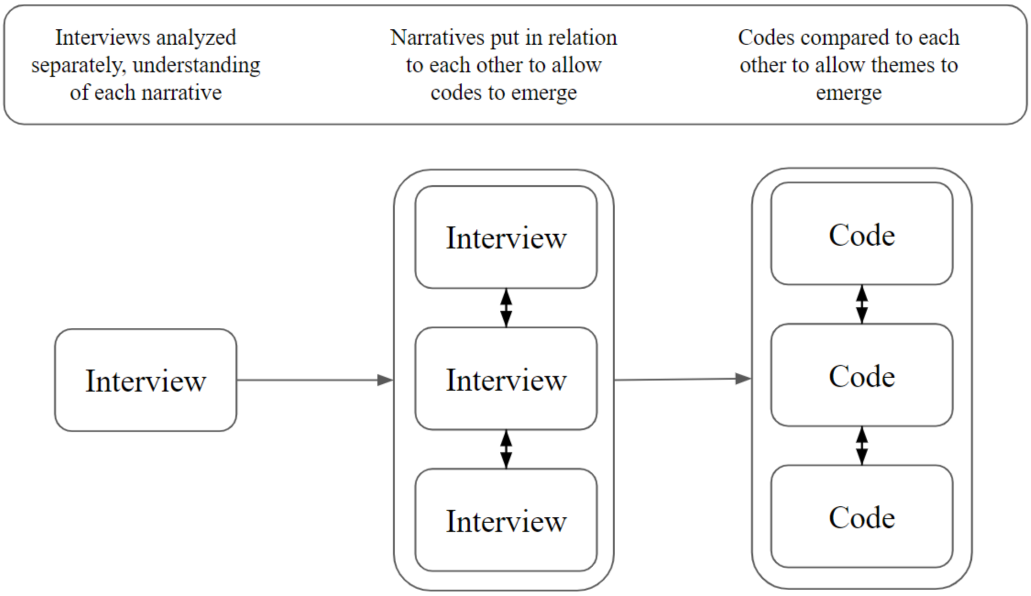

Figure 3.1: An illustration of how the data analysis was conducted

replicability, reliabilty and validity. (Bell et al., 2019) This discussion will focus on the criteria of validity.

3.5.1 Validity

Validity as a criteria aims to evaluate the integrity of the generated results. It can be divided into four categories; measurement, internal, external and ecological validity. The first is concerned with how well a measure manages to capture the intended phenomenon and will not be further discussed as the study does not entail any measures. The last criteria concerns to what degree findings can be applied in everyday social settings, which is not the goal of the study and will thus neither be further discussed.

Internal validity requires investigation of relations of causality. That is, to understand how different variables in the context influence each other, a relation that is often characterized by a dependent variable and an independent variable. (Bell et al., 2019) In order to increase the internal validity of the study several interviews spread over different segments and with different roles within companies have been conducted. During these interview, relations between variables have been discussed and the causes concluded by the study have been confirmed by several interviewees.

External validity is a concept used to refer to whether the study can be generalized to other situations than the specific studied context. Important for a result with high external validity is how representable the interview samples are. The sampling scope of this study is *Industry*, which applies a very wide number actors. Still, the study has mainly interviewed actors within material handling, marine and construction. In other words, the study is not concerned with actors from the entire industrial sector. While the result presented are a summary of needs and challenges seen within all interviewed segments, there are nuances and differences between them. This implies that applying the findings of the study directly to another context might not fully capture the complexity of needs and challenges for that part of industry.

3.5.2 Potential bias in the research methodology

The following section will outline the potential sources of bias that the researchers have identified with the research methodology. It will also explain what actions were taken to minimize the potential impact of these.

As with all qualitative research, since it is largely based on experiences and subjective understandings of these, there is a risk of bias. This bias could be a result of the researchers own experiences and proneness to interpret results in a particular way. It was to reduce this risk that the study was designed so that both researchers took part in all interviews and took part in analysis of all interviews, since this provides a wider range of experiences. The sampling of interviewees could also be a source of bias, which is why interviews were conducted over different companies and segments and with employees in different positions. In the results section, some participants are over-represented in comparison to others. This could be a potential source of bias as one perspective is given more room than another, but all quotes have support from at least, and usually more, one other participant. The quote that best highlights the issue was then selected to be presented.

3.6 Research Ethics

Following is a discussion regarding the ethics of the study. There are four factors that are common in discussions of research ethics. These concern whether there is harm to participants, whether there is a lack of informed consent, whether there is an invasion of privacy and whether deception is involved. (Bell et al., 2019)

All participation was voluntary and participants were informed of the purpose interview both at the first point of contact, and just before the interview started. At the beginning of the interview, the method was shortly outlined and the participant given the opportunity to answer questions to reduce any risk for deception. After the interviews, results were handled in the way outlined to participants. In addition, each participant was asked whether they accepted a recording of the sound and the recording was not started until they had consented. As the study is focused on the business and larger themes the researchers see no reason that there should have been an invasion of the participants privacy. The interviews have partly covered areas that could be of competitive importance for the participants organization. Thus, follow-up questions have at some points been left unasked in order to protect the integrity of the participants. Participants have in some cases also preferred not to answer, which minimizes the risk of any indirect harm to the participant due to sharing too much information.

4
Results

The following section will outline the results of the study. These results are exclusively built on the insights gained during interviews with employees at organizations within the industrial sector. Firstly, the structure and configuration of the industrial sector and network of a li-ion battery producer will be outlined. Secondly, identified themes that drive needs and challenges within the industry are laid out. Third, and lastly, the mentioned, exiting or potential, digital solutions that have appear during the interviews are presented.

4.1 Industry Structure

The interviews show that, within the industrial sector, customers and end-users are not necessarily the same thing. Several actors will typically handle, or add value to, a product before it reaches the end-user. For example, a li-ion battery could be sold from the producer to a construction equipment company that assembles a machine that is then sold to a rental company. The rental company will then offer the product to the end user. Some interviewed organizations sell both to end users and rental companies and others to dealers: *"Our buyers are both end-customers and customers that act third hand partners/dealer that re-renting or leasing out the equipment"* (Participant E) Consequently there are many levels of needs to take into account and end user needs will, in many instances, have to pass through several actors before they reach li-ion battery producers. Customers will be referred to as Level 1, Level 2 or Level 3 depending on how far from the producer they are, where Level 1 is the closest. Figure 4.1 illustrates how these relations can look for two segments.

4.2 Current and Future Challenges and Needs

All interviewees agreed on that batteries, together with an electric motor, have potential and perform well along some dimensions. Interviewee J empathises this; *"An electrical engine is cheaper, more quiet, requires less entertainment, have more environmental advantages, does not contribute to pollution and give a faster power response"*

The cost, or relative cheapness, of batteries in the quote refers to the Total Cost of Ownership of li-ion batteries. Still, there are a number of parameters along which performance for electrical motors with lithium-ion batteries is not as good as

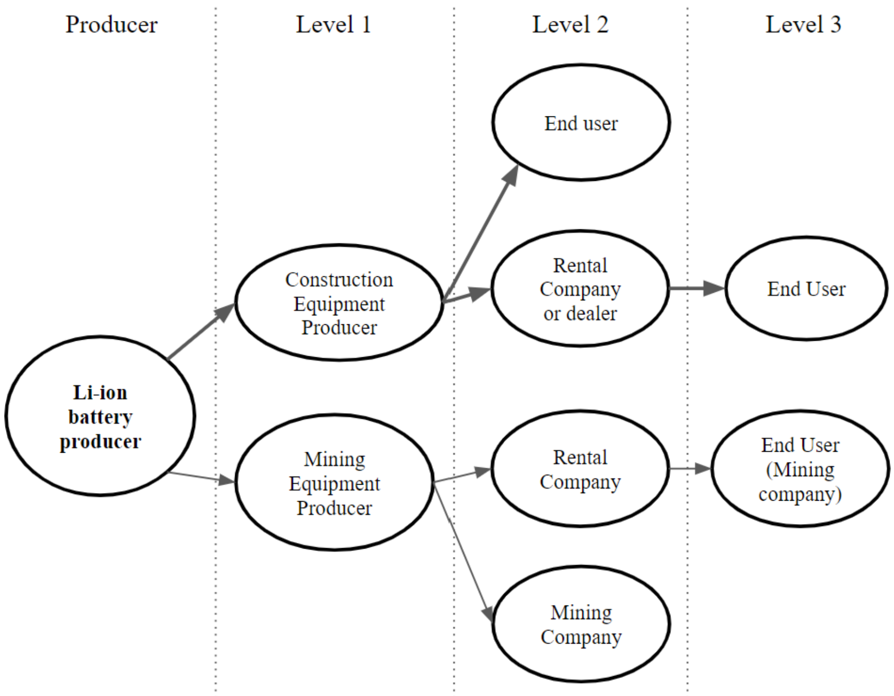

Figure 4.1: An illustration of network configuration for industrial applications of li-ion batteries, from producer to end user.

customers demand. These aspects of performance and customer needs will be elaborated in the following section. The different themes and sub themes are presented in Table 4.1.

4.2.1 Security

The interviewees expressed different concerns and needs in term of security of batteries and electrical products, both regarding hard- and software. The following section will present each and the findings within those.

4.2.1.1 Software

Many of the participants expressed concerns of cyber security when collecting, or sharing, data from their products. Still, many see that data holds great potential value if used properly. Participant H claims that within their industry, the infrastructure is very critical and leakage of usage data can result in major problems and legal challenges which might affect the integrity of the individuals using the system. However, they highlight that this data is needed and is *"essential to build the future services and products within ESS"*. There is also a common understanding within the material handling industry that cyber security is a concern. Data including layout, monitoring of cargos, regarding date and time, is usually company sensitive information and it is hence important to handle the data collected in a proper way. Furthermore, Participant D empathise the importance of collecting data on product usage as it helps the end customer to increase efficiency and quality of their opera-

Table 4.1: Themes and subthemes

Theme	Subtheme
Security	Software Hardware
Productivity	Charging Change batteries
Energy Density	Charging Weight
Financial Factors	Expensive technology Government regulations
Environmental	Customer demand Regulation compliance
Technical	Working environment Knowledge and competence
Uncertainty	Investment Technology

tions. *"Collecting information on the operations, let's say that there are bar codes, on how they are lifting them [packages] up and putting them down somewhere else. We are helping the customers collecting that information today".*

4.2.1.2 Hardware

Across different sectors there is a common understanding that end customers express concern about the hardware security of li-ion batteries. Participant F explains that *"there is a certain concern from customers, we get a lot of questions on handling of the products, something we were surprised over. We need to support and educate the customers about this; how to handle, stock, repair and recycle [lithium ion batteries]. There even was a concern internally in R&D, service and production, on this.* To counter this, the company worked to increase knowledge, both internally and externally; *We then educated and informed internally, which also later helped us inform and educate the customers"*

One challenge for the interviewed companies, whether they sell energy solutions or industrial products with batteries, is that customers perceptions about the product differs from what the supplier organization regards to be true. One such aspect is security. *"One thing that the customers view as a hinder is safety: they read a lot about the risks of lithium-ion batteries and different accidents get a lot of medial attention. It is mainly connected to lack of experience."* (Participant G). These perceptions are largely built on customer organization's earlier experiences and routines.

4.2.2 Productivity

A big majority of the interviewees, across all sectors, highlighted the high importance of productivity for all different levels of customers, and how electric products may affect this. *"It's about the maturity of the customer as well. They don't really want to buy or own machines, they want to move cargo"* (Participant E). This is elaborated in the sections below.

4.2.2.1 Minimize Downtime

The electrification of industrial products has affected how the products can be run, which, in turn, affects the operations of the customer or end user. Many of the interviewees express that they are struggling with minimizing downtime as the batteries won't be able to run the equipment without breaks for charging. Productivity is central to all customers as each minute of unproductive time is revenues lost. Participant B says that in material handling *"some customers work their trucks really hard and won't get a full shift out of the lead-acid battery"*. In the construction equipment sector, it is the same way; *"A limited running time is a big challenge, to have the same running time as a combustion engine would have, would require a very big [li-ion] battery and that is not feasible. On the other hand, the battery driven products are more technically advanced and can help the products run more safely in the operations, e.g. help with breaking and steering"*, according to participant F. They also explain that depending on where the operations are located, it is more or less challenging to find a charging option. This is also expressed by participant I, working with forestry products; *"When the trucks go into the woods, it is hard to bring a cable, or other charging options, out. You could bring batteries charged for about 3-4 hours of work, and that would require putting a lot of time changing batteries*".

Participant E states that, to find the optimal solutions for charging and operations, close understanding and collaboration between supplier and customer is the solution. To understand their customer's operations, they collect data from the equipment in use; *"The batteries are connected to the products and also connected to the internet. The BMS is looking at different data sets; temp, state of Health, etc."*. By understanding the customer's operations and running time, they can give suggestions of when and how to charge and/or change the batteries. Participant A says that *"the most important information for batteries are where they can charge, when they should charge in order to maximize operations and how they should be charged"*.

Both interviewee J and C within the marine sector express that there is a significant difference between customers and how sensitive they are for downtime. Customers in the private sector are far less sensitive than the ones in the commercial sector.

4.2.2.2 Energy Density

The energy density of li-ion batteries is something most interviewees touch upon. Participant G states that *"We will never reach the same energy density as diesel, however [lithium-ion] batteries have a high energy storage efficiency"*. Further, this is one of the highest wishes' of another interviewee *"The wish would be to replace combustion with a technology with the same density. That is the challenge today"* (Participant C). Interviewee B compares lead-acid batteries to lithium-ion batteries; *" More customers are asking for lithium batteries: Rather than having many different lead-acid batteries in charge swooping, you can have one [lithium-ion] battery and run it for the whole shift"*.

Interviewee K share their thoughts on common knowledge on electric power, and energy *"there needs to be an increased common knowledge on this in society, maybe start with learning kids in school how this works. In order to electrify, the users must understand the terms"*. This is also stated by other interviewees; the fact that there is a poor knowledge in general on batteries, electricity and how they work. A few of the interviewed companies are solving this problem by educating their industrial network; their employees, customers and suppliers.

In the forestry sector, there is a large gap in what energy density is needed and what is on the market today, in order to fully electrify their products according to interviewee I. *"If there was a battery solution to work for 8-10 hours, it would be feasible. Today however, that would require very large batteries and that is not possible"*.

Two participants, A and F, express the problem with energy density and handheld industrial products; *"there are still some products that require a very high effect, yet the products cannot be too heavy. Then they would be hard, or impossible, to operate"* (Participant F). They explain that this is a huge technical challenge and requires a lot of resources to develop and find solutions to.

Li-ion batteries are among the most efficient way to store energy, but due to a high degree of passive materials they are heavy compared to the amount of energy that they can store. *"You have to have a power source and currently diesel is the one [compared to lithium-ion batteries] that has enough energy per weight"* (Participant I). Many applications are limited both in space and weight that they can carry, hence too low energy density is a common reason why applications are not suitable for electrification. Interviewee C empathises this *"If I could dream free, the thing that would make the biggest difference would be a battery with the same energy density as diesel"*

4.2.3 Financial Factors

The financial incitements for producing electrical products are, according to the interviewees, not always clear. In material handling, there was a financial obstacle trying to sell electric products; *"there was a stage when the sales guys wanted to sell the engine truck, it was a cheaper truck than the battery and the motor, so it used to* *be the easier sell and a simpler one just for all our dealers to work with because they knew engines"* (Participant B). The construction equipment sector is also affected by the cost factor; *"When the batteries needed to be swopped out for charging during the shifts to minimize downtime, it became expensive due to the customer having to buy many batteries. We tried to solve this with a battery leasing model"* (Participant A). Interviewee E, operating in the material handling sector, agreed with this as well and stated that *"Its about the maturity of the customer as well. They don't really want to buy anything, they want to move the cargo. [...] [That is why we] will be selling things as a service; a monthly fee based on km, lifts, hours etc. Would like to see that the whole equipment is sold as a service, it is natural to sell battery as a service"*. Participant L also mentions ideas of financial models; *"business models that can balance the costs and benefits. That would be to do batteries as a service and rent the batteries. They have this on the products as well, but there is a bigger need on the battery side. "*

As the business network is figuring out a sustainable financial model for this, there is also a challenge to develop the business model accordingly *"I would say that in the next years we should work more and more with business models that focus on services rather than selling products. Maybe we wont be selling equipment with a fixed price, but a service with a monthly fee for km driven or containers lifted"* (Participant E). Many interviewees bring up the economic challenges with li-ion batteries. *"The biggest challenge is to find financial feasibility for some of the applications"* (Participant F). Li-ion batteries require bigger capital expenditures at acquisition, but are cheaper to operate and operating costs for both maintenance and fuel, electricity, are lower. A construction equipment company where participant F works, have had a hard time to find financial viability due to expensive battery development and production. Compared to e.g. the automotive sector, the construction industry will not buy as high volumes which will make it hard to push down the costs, according to participant F; *"this makes the gas and diesel alternatives a much cheaper option in terms of financial measurements"*.

Although companies are challenged in finding economic feasibility for electric products, there are already many applications for batteries with solid business cases. According to participant E, *"Many customers see that there are actually less costs for electrical motors if you consider the entire life time."*. In addition, interviewees highlight how it is hard for customers to motivate a higher CAPEX although OPEX is lower. One possible explanation that is brought up is that the way that investments are accounted for and understood favours reoccurring costs over high procurement costs.

4.2.4 Environmental

One of the strongest drivers for customer demand of electrification of industry that has appeared is the strive to reduce environmental impact. *"The main driver [for going electric] is the customers demand us to go green"* states participant B. This view is supported by participant E who also thinks the importance of environmental factors will only grow; *"I can not talk about drivers without mentioning sustainability, [I am] 100 percent sure that sustainability is going to be the main driver"* One reason why customers favour greener options, is brand related. As participant J says; *"Some do it simply just to be more attractive in their market"*. Another reason is that customers are anticipatory and believe there is a transformation to come. This belief is shared by several interviewees *"Electrification is here to stay. A lot of the customers are asking for electric products. In this decade, a majority of the trucks will probably be electrified"* (Participant M). A concern regarding environmental factors during the interviews was the issue of electricity production. Interviewees see that a long term solution for electricity supply is necessary to reap the benefits of electrification. *"Where does the electricity come from? If its gas or coal, then it will eat up the benefits of electric trucks"* (Participant M). Further, participant A underlines the importance of how the battery itself is produced in order to reach a greener end product.

There are some environmental aspects that are specific for some sectors. In the material handling sector, the electric trucks create a better environment indoors, as well as outdoors, in terms of pollution and noise which in itself is a big driver, according to both participant B and E, as it creates a better working environment for the operator. In the construction sector, participant F states that a couple of years ago, it was hard to convince customers to buy electric products. Now however, most companies in the industry have environmental policies which have changed their perceptions to buy the electrified products.

However, environmental factors are also affected by external forces, such as regulations and agreements. Participant K witnesses on the matter of institutional environmental regulations and goals in order to use electric products; *"we saw that electric products were necessary to meet the agreement of the Paris Agreement"*. Participant C, in the marine sector, also saw this as a factor and describe that *"in a couple of years it will not be legal to run combustion engine boats in some areas due to laws and regulations"*. This, of course, drives the need to get electric products on the market to meet the new needs.

4.2.5 Technical

The results show that building electric products entails some technical challenges, such as that the products will operate in multiple different environments and the batteries might be affected by e.g. different temperatures. *"One of the challenges now are the freezing temperatures as the trucks go outside. The battery doesn't work well in cold temperatures. That do complicate the electric machines"*, participant B states. Participant J talks about similar challenges in the marine sector; *"Standards can be how the battery should be installed, to saltwater resistance. They can differ between different regions, can be very different"*.

Yet another challenge is the shift in required knowledge when going from mechanical to electrical products. Participant B explains that *“We were a mechanical company [. . .] it still is but there are adoptions that have had to be made [. . .] The forklift service people was very much about engine knowledge and the dealers had to get up to date with the electric trucks and how to serve those”*. For electric products, much of the existing knowledge is obsolete and new knowledge and competencies have to be built. *"Service and maintenance are big struggles, it require a lot of new knowledge and competences to do this"* (Participant M). Participant L also witness the knowledge gap internally in the material handling industry when shifting to electric products. Participant K, from the construction equipment industry, confirms the knowledge gap externally; *“the customer is lacking understanding, it is a whole new technology and machine. The aspects of alternating current, charging, downtime and effect are new to people who are used to driving diesel run products”*. They stated that the company have to educate and answer a lot of questions on this from the customers.

Another aspect that is heavily influenced by previous experience and routines is how energy is understood. *"Today capacity is understood as liters of diesel, with electric products it becomes something completely different.You need to understand one liter of diesel relative to 1 kWh. It is hard to know how to put it into relation so that the customer understands."* (Participant K). Thus, capacity of batteries is often compared to that of diesel, simply because that is a fuel with which customers are used to operate. But understanding batteries through knowledge acquired through combustion engines might not always lead customers right. *"Selling a combustion engine is a completely different thing compared to selling electric ones. It is also completely different for the customer"* (Participant E) The dependence on the combustion engine will strongly influence the customer’s perception of the product.

4.2.6 Uncertainty

Li-ion batteries are a relatively new technology and are still being developed to fit different applications within industry.*"The main challenge is that the battery technique is not yet very developed. [Lithium-ion] batteries have a lower energy density compared to diesel"* (Participant J). With new technology, comes new challenges that have yet not been solved. This is confirmed during the interviews, among them the one with participant J; *"Standards and infrastructures are some of the bigger challenges that we are facing now. [We] want to know where these questions are headed and what the results will be, as uncertainty is very high right now"*. The novelty and uncertainty that surrounds batteries implies that customers are also lacking knowledge and understanding about the technology. Interviewee K states that *"The customers are lacking on knowledge, this is a new kind of technology and machine. [...] The charging, active time, effect, [...], those aspects are new to a participant that is used to operate a machine running on diesel"*. Another aspect of uncertainty regarding the technology is what happens as a battery reaches the end of its life cycle, as confirmed by participant F *"Even when the battery has decreased its capacity, there is much value left. Many businesses do not have the capacity or opportunity to capture this value, or recycle. This would be a hallelujah-moment to* *find a solution to"*.

There are applications for which the use of li-ion batteries are better researched and established, but this knowledge is not directly transferable, which means that the technology needs to be adopted to each application. *The excavator is used in a very different way, compared to a car, [the excavator] needs to run longer and needs more energy and power. On the other hand, there is a lot of limitations regarding location and charging options"* (Participant K).

4.2.7 Networks and relationships

Organizations within the industrial sector operate within networks made up of suppliers, customers and other actors. When an organization changes its business, it will likely also change its position within and interaction with the network. Interviews show that some organizations work to support their customers navigate their network, such as Interviewee F explain; *"Customer's focus is on running their machines. [With electrification], there are more actors on the market in order to do so; charging and other functions. This makes the customer having to interact with more stakeholders to have a product up and running. Our organization have learnt to answer questions from customers on this matter"*.

As mentioned above, misalignment between customer perception and the true performance of the technology, is a reoccurring issue found in the interviews. To counter this, interviewee organizations strive to take an active role in changing that perception. One way is through searching third-party approval through certifications or alignment with existing standards. Interviewee H states that *"To meet the customer's lack of knowledge and fears linked to lithium-ion batteries, we are working with certifications and strive to overachieve the ones that exists."*. Further, customers will not only find themselves with new external interactions, new internal knowledge also needs to be built within the organizations. There are many uncertainties regarding how batteries should be handled, both during their lifetime, and after. *"We acknowledge that there is a fear for batteries among customers and we get a lot of questions on battery handling, something we were not prepared on. The customers are lacking knowledge on handling, reparation, storing and recycling of batteries. We need to be able to help customers with this"* (Participant F).

It's claimed in the interviews that it is not only the end-customer's organization that is challenged as products and core concepts for propulsion are changed. Level one customer organizations also face challenges in reinventing their organization and business model. Interviewee A states that *"We created an incubator, internally, to be able to work with electrification. This was received by a strong internal resistance, however it has to be this way due to the new and deep knowledge that is needed about batteries, and their chemicals and behaviours"*. Companies that produced electric products from their start or have had electric products alongside seem to face less challenges in terms of internal resistance and lack of competence.

4.3 Macro factors and regulations

The demand for li-ion batteries is partly due to technological performance and partly spurred by other factors. According to participant C *"Electrification is driven by different factors. Could be cost or different requirements that push into electric. Other factors could be political pushes."*. Companies are anticipatory of changes that could come as that could alter the conditions of competition or viability of different applications. Interviewee G states that *"We're expecting that there will be regulations enforced on recycling and safety handling "*.

The success of electrification is not solely dependent on what actions organizations on the market take, but also on large-scale management. *"The solution for electrification is huge. It's not just about the customer, or the vendor, it's much bigger than that. This is very important to communicate, and it is also important for people in the industry working with those questions to understand how to steer this in a smart way"*, explained by participant G working with energy storage systems.

Successful electrification requires, other than satisfying technologies for energy storage, an entire infrastructure that can supply electricity, both to sites, and cities, but also to specific charging locations. Interviewee D says that *"Charging and electricity availability is a problem. Electrification is used as an option to fossil fuels, but in the end electricity in many countries is still produced from fossil fuels. Energy production needs to be sustainable."*. A recurring concern is how the electricity that is used for electrified products is produced. A major driver for electrification is sustainability, but that requires that the energy is produced in a clean way, as participant B explains; *"The main driver for electrification for us is that customers demand us to go green"*.

In some cases it is easier to financially motivate the electric industrial products, the mining industry is given as an example, as they can take out the cost of cleaning the air in the mines. Another such example is given in the marine sector; governmental decisions will make it expensive to pollute the environment in terms of pollution fees etc, hence it will be a better financial decision to go electric. There are also governmental decisions that will give financial incitements to use electric products instead of ICE. Norway, for example, give governmental grants to buy certain electric products (participant C). This is a driving factor and companies in material handling are also mentioning this; participant L state that *“governmental funding is very important to get the technique going”*.

4.4 Digital solutions

"The combination of electrification, digitalization and automation - that is where you find the real customer value for the future" (Participant D). Industrial products have traditionally been powered by combustion engines or by electric engines with

lead-acid batteries. While some products have been connected and performance tracked to some extent for some applications, li-ion batteries open up for a whole different kind of digital applications. *"One thing that the lead-acid battery customers are not use to is 'smart batteries'. The lithium-ion batteries have a circuit board and a BMS"* (Participant G). Thus, the potential for digital solutions for li-ion batteries is large and numerous existing and potential solutions were brought up. Interviewee A highlighted the strategic importance of this issue; *"The high managerial topics are electrification, digitization and automation"*

Table 4.2: Digital solutions that appeared in interviews sorted by category

Solution	**Explanation**
Customized Warranty	Analyzing usage data to customize warranty program from customers. Usage as prescribed will be rewarded with longer warranty.
Fleet Management	Offering overview of fleet location and status. Used to optimize usage of entire fleet, includes many of the other solutions.
Usage optimization	Optimizes the usage of a single battery.
Predictive Maintenance	Triggers maintenance alert before battery breaks down and needs to be taken out of operations.
After-Market Services	Helps the user optimize life time of the battery by e.g. digital spare part order.
After-life	Informing when battery reaches end of life and how to recycle the battery, or giving recommendation of other suitable application.
Remote service and updates	Enables immediate updates to battery systems as improvements are made.
State of Health	Gives an overall picture of the main points of the battery's health.
State of Charge	Informs about how much energy the battery is currently carrying.
Security Communications	Informs the user when the battery is used in a way that is potentially harmful and how to counter this.

Most of the existing or potential solutions that were brought up have in common that they rely on data collection from the battery while in use - to make the batteries connected. There is an agreement on that this has great potential for value creation. *"Batteries is a sweet spot for connectivity. They are a consumables and you [the user] need to know where you stand regarding that"* (Participant F). Data points of interest can, for example, be temperature or location. Collecting data requires some sort of digital infrastructure and willingness of the organization using the batteries. It can also be hampered by strict regulations. Interviewee H state that *"A requirement to develop digital services is to access data. This is complicated due to organizations is not used to this and they have very high security standards"*. Several interviewed organizations have operating connected batteries with solutions ranging from Bluetooth connection to 4G connections.

Although most technical aspects for connected batteries are already in place, organizations face challenges to get access to the data required to drive the digital solutions. As mentioned, it can be due to strict regulations, limiting what can be shared, or not, or it can be because of customers' unwillingness to open up their data. Security is one reason that is mentioned. *"In order to transfer the data, there needs to be a cloud-to-cloud-integration solution that is encrypted"* (Participant F). Another is that customers are unwilling to employ one additional system, they want new solutions to be compatible or integratable with their existing ones. *"Lately, the focus has been heavy on integrated solutions. Solutions should work together with other systems"* (Participant D).

The interviewed organizations see that productivity is central for their customers and that digital solutions could help enable that, for example through Battery-as-a-Service solutions. *"This enables looking into battery-as-a-service. Customers are not interested in owning batteries, they have a task that they want to perform and want to focus on that"* (Participant F).

While some technical aspects of digital solutions, namely data sharing, pose a challenge to organizations many things are already in place. Rather, it is the understanding of what would create value for customers that lagg. *"To get the data into the cloud and calculate State of Health and so on is something we can already do. The challenge lies in how to present it in a good way. Feeding data into the cloud requires that the customer has a gateway or some other kind of connection that allows it"* (Participant F). Digital solutions are argued to offer a clear value-add and not only a nice-to have, but it is hard to communicate this to customers. *"A major challenge is how to make customers understand the value that digital solutions and batteries offer"* (Participant C). If digital solutions are offered in a way that customers understand and value they can enable smarter use of batteries and thus increase the customer organization's productivity. There is also reason to believe that a customer's size might influence its propensity to adopt an innovation according to Participant P; *"large customers are keen on having access to this data, they are doing a lot of analysis so that they can optimize usage, fuel consumption. But most customers are small, and they always know where the machine is and are thus more skeptic, they already know their machines."*

5
Discussion

The following section will analyze and discuss the results of the study, and the findings from the interviews will be compared and contrasted to theory. The section will discuss needs and challenges both from a battery specific perspective and from the perspective of an organization working to adopt the technology.

The interview results imply that electrification can cause big shifts in industry structure as companies need to engage with new stakeholders and suppliers. As stated; *"Customer's focus is on running their machines. [With electrification], there is more actors on the market in order to do so; charging and other functions. This makes the customer having to interact with more stakeholders to have a product up and running. Our organization have learnt to answer questions from customers on this matter"* (Participant G), there is a need to evolve the industrial networks. All companies within a network might not be as well equipped or prepared for a transition, but probability of a successful transition is higher if actors understand that they are interconnected. As Bower and Chrtistensen (1999) implies, some companies might not be willing to invest in the new technology, which might leave them obsolete as the industry changes. As a consequence, electrification could lead to a changing industry structure.

5.1 Battery Performance Needs and Challenges

This section will discuss the different challenges and needs, connected to battery specific aspects, found in the results.

5.1.1 Performance Parameters

According to Foster's (1986) theories about the technology S-curve, technologies perform along different parameters that are of different importance to customers. The results show that the diesel run combustion engine is pre-dominant within industry and consequently the one that li-ion batteries and electric motors primarily compete against along these parameters. Following is an analysis of the performance parameters that appeared in the interviews and which technology serves them best. Understanding which parameters decide current customer needs and how li-ion batteries perform along these can presumably guide where efforts should be directed to best support a transition.

Table 5.1: Performance parameters brought up in interviews and which technology best serves them

Performance parameter	**Best technology**
Productivity	Combustion w. Diesel
Availability	Combustion w. Diesel
Energy Density	Combustion w. Diesel
Cost	Depends on situation
Emissions	Electric w. li-ion batttery
Precision	Electric w. li-ion batttery
Security	Depends on situation

Productivity Productivity has shown to be of utmost importance for all industrial customers. Electric solutions perform worse along productivity because the charging solutions are time consuming in comparison.

Availability Some industrial applications operate in a controlled and continuous environment, but many are operated in different locations and sometimes far away from civilization. While controlled environments can be equipped with charging stations, it is harder for equipment that is moved or operating far away which is why electric solutions seem to perform worse in terms of availability.

Energy Density A recurring theme in the interviews is how li-ion batteries are simply too heavy in relation to the amount of energy that they can carry. This limits the feasible applications.

Cost There are different views on the economic aspects of the technologies. It is clear that electric solutions require a higher cost for acquisition but require a lot less maintenance. The advantage of the combustion engine is that operational cost are easier to motivate than high acquisition costs.

Emissions Electric solutions are a clear winner when it comes to emission and environmental aspects. This is a parameter that has been important in industries with indoors operations as it ameliorates the working environment and reduces costs for ventilation. Also other industries express that this parameter is important and many times a driver for customer demand. Further, the importance of this parameter is tightly connected to policy and regulations from authorities.

Precision Electric solutions offer a higher degree of precision due to smoother conversion of energy. This is valued in some industries, but has not surfaced as a major performance parameter.

Security Interviewees express worry on the behalf of their customers regarding the security of batteries. Still, the interviewees regard batteries as safer as they can be controlled in a better way through e.g. software. Instead, they highlight the novelty of batteries for industrial applications and the consequential lack of knowledge. Thus, from a Level 2 customer perspective, batteries might be perceived as less secure, but with time and knowledge this perception might come to change.

It becomes clear that electric solutions perform better along some dimensions, but that combustion engines still have the upper-hand on some of the most critical parameters. Existing technologies and solutions are often out-competed by technologies that perform well enough along the know parameters, but also creates value in a new parameter.

It is hard to say from the results whether batteries demonstrate a new parameter for value creation as they only cover parameters along which combustion engines also have a performance, although way lower for some. One aspect of batteries that can create new value is the possibilities for digital solutions. As Yoo et. al. (2012) writes, digital technologies are malleable and characterized by generativity. This opens up for continuous change and optimization of products that are already put into operations in a way that is not possible for combustion engines. Could such digital solutions be leveraged to compensate for lower performance along some of the most critical performance parameters? This will be further discussed in 5.4.

5.1.1.1 How will Technology Development Influence Performance Parameters?

The results outline the market for industrial applications of li-ion batteries as uncertain. There is a lack of standards, lack of knowledge regarding the product and lack of understanding of what the customers need. Interviewees describe how they regard electrification as a next step, but are still searching for a way to make it reality. These circumstances have a lot in common with what is called the Era of Ferment, or the fluid phase, in the TLC Macro View. At this point, the technology is primarily characterized by product innovation and properties of the technology can change. Li-ion batteries as a technology have already existed for some time and the innovation in this context is the adaption to a new application. This could imply that the knowledge about the technology already exists, but is now being made to fit the specific application. Thus, it would be optimistic to believe that technological development of the batteries alone could help the technology perform as well as combustion engines along all performance parameters.

Still, improvements of the product through adaptation to the application and process innovations that drive down cost will likely align it with what customers need and allow a more standardized design to emerge. Better alignment with customer needs will likely reduce uncertainty both for customers and producers. The results show that uncertainty is a blocker for customer demand today, which means that reducing uncertainty could potentially spur new customer demands.

5.2 Organizational Needs and Challenges

Moving from the use of combustion engines to electric solutions introduce a new component into the product structure. In this case, other than requiring new competences to manage that component, relations and linkages need to change both internally and with the external environment. This shows resemblance with architectural innovation, which is known to challenge organizations in many ways. One such is through changing knowledge and competence needs. Below, consequences of this change and some of these new competence needs will be further discussed.

5.2.1 Business Model Renewal

The results show that as a result of electrifying products, the business model need to change as well. This result correlates with Sandström and Osborne's (2001) findings regarding new products and renewal of business models. As they write, this can meet some resistance to change as it shifts balance within an organization (Sandström and Osborne, 2011). The results from the interviews show that some of the firms met internal resistance to organizing in a new way as a consequence of starting to produce electric products.

Some parts of the business model are likely to have to change in some way. Following is a discussion on what building blocks of the Business Model Canvas described by (Osterwalder and Pigneur, 2010), that are most likely to require change, and in what way.

Key Partners Some key partners may be unchanged, however some may be different when the firm is producing electrical products. The results show that electric products require new suppliers to the business, which will also add to the change of the key partnership landscape. Some of the interviewees mentioned examples like charging partners and energy storage solution partners, amongst more.

Key Resources As mentioned in 5.2.2, the firms within industry need to acquire new key resources in order to produce electric products. Assets can be knowledge as described in 5.2, or equipment or processes.

Customer Relationships As Vowels et al (2011) state, an innovation will have early adopters and it is crucial for the producing company to understand which those are. As seen in the results, the first level customers are aware of that their current end-users asking for electric alternatives, they are the early adopters of their electric products. The relationships with those might be extra valuable and might require the firm to in new ways to build customer relationships. Furthermore, the new offer might enable the company to initiate new such relationships, however the shift might result in ending of some previous strong and important such as well. Nevertheless, as some of the interviewees expressed, there is a worry among the producing companies to not listen to the current customer's needs enough. A counter argument, in theory, to this is the argument stated by Bower and Christensen (1995). As this can result in missing of business opportunity, it is important for the firms to try to look into new customer relationships if they want to take market shares with their electrified products.

Cost Structure As the study by Yukselen et al. (2020) also shows, the cost of li-ion batteries is one of the main challenges with electrification for organizations within industry. Still, higher costs can be motivated by other factors, such as environmental or technical goals and needs. End-users prioritize a low CAPEX over a low OPEX, although lower running costs might result in lower TCO. This is likely because there is a greater financial risk associated with binding capital in assets. The extent to which this issue was brought up during interviews implies that changing how costs are incurred for customers might influence the decision to adopt. One alternative could be to offer batteries-as-a-service, which would change the customers expenditure from captial to operative. If these needs can contribute to the revenue stream, discussed below, it might be easier for businesses to accept the changes in the cost structures.

Revenue Streams Many interviewed companies sell their products to customers, but several are also looking into offering their products as services and some already do. Selling their product-as-a-service could potentially increase financial risks for the company, as revenues are spread out over a longer time. However, with a matching cost structure that does not require the company to bind their capital in owning batteries, risk could be reduced.

5.2.2 Knowledge and Competence

The results show that organizations on all levels experience knowledge gaps regarding electrification. This lack of knowledge is claimed to be one of the bigger challenges firms face when electrifying their products.

Electrification is of strategic importance for interviewed companies, but there is an industry wide lack of knowledge on electric products. Companies within industry struggle to understand how to , for example, measure electric energy and standards that could facilitate this are not yet existing. The emergence of such knowledge and standards would facilitate communication and collaboration within industry.

The knowledge gap experienced by 1st level customers, producers of electrical products, requires these actors to acquire new knowledge and competencies. Also end-users lack knowledge electrification, which does in some cases lead to resistance towards the electric solutions. Such resistance can be devastating for sales and can complicate market-introduction of the innovation, and delay or obstruct the development of the electric technology.

Bower and Christensen (1995) describe that it is essential to not let end-customers' resistance steer the development of the product too much. Rather, it is important to help the users navigate the landscape of the new products and 'hold their hands' in the challenges that they meet during this phase. As there is new knowledge required, it is a often question on building that internally or/and acquire it from external sources. As Teece (1986) states above, a company may need complementary assets in order to profit from an innovation, for example, knowledge. In other words, to profit from electrification it is crucial to get access to the relevant knowledge.

Another aspect on knowledge discovered in the results is that some companies interviewed, in the material handling sector, already offer electric products with lead acid batteries. Due to existing experience with electric products and battery handling, they express less concern regarding knowledge and competence and see a transition to li-ion batteries as less challenging. For these companies, the adoption of li-ion batteries is not architectural, but rather modular as it does change a core concept but not how it is linked to the rest of the product. This helps explain why these organizations are less challenged.

5.3 Macro-Factors and Externalities

The results show that electrification is under influence of macro factors that impact customer needs and demands. One such influence is that of policy and regulations. There are world-wide agreements, such as the Paris Agreement, that emissions should be reduced. To follow these, authorities stipulate regulations to limit emissions that also affects the industrial segment. Moreover, there are more regional or local regulations that work to limit emissions. Regulations like these will typically favor electric solutions over combustion engine as the first has close to zero emission in use. Some applications of electric solutions, such as electric ferries, are feasible in part because of such regulations. It can not be excluded, and rather be anticipated, that further regulations will come with time. This could potentially enable further applications for electric solutions as conditions for competition are changed, for example through emission regulations which could make combustion engines unfeasible or favour electric solutions economically. Frambach and Schillewaert (2002) describe in their theory on organizational adoption how external pressures can directly influence an organizations propensity to adopt an innovation.

Another macro aspect that has surfaced in the interviews is the fact that some customers request electric solutions simply because they want to go greener. This could be a result of changes in socio-cultural perceptions. Put differently, societal expectations are increasing on companies to take sustainable actions and doing so can be wielded as a competitive advantage. The increased interest in greener solutions could also be a sign of anticipation - companies are expecting further regulations of emissions. By acting sooner than later they increase their ability to take advantage of further regulations and decrease their risk of lagging behind.

5.4 Digital Solutions

This section will match the identified needs and challenges with digital solutions that could potentially meet them. First, digital solutions that can meet needs and challenges related to battery performance are discussed. Second, several of the identified needs and challenges are related to the organization rather than the battery technology and will thus be hard to meet with digital solutions. These are still central to electrification of industry, which is why alternative solutions for these challenges and needs will be shortly discussed.

5.4.1 Battery Performance Needs and Challenges

Electric solutions with li-ion batteries perform worse along some of customer's critical performance parameters compared to diesel driven combustion engines. These are productivity, availability and energy density. Interviewees disagree on which technology performs best in terms of cost and security. If industry is to be electrified, with li-ion batteries as energy storage solutions, the technology needs to perform as good along these parameters, or introduce a new parameter that customers value. One solution to this is that the li-ion technology itself develops, but as discussed it is unlikely that the technology will ever perform as well along some dimensions, such as energy density. Another alternative is to leverage digital solutions as complementary assets to the electric solutions. Of the digital solutions that appeared under the interviews, several have the potential to contribute to li-ion batteries performance along the mentioned parameters. Table 5.2 outlines which digital solutions could potentially be leveraged to meet each of the identified performance parameters.

The most important function of digital solutions for li-ion batteries is to increase efficiency in different ways. By predicting maintenance needs, maintenance can be planned during unproductive time so that they do not break down and cause downtime. Understanding how a battery is used and behaves in a certain application can allow for updates that enables energy to discharge to a lower level, thus leading to higher energy density. Controlling how a battery is used after sales can allow the producer to custom a warranty and extend it if used properly, which would reduce risk for the buyer. Moreover, digital solutions can be used as a means of communication to increase security, keep the battery updated and inform the user of its status.

Table 5.2: Needs and challenges that have appeared in the interviews, matched with digital solutions that could potentially help met those

Parameter	**Digital Solution**	**Example**
Productivity	Usage Optimization	Minimize down-time for specific machine
	Fleet Management	Utilize battery fleet to minimize need for charging during operations
	Predictive Maintenance	Maintain before battery break down causes downtime
	Remote Services and updates	Reduces the need to take batteries out of operations for updates
Availability	Fleet Management	Plan charging based on location and State of Charge
Energy Density	Usage Optimization	Plan more efficient use of battery based on application
	Remote Services and Updates	Updates can e.g. change depth of discharge
Cost	Customized Warranty	Proper use of battery can lead to extended warranty
	Fleet Management	More efficient use requires fewer batteries
	Usage Optimization	Reduces waste for individual battery
	Predictive Maintenance	Early maintenance can pro-long battery life time
	After Market Services	Support and spare parts can pro-long battery life
Emission	Usage Optimization	Properly used batteries will have a longer life
	After-life	Recommends the user alternative applications or how to recycle the battery
Precision		
Security	Security Communications	Alerts the user when the battery is used in a way that reduced security
	Remote service and update	Ensures the battery is updated with the latest safety applications
	Predictive Maintenance	Battery can be maintained before an unplanned event takes place

5.4.1.1 The Data Paradox

Many digital solutions that are brought up rely on the collection of data from batteries in operation. The study shows that there is a resistance from customers and end-users to share data on the use of the electrical products. However, in order to create the digital solutions brought up in Table 5.4, this data is crucial. The theory on organizational adoption tells that how an innovation is perceived is vital for the decision to adopt or not. Perception depends on, for example, trailability and observability, but these aspects of perception are hard to serve before an offer has emerged. Digital solutions are still surrounded by uncertainties as customer need is still to be identified, which further influences customer perceptions. Before the innovation has been tested and knowledge has been built up, it is likely to be perceived as excessively complex.

This puts organizations in a tricky position where they need a defined offer to get customers interested, but also need customer engagement to find that offer. To influence how customers perceive the innovation and thus their propensity to adopt, organizations can work to reduce risks for customers and target relevant segments with clear communication. Early adopters will be key partners not only due the diffusion of the electric products, but also to contribute to the data lake that is needed. In one way, this can be viewed as a kind of Prisoner's Dilemma as the ability to demonstrate value to customers is dependent on existing customers. In order to overcome this obstacle, it of significance that the problem on resistance to share data is concurred and that the chasm is crossed.

5.4.2 Organizational Needs and Challenges

As seen in the results and the above discussion, the are many of the needs and challenges that arose that are of organizational character. Stated in the Table 5.3, the organizational needs can be themed either as business model renewal ones, or knowledge interlinked ones. The proposed solutions for those challenges and needs are primarily other than digital, but will non the less be discussed below.

The needs and challenges in the Business Model renewal section are highlighted in 5.2.1, and possible solutions for those lie within the process of the renewal, which can be a very company specific solutions. In order to organize new key partners and customers, a digital service such as a digital network or platform can be of help. New resources could also be brought to the company by digital tools, such as educational systems and forums specific to the industry. The cost structure and revenue streams can be helped in the way of digital analysis tools to understand the financial streams.

As discussed above in 5.2.2 the different angles of the knowledge gap is a challenge for industrial firms producing electric products. To close the gap, there are different factors and efforts needed. One such can be for an energy storage company to create material and education on batteries. These could be included in workshops or sessions with the customers and also the end-customers. In order to do this, it is important to know what details that the knowledge gap consists of, to focus on the right parts. In terms of digital solutions, another aspect of this can be to create digital offers that help customers and end-customers operate the electric products in the right way, such as usage optimization. The digital offer can also include educational aspects. This all together can help close the gaps and enable a steady market growth.

Table 5.3: Needs and challenges that have appeared in the interviews, matched with digital solutions that could potentially help met those

Category	**Need or Challenge**
Business Model Renewal	Key Partners Key Resources Customer Relationships Cost Structure Revenue Streams
Knowledge	Industry Wide Knowledge Company's Internal Knowledge Customer's Internal Knowledge

6
Conclusion

The aim of this study has been to investigate what needs and challenges industrial customers encounter related to electrification of their products and to see how these could be met by digital solutions. The industrial sector is currently characterized by a strong ICE paradigm that influences the conditions under which electrification is happening. This is expressed, for example, in units to measure energy, lagging regulation, uncertainty about charging and general knowledge. The study has identified seven battery performance related and two organizational needs and challenges. In addition to presenting possible digital solutions, the study briefly discusses alternative solutions to meet customers needs. The identified needs and challenges can be divided into two groups; battery performance and organizational needs and challenges. These different needs require different actions from a li-ion battery producer point of view.

The former, battery performance parameters, consist of productivity, availability, energy density, cost, emissions, precision and security. The study has found that digital solutions can be used as a complementary asset to increase performance along the identified parameters. Due to the strong ICE paradigm, electric motors with li-ion batteries mainly compete with diesel fueled combustion engines. The study shows that the electric solution performs better along some dimensions, while the combustion engine performs better at others.

The latter, the organizational needs and challenges, includes the challenge to renew the business model as the product changes as well as a knowledge gap that has been identified both with Level 1, 2 and 3 customers. These challenges and needs can be met primarily by alternative solutions, such as education and knowledge spreading. Still, even for organizational needs and challenges, digital solutions can support customers to some degree. The benefit of digital solutions are especially strong for battery performance related challenges.

6.1 Theoretical Implications

The study has contributed to theory by combining existing theory and empirical data from a context that is yet rather uncovered. By doing such, the study has provided an example of how the presented theories can be applied to understand industrial customer's needs and challenges with electrification.

It seems that the theories presented on organizational adoption (Frambach and Schillewaert, 2002), are applicable to the adoption of electric motors with li-ion batteries for industrial applications. Just as the theory states, the results show that the participating organization's perception about the innovation guides their decision to adopt. Moreover, the discovered organizational challenges indicate that adopting an innovation is not simply about the adoption decision, but also about adapting the organization thereafter. This confirms aspects of theories about business model renewal (Sandström and Osborne, 2011) and architectural innovation (Henderson and Clark, 1990).

6.2 Practical Implications

This study's main contribution to practitioners is an overview of the customers' situation - their needs and challenges. Having understanding of customer's needs and challenges can make it easier for practitioners to build offers that create value for customers and thus increase the likelihood of adoption. Further, the study also contributes by suggesting different solutions to meet the different needs.

One conclusion that is of special interest to practitioners is the fact that industry is characterized by such a strong ICE paradigm. It implies that electric options with li-ion batteries will be compared to ICE's, which must be outperformed along many enough dimensions to fully electrify industrial products. In addition, prior to marketing of an innovative product, practitioners need to spread knowledge and awareness about the product to the future adopters and users. Further, it is crucial to be aware that customers have not only performance related needs and challenges, but also organizational ones. Meeting or supporting in these will require different actions, for example curiosity about customer's existing business model and how it might change.

6.3 Future Research

As this study was conducted, some areas evolved that would require further research. First, we suggest a study that focus on the organizational aspects of the setting of li-ion electrification. They were not the focus of this particular study, however, turned out to be of greater importance than expected. Further, an interesting area to be further explored is to quantitatively measure industrial customers limits for the main performance parameters. Lastly, we can see that in order to understand how business models change for companies electrifying their products, there's a need to conduct a study in detail on this in order to understand and support these. A suggestion for this study, is to use the Business Model Canvas formulated by Osterwalder and Pigneur (2010).

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A
Appendix 1

A.1 Interview Questions

Person/position
- Tell me about yourself and your position in the company
  - Responsibilities, authorities, degree of "connected"
- How engaged are you in electrification?
  - Operative/strategic engagement, daily/monthly?
- What position does your manager have?
- Have you recently initiated any changes in your organization?

Organization, Decision-making, and stakeholders
- Is there an effort (or teams) to work with electrification?
- Who are the stakeholders and who owns the project?
- Is management involved?
- Is it a top priority? If so why?
- How are resources and funding distributed/given/applied for?
- Is it from close management or far management?
- Has the organization changed or adapted its way of working in the past? (Not too past)

Business and operations *Current operations, Products, Their value creation*
- Tell me about your current business
- Which part of this is/has the greatest potential for electrification?
- Products (what processes are those products part of?
- Challenges, opportunities?
- Who are your customers? Size, industry etc.
- Are they end-customers or not?
- What digital solutions/services do you use today?
  - In-house or bought?
  - How do they work? Any struggles? Greatest value?
- How are you using data today?

Status in transitioning
- How long have you worked with electric projects and where are you on that journey?
- Did you need to develop/hire new competences for this? Outsource?
  - Struggles?
  - Opportunities? Where are you heading for the next few years?
- Are you currently using any digital products linked to this?

- What is you understanding on where the industry is headed?
- If you could dream and wish, in your situation, what problems would you most want to be solved and why?
- What value would that have?

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