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Master thesis

Exploring Emission Management Information System Software

A case study of the Emission Reduction and Revenue Growth Program

Eyvind Hilding Eikeng and Henrik Rief

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Exploring Emission Management Information System Software

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Abstract

Climate change poses a significant risk to humanity, and the private sector has a crucial role to play in mitigating its impact. In this context, Emission Management Information Systems (EMIS) can help businesses become more sustainable. While the adoption of such systems has been studied in the context of both small and large enterprises, there is little research on how small and medium-sized enterprises (SMEs) can utilize software to support EMIS adoption.

This thesis aims to explore how software can be designed to support EMIS adoption by SMEs. The study is based on a case study of a Norwegian EMIS-software development project as well as a review of the EMIS and overall Green IS literature. The findings of this research provide insights into how an EMIS-software can support EMIS adoption in SMEs. Based on this, we propose ten software requirements that can support certain CSFs for EMIS adoption: **[1]** Measure Efficiency, **[2]** Display Available Government Incentives, **[3]** Implement Data Recursiveness, **[4]** Implement Employee Surveillance, **[5]** Ensure Accurate and Reliable Data, **[6]** Inform on Laws and Regulations, **[7]** Inform on Ecological Opportunities, [**8]** Create/Use Industry Standards, **[9]** Implement External Interoperability, and [**10]** Implement Goal Oriented Design.

This research contributes to the understanding of EMIS adoption in SMEs and the role of software in supporting this adoption. The findings from this research will be of interest to similar software development projects, academics interested in the adoption of EMIS and Green IS, and policymakers.

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1. Introduction

This thesis explores how software can support the adoption of Emission Management Information Systems (EMIS) in small- and medium-sized enterprises (SMEs). According to the UN Secretary-General António Guterres, the world is “on the highway to climate hell with the foot on the accelerator” (Harvey & Carrington, 2022) - the need to reduce our collective carbon footprint has been widely recognized, and governments, businesses, and people around the world are increasingly expected to become more sustainable.

At the same time, current literature in the research field of social-economics reveals that a large portion of the private sector has untapped potential for reducing our collective environmental footprint (Strøm et al., 2021), namely the SME market. SME Norway defines every business with less than a hundred employees as small or medium-sized (SMB Norge, 2020). In 2019, there were 585.000 registered businesses in Norway (Røe Isaksen, 2019), and only one percent of these employed over a hundred people. SMEs collectively account for almost half of the annual value creation in Norway, which amounts to nearly NOK 700 billion, or half the nation's budget per year (SMB Norge, 2020).

However, there are few to no regulatory measures required for SMEs to reduce their environmental footprint compared to the reporting and regulations larger corporations are subject to (*Bærekraftsrapportering*, 2023). And the few measures that exist are often too complicated or aren’t compatible with the business models of smaller organizations (Strøm et al., 2021). There is also a lack of awareness for both financial and general support for these businesses to reduce their environmental impact (*European Union*, 2023). In order to address this, businesses can adopt EMIS’ to manage and monitor their carbon emissions and energy consumption, allowing users to identify problem areas and implement emission- and cost-reduction strategies. This is especially vital for smaller organizations, as they operate on thin margins and must be able to maintain their financial security while implementing emission reduction strategies.

In the current literature, Green IS research is viewed as a branch of the greater research field of Information Systems (IS) and consists of many different research avenues, with a primary focus on reducing the negative environmental impact of IS'. Early research in this field focused particularly on the efficient use of IT and IS to reduce the direct and indirect negative environmental impacts, where Green IS is sometimes portrayed as the villain due to the energy consumption of IT products (Trimi & Park, 2013), e.g., "greening" of IT.

However, a smaller stream of research within Green IS, EMIS, actively researches how the use of IS can aid businesses in becoming more sustainable by monitoring their overall carbon emissions, with the goal of introducing greener business practices and ultimately inducing a transformation of the entire business itself (vom Brocke et al., 2013). In this stream of research, Green IS is considered a contributor to reducing the entirety of carbon emissions, not just the emissions caused by the IS itself. We categorize these types of Green IS' as EMIS'. Despite existing research regarding EMIS', there is yet little normative knowledge related to the design of software to support the adoption of EMIS' in SMEs.

To address the research gap in the current Green IS literature regarding the use of software to support EMIS adoption, we ask the following research question:

1.1 Research Question

RQ: How can software be designed to support EMIS adoption by small- and medium-sized businesses?

To address this research question, we investigated a newly developed software designed by a Norwegian software company specifically for SMEs to monitor and track their carbon emissions. We will refer to this software as the Emission Reduction and Revenue Growth Program (ERRGP), which is founded on a set of certain economic perspectives and theories that enable smaller organizations to reduce their emissions without jeopardizing their economic future. It accomplishes this by founding the software on the social-economic theories presented by Per Espen Stoknes (2020) that emphasize *carbon-efficiency* rather than just focusing on carbon emission reduction as a metric alone, providing a new lens to view sustainable business through. This will be further detailed in the background chapter of this thesis (Chapter 3).

This study was conducted using a qualitative approach. We took part in the development process of the ERRGP as active participants in the development team, in addition to conducting several interviews with some select SMEs taking on the role of pilot customers of the ERRGP. The collected data was then analyzed using a thematic analysis, which enabled the identification of key themes and patterns in the data.

Our findings suggest that software can support EMIS adoption by implementing the following requirements:

[1] Measure Efficiency, **[2]** Display Available Government Incentives, **[3]** Implement Data Recursiveness, **[4]** Implement Employee Surveillance, **[5]** Ensure Accurate and Reliable Data, **[6]** Inform on Laws and Regulations, **[7]** Inform on Ecological Opportunities, [**8]** Create/Use Industry Standards, **[9]** Implement External Interoperability, and [**10]** Implement Goal Oriented Design.

With these proposed software considerations to support EMIS adoption, we contribute to the overall research field of Green IS by providing insight into Green IS and EMIS adoption factors. We also contribute normative knowledge to current and future EMIS-software development projects. As previously stated, there are few to no regulatory measures in place to limit carbon emissions in SMEs. Most prominent is the fact that they are not obligated to report on their CO2 emissions, leaving them with few incentives to adopt Green IS' in the first place. This, however, will not be the case for long. The European Union is expected to pass new legislation regarding emission reporting requirements for the SME sector in the near future, which will dramatically raise demands for EMIS-software. Moreover, some manufacturers of such software already exist. Such as SAP, and there are now ongoing EMIS-software development initiatives spearheaded by the United Nations.

1.2 Chapter Summary

This thesis is organized in the following manner:

Chapter 2: Related Research

We provide an account of the current Green IS and EMIS literary landscape, established by IS researchers over the past decades. Then, we explain EMIS-software and detail what the literature states in relation to Green IS adoption. The focus of the chapter is then narrowed down to the individual critical success factors for Green IS adoption.

Chapter 3: Theoretical Foundations

This chapter provides an overview of the necessary contextual understanding needed to fully comprehend the utility of the ERRGP by presenting the economic perspective and theories the ERRGP is based on.

Chapter 4: Research Approach

This section contains a description of the background for this research project, our choice of philosophical assumptions, methodology, methods of data collection, and our data analysis.

Chapter 5: Findings and Analysis

Here we present the findings from our empirical research. We first present some end user challenges and conditions before presenting factors for EMIS adoption.

Chapter 6: Discussion and Contribution

Our analysis of the findings from the previous chapter will be discussed in relation to the existing academic literature in order to provide our contribution to the Green IS research field.

Chapter 7: Conclusion

In the final chapter, we will conclude our thesis. We will also present future research avenues for Green IS adoption research identified during the process of writing this thesis.

2. Related Literature

This thesis explores how software can support EMIS adoption in SMEs. We aim to accomplish this by identifying software requirements that can support certain critical success factors (CSFs) for Green IS adoption. In this chapter, we will present the current literary landscape that pertains to the overall research field of Green IS, which encompasses EMIS'. To this end, we begin the chapter by presenting the definitions of Green IS and EMIS that will be used in this thesis. Following that, we present an overview of the EMIS-software, outlining the details of the software and what past research has stated on the topic, as well as presenting our own description of the term as it will be used in this thesis.

Following that, we will close in on and review the CSFs for Green IS adoption derived from Sing and Sahu's extensive literary review (2020). The review presents seven principal categories of CSFs constructed from an in-depth systematic review of the accessible Green IS literature in the time frame since the field's emergence up until recent years (2000-2019). The chapter will then conclude with a brief summary of the key points that were raised for the reader to keep in mind for the subsequent chapters.

2.1 The Green IS Research Field

Green IS emerged as a research field in the early 2000s as part of corporate social responsibility to respond to social pressure on climate change (Watson et al., 2010; Esty & Winston, 2009). This new IS focus was expected to assist leaders of organizations in gaining a deeper understanding of their operations in order to redesign their business processes to be more environmentally sustainable (Watson et al., 2010). Scholars of traditional information systems have for a long time been focused on aiding organizations in improving their productivity in terms of enhanced information flow and use, resulting in increased efficiency and financial gain. By contrast, some Green IS researchers are less concerned with the economic values provided by an IS and are content with the trade-off in favor of more environmental-oriented values (Lee, 2020).

Since its emergence, the field has grown vastly, and many different definitions of Green IS have been used in various contexts. In the aforementioned literary review, Sing and Sahu (2020) present 17 different definitions of Green IS. The numerous definitions are all equitable for the significance and purpose of the respective research they are derived from. We further categorize the type of Green IS we research as an Emission Management Information System (EMIS).

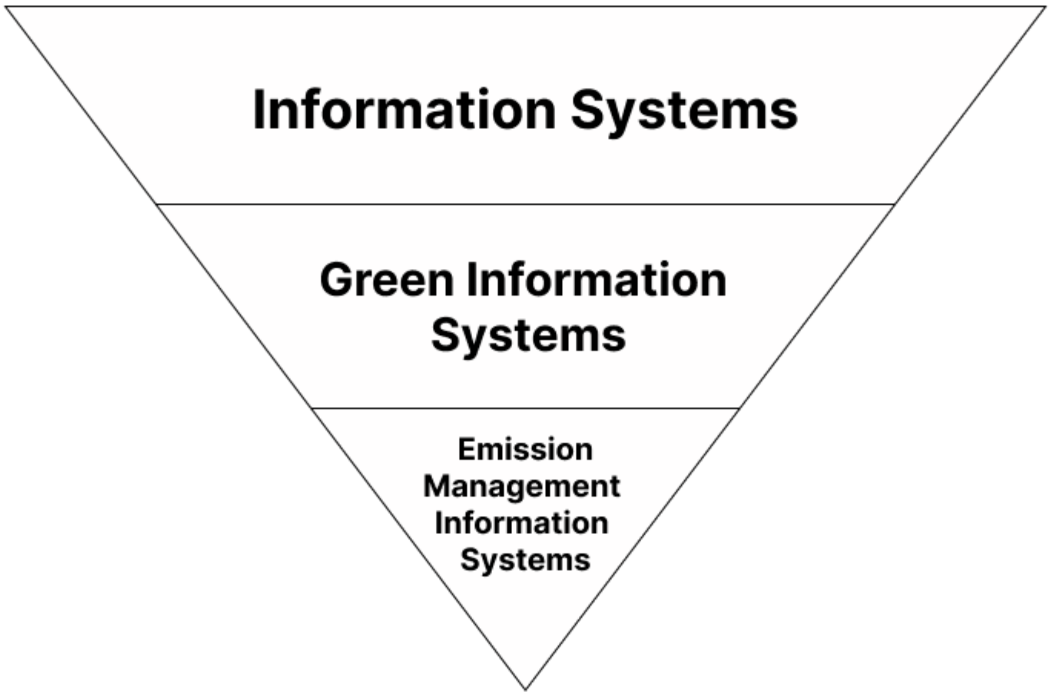

Figure 1: Illustration of related research scope.

2.2 Emission Management Information Systems (EMIS)

In a conceptual review, El-Gayar & Fritz (2006) present the term Emission Management Information Systems as "organizational-technical systems for systematically obtaining, processing, and making available relevant environmental information available in companies" (El-Gayar & Fritz, 2006, p. 1). We use this definition to describe our research scope.

They present 11 research areas within EMIS research, indicating the degree of research that has been conducted in each of the corresponding areas: **1)** Data Collection, **2)** Data Dissemination, **3)** Data Integration, **4)** Data Analysis, **5)** Data Management, **6)** Data Processing, **7)** Data Storing, **8)** Data Visualization, **9)** Decision Making, **10)** Environmental Management, and **11)** Monitoring.

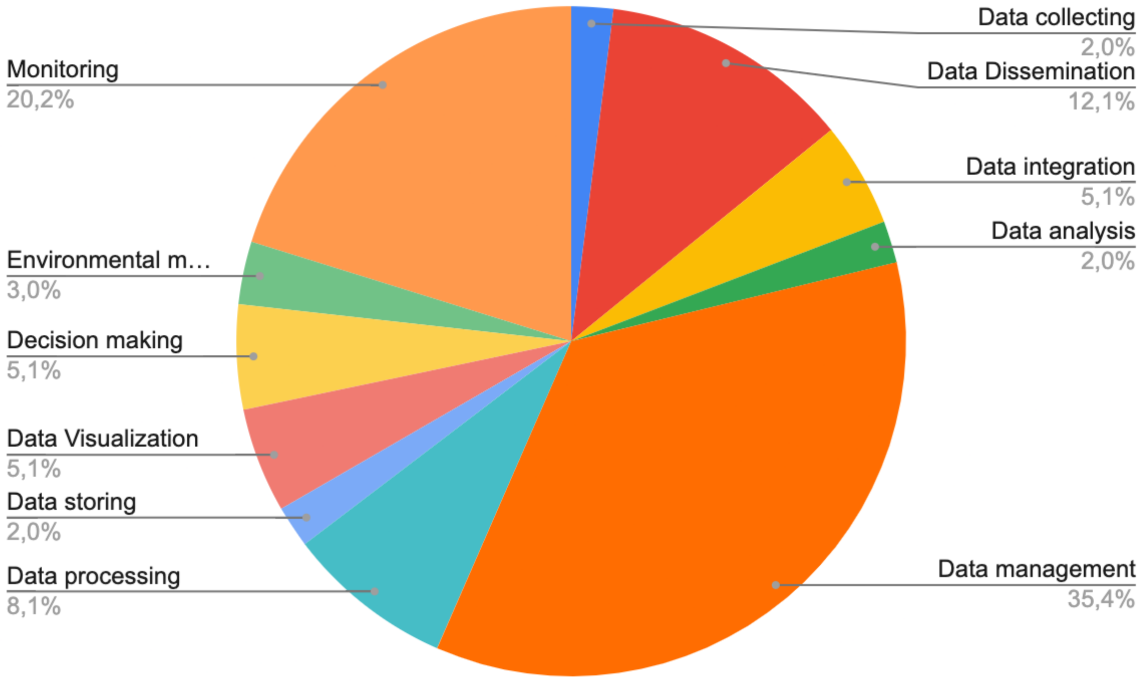

Figure 2: Pie chart illustrating focus areas within EMIS research.

As the pie charts illustrate, research within EMIS in relation to decision-making and environmental management accounts for less than six percent each. EMIS are primarily designed to guide decision-making towards more sustainable practices (Sing & Sahu, 2020). In order to better understand the factors that influence the adoption of such systems, it's evident that there is a need to conduct more research on multiple fronts in order to gain a deeper understanding of these factors and the respective mechanisms that lead to adoption. We hope to contribute some insights to some of these under-researched sections of the pie chart with this study, specifically the environmental management and decision making segments.

2.2 EMIS-Software

We refer to EMIS-software as software that is designed to help organizations manage their environmental impact. The software does so by providing a means to collect, monitor, and analyze the resulting figures related to energy consumption, greenhouse gasses, and other pollutants.

Most research regarding software designed to manage emissions seems to be conducted on emission calculations and measurements (Ogle et al., 2013; Winiwarter & Schimak, 2005). Through our literary search, we have found a limited amount of research that directly relates to software as a tool to support EMIS adoption. However, there is some research that suggests that recent technological advancements in ICT could present opportunities to enable such software to be transformed from a monitoring tool to a support system for strategic decision-making. This would, however, require the alignment of corporate management and business strategy (Lütje et al., 2018). There is also some research on software tools used in operational environmental information systems (betrieblicher Umweltinformationssysteme - BUIS) that specifically support the development of industrial symbiosis (Isenmann, 2013), a phenomenon that affects corporations on a larger scale than what this thesis researches.

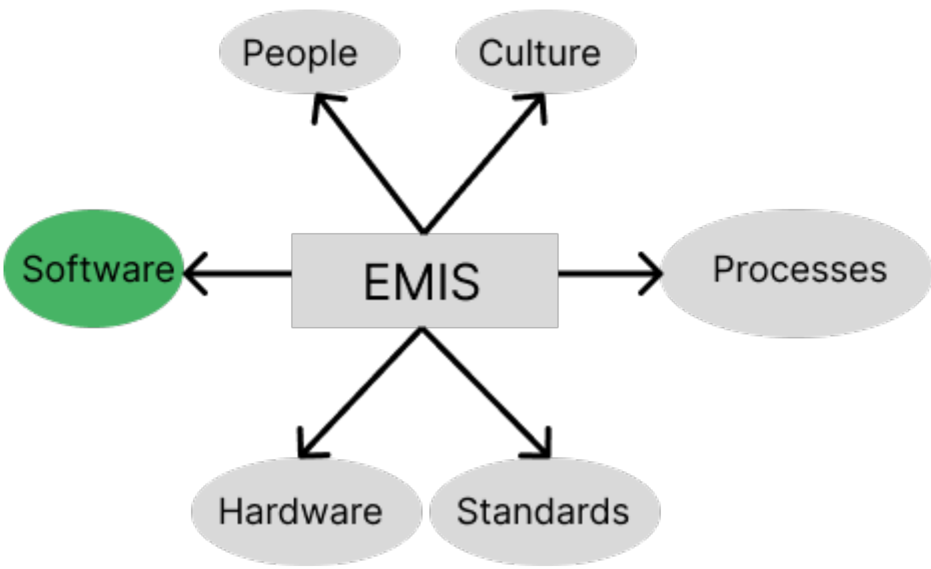

Figure 3: Illustration of software in relation to EMIS.

2.3 Green IS Adoption

Sing and Sahu's 2020 literary review presents five main fields within Green IS research, which were initially established by Chou and Chou (2012): **1)** Understanding of Green IS, **2)** *Green IS Adoption*, **3)** Impact of Green IS Initiatives, **4)** Measures and Policies, and **5)** Global Context. Our research focuses on EMIS, which is a *type* of Green IS that is concerned with obtaining, processing, and making relevant environmental information available in companies. We consider the research on Green IS adoption to also encompass EMIS adoption.

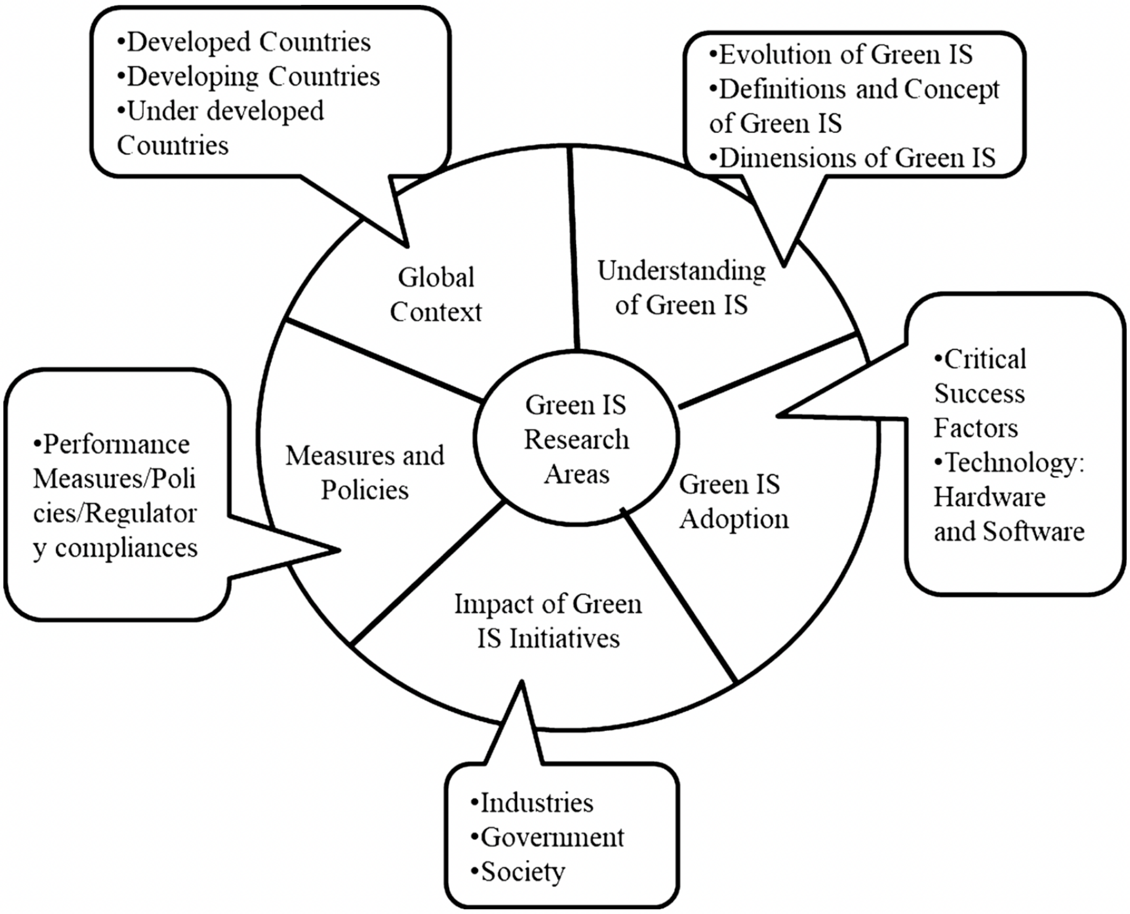

Figure 4: Illustration of Green IS research avenues.

Adoption refers to the process by which organizations and the people within them start using a new technological system. This involves acceptance, integration, and regular use. Adoption is the field that is most closely related to practice because it is concerned with involving businesses in EMIS. Understanding Green IS is concerned with its evolution, concepts, and dimensions. The impact of Green IS initiatives speaks to the outcome of Green IS. Measures and Policies focuses on performance and policies, and Global Context is concerned with developed, developing, and underdeveloped countries.

2.3.1 Critical Success Factors for Green IS Adoption

In their literary review of the Green IS research field, Sing & Sahu present seven categories of critical success factors (CSFs) that are derived from over 50 different research articles. We will now present these categories from Sing and Sahu's literary review (2020), as well as explain the significance of the CSFs in detail.

2.3.1.1 Economical

Economic success is critical for all businesses for a variety of reasons. At the very least, it ensures the company's survival by allowing it to continue providing its products and services to sustain itself. When a business is profitable, it has enough capital to reinvest in its development and operational practices, enabling it to grow and expand. Sing & Sahu (2020) provide two subcategories of adoption within the economical category: **[1]** Cost Reduction and **[2]** Government Incentives.

In the context of Green IS adoption, Cost Reduction **[1]** is recognized as a critical factor and refers to the processes and strategies implemented by a business to reduce its overall operational costs, as well as the costs associated with the adoption itself, while still achieving its targeted environmental and sustainability goals. There are many ways for a business to facilitate this, and different businesses can leverage different green practices according to the individual nature and services provided by the business, which we will provide examples of below.

Energy-efficient lighting and thermostat equipment, such as movement or time-controlled systems, could provide economic benefits for businesses with high energy costs by reducing the amount of energy used when a section of a building is unoccupied or in any other situation where it is not required. Furthermore, if the business is located in an area with an abundance of untapped natural energy, it can reap additional economic benefits by investing in renewable energy sources such as solar panels or windmills to power its operational practices. This transition, however, would result in increased expenses in the short term before gradually becoming cost-efficient over time, further reducing energy costs and the carbon footprint of the business (Uddin & Rahman, 2012).

Virtualization technologies and cloud computing can allow businesses to reduce their hardware expenses by consolidating their operational systems and applications on a single server or data center. This also provides greater flexibility because businesses are able to scale their IT infrastructure requirements in terms of server capacity based on current demand (Uddin & Rahman, 2012). By doing so, businesses can save energy costs by only using the server capacity that is needed at the time, rather than having a fleet of unused servers that are draining electricity at all times.

Using products made from recycled materials is another way for businesses to reduce costs and contribute to waste reduction. By using recycled materials in the production processes, manufacturers are able to limit their dependence on “virgin raw materials," meaning natural resources that are extracted in their raw form (*Materials & Resources - GSA Sustainable Facilities Tool*, 2023). Moreover, businesses can save expenses as recycled materials can often be purchased at a lower price, in addition to reducing the amount of waste generated in their production processes, resulting in lower waste disposal costs, which can be significant over time (Bigdeloo et al., 2021).

Government incentives **[2]** are another critical factor that could have a significant impact on the adoption of green IS across industries. Incentives in the electric vehicle industry have already had a significant impact in countries such as Norway, the Netherlands, and China, to name a few. Subsidies for electric vehicles in Norway have resulted in half of all new cars sold being electric, with the goal of reaching 100 percent by 2025 (*Samferdselsdepartementet*, 2021).

Financial incentives such as subsidies, tax breaks, and low-interest loans could all play a role in encouraging businesses to adopt green IS. In the United States, the Small Business Administration (SBA) provides low-interest loans to small businesses that want to invest in energy-efficient equipment and technologies (*SBA*, 2023). A similar arrangement exists at the Federal Economic Development Agency for Southern Ontario (*Government of Canada*, 2021). Other forms of incentives could include government technical assistance, consulting services, or educational programs. Assistive services such as energy audits are available, where businesses can receive free or low-cost audits to help them identify areas where they can improve their energy efficiency and reduce their energy consumption (*SSE*, 2023).

Certification programs such as ISO 14001, or "Miljøfyrtårn", are designed to assist organizations in improving their environmental performance and encourage businesses to operate in a more environmentally responsible manner. These programs include guidelines in relation to energy efficiency, waste reduction, and sustainable procurement, all of which must meet certain standards in order for the business to be certified. ISO 14001 is widely recognized in a variety of sectors and industries around the world, with certificates issued in over 170 countries (*ISO*, 2023) and prior studies demonstrating measurable benefits in environmental performance, efficiency, and profitability (*Leskinen et al.,* 2020).

2.3.1.2 Organizational

The adoption process of green information systems in organizations demands a multifaceted approach that takes a variety of factors into account. Organizations, due to their complexity, can be viewed as entities made up of the employees who work there, the established hierarchical structures, the strategies and technologies used, innovation, and the products and services offered to a greater community. There are numerous advantages to having clearly defined success factors, such as a clear focus, alignment with strategic goals, risk mitigation, improved performance, and financial profits (Sing and Sahu, 2020). All of the above could contribute to an organization's goals of reducing its environmental footprint, increasing efficiency and revenue, and gaining a competitive advantage.

This sentiment is also aligned with the literature on Green IS adoption in organizations, which states that "adoption and diffusion of green IS & IT can be driven by a multitude of internal and external factors, such as financial, technological, organizational, regulatory, and ethical factors" (Kuo & Dick, 2010; Molla, 2008). We will now present the established critical success factors for adopting Green IS in an organizational setting, which are further subdivided into **[**10**]** subcategories: **[1]** Leadership, **[2]** Employee Stewardship, **[3]** Capabilities, **[4]** Structures, **[5]** Firm Size, **[6]** Organizational Climate and Culture, **[7]** IT Diffusion, **[8]** Environmental Impact of Industry, **[9]** Commitment, Attitude, and Belief, and **[10]** Competitive Strategy and Advantage.

Leadership **[1]** and top-management support are considered to be some of the most important determining factors for the adoption of Green IS in organizations. According to Sing and Sahu (2020), there are many changing processes that an organization must go through in order to accommodate the adoption and integration of Green IS. Leaders and management are important in this context because they are the ones in charge of work procedures, employee training, and influencing company culture.

Following on from this, employee stewardship **[2]** is another important factor in adoption of Green IS. The term refers to the employee's active participation and sense of ownership in adopting and implementing Green IS within an organization (Bokolo, 2020). This process, however, is significantly influenced by top management, as they are the ones that initiate and facilitate the adoption in the first place. Nevertheless, employee stewardship still plays a vital role, as they are often the ones interacting with technology on a daily basis and can provide insights into how the system can be improved for environmental sustainability while also contributing to the company culture.

Prior research has also found that an organization's climate and culture, as well as its size **[4, 5, & 6]**, have a substantial impact on Green IS adoption. As previously stated, the organizational climate and culture are heavily reliant on top management support and personal environmental concerns, which have been shown to be significant predictors of adoption (Satchapappichit et al., 2020). Moreover, an organization's size and available funds have also been shown to be decisive factors in facilitating adoption. The funds available to an organization, in terms of the resources dedicated to implementation, personnel training, and maintenance costs, are often closely related to its size.

For smaller organizations, this could act as a barrier to adoption, as they just don't have the financial resources to pursue a technological shift towards greener solutions. On the other hand, organizations of a smaller stature often have fewer bureaucratic restrictions compared to larger organizations, allowing for a faster transition phase (Aguilar-Fernández & Otegi-Olaso, 2018). However, this does not represent a pattern of binary truth but is more of a general tendency.

Capability **[3]** is closely related to IT diffusion **[7]** within an organization. Capability refers to an organization's internal functional competence and external knowledge and skills (Easterby-Smith & Prieto, 2008; Dangelico & Vocalelli, 2017), which act as determining factors in order to effectively implement and integrate Green IS into an organization's business practices, i.e., the diffusion of information technology. This could in turn favorably impact the organization's ability to identify areas for improvement by having adopted technologies tailored for this purpose and could reinforce the capabilities that were responsible for the diffusion in the first place.

The environmental impact of industry **[8]** refers to the detrimental repercussions of industrial operations and processes. The type and severity of impact are dependent on the nature of the industry in terms of carbon emissions, the creation and disposal of hazardous waste, and other negative outcomes. However, implementing measures like management systems to regulate energy consumption, product life cycle, or carbon emissions has been shown to lower operational expenses (Uddin & Rahman, 2012) and decrease the organization's environmental footprint (Bigdeloo et al., 2021).

Commitment, attitude, and belief **[9]** and competitive strategy and advantage **[10]** overlap to a certain extent with some of the previously discussed factors. The leadership **[1]** and culture

[6] of an organization greatly influence their commitment, attitude, and beliefs in their willingness to adopt and allocate the necessary resources to support these systems. Prior research has shown that management commitment and support are considered important determinants for the success of new technologies in different IT adoption contexts (Mouakket & Aboelmaged, 2021). Moreover, organizations that adopt and implement green initiatives as a part of their competitive strategy could gain a competitive edge over their competitors due to the financial benefits of reduced costs and enhanced operational efficiency, in addition to being proactive in complying with regulatory requirements and catering to increasingly environmentally aware customers (Barman et al., 2021).

2.3.1.3 Technological

Technological components within a Green IS, such as emission management software, must meet certain technical requirements in order to facilitate the process of Green IS' adoption (Bokolo et al., 2018; Moini et al., 2014a). These requirements, or success factors, are brought up in the literature as important qualities for the different technologies within the Green IS to ensure adoption, and they are further subdivided into **[6]** categories: **[1]** Interoperability, **[2]** Relative Advantages, **[3]** Scalability, **[4]** Reliability, **[5]** Energy Efficient Chips, and **[6]** Design.

Interoperability **[1]** refers to a system's ability to work and/or communicate with another system ("Interoperability", 2023). There are several research papers that refer to this concept as the key to successful Green IS adoption (Bokolo et al., 2018; Kapoor et al., 2014, Moini et al., 2014; Chen & Chang, 2014; Jenkin et al., 2011; van Osch & Avital, 2010), with some of them being more direct than others. In general, there is consensus in the world of information technology that interoperability is something to strive for (Bento et al., 2020), so it should come as no surprise that this is also true for Green IS.

Bokolo et al. (2018) suggest that interoperability is important for Green IS adoption because of the nature of modern business. Today, more and more businesses are starting to become more IT-based, as technology often provides clear competitive advantages. If a Green IS does *not* have the ability to be integrated with the existing technologies in a business, they will soon abandon the IS, they argue. Companies use technology to improve their business operations in a variety of ways. If the technology is not perceived as useful, it will not be used. This is the basic cost analysis: if the cost of using a technology exceeds the benefits, it will surely no longer be used.

Relative advantage **[2]** is another important factor and refers to the degree to which Green IS offers advantages over existing non-green technologies or systems. The factor considers how a particular green technology provides environmental benefits compared to conventional technologies as well as how it improves the efficiency and effectiveness of business operations. This critical success factor is argued for by multiple research papers (Bokolo et al., 2018b; Kapoor et al., 2014b; Moini et al., 2014b; Chen & Chang, 2014b; Gupta & Sahu, 2011; Jenkin et al., 2011b; Bose & Luo, 2011; van Osch & Avital, 2010). Most prominent is Kapoor et al. (2014)'s research on adoption attributes literature, where they describe how new technology needs to have a relative advantage to ensure adoption.

The degree to which the system accurately performs its intended functions is referred to as reliability **[4]**. It should be able to collect, store, and analyze data in a timely and accurate manner, without interruption or error. This factor is especially crucial in order for the software within a Green IS to do what it is intended to do. According to several studies, if the software displays inaccurate emission data, the effects may be the opposite of what was intended for the system in the first place, resulting in the failure of the system being adopted (Bokolo et al., 2018b; Moini et al., 2014b; Bose & Luo, 2011; van Osch & Avital, 2010).

Another more tangible factor for successful adoption is "Chips" **[5]**, which refer to microprocessors and other electronic components designed to consume as little power as possible and use power as efficiently as possible. This factor exemplifies how Green IS and Green IT are inextricably linked - it's difficult to discuss one without mentioning the other. Energy-efficient chips are essential in Green IS, as chips are essential for any type of software. They are used in computing systems that require significant processing power. Green IS are complex in nature, as much of the software often deals with large data sets and complex algorithms to provide exact and meaningful data. In addition to reducing power consumption, energy-efficient chips also improve performance and reliability, - factors important for Green IS adoption.

The final factor we want to examine in this section is design **[6]**, which, in the context of technology, plays a significant role in the context of adoption. The field of design is vast, encompassing everything from user requirements to the color scheme of the Graphical User Interface (GUI). The importance of design has gained a lot of traction in the field of informatics (Svanæs & Gulliksen, 2008), especially in the business world where competition is ever-increasing. The modern design process is based on the idea of focusing solely on the end-user and providing products that are tailored to their needs and desires. It is also essential to maintain a certain level of user experience (also known as UX-design), which refers to how easy the product is to use and is vital to achieving a high level of usability to ensure adoption (Singh & Sahu, 2020).

2.3.1.4 Political-Regulatory Forces

The government apparatus influences all parts of modern society and is especially important in its role in incentivizing and regulating the adoption and implementation of new technology standards, such as Green IS. It accomplishes this by establishing rules and guidelines for organizations to follow, in addition to using its platform to raise awareness about the importance and benefits of establishing greener practices. It also facilitates innovation through collaboration with the private sector to develop workable solutions. We will now present some prudent ways the government can impact the adoption of Green IS from the established academic literature containing a single category: Laws and Regulations **[1]**.

Laws and regulations **[1]** refer to the regulatory and legal frameworks that organizations have to consider. They govern the impacts of technology, which can ultimately influence the adoption of Green IS'. The government can regulate this process in a variety of ways. One example of how governments have been able to impose regulations in order to decrease greenhouse emissions is through *Carbon Pricing*.

Carbon pricing has been effectively implemented in the past in countries like Canada, Sweden, and the Republic of Ireland. British Columbia introduced their carbon tax in 2008 at $10 CAD per metric ton of CO2, which has since increased to $40 CAD per metric ton of carbon emissions (5–15%) without harming the economy (Barman & Sana, 2021). The tax is expected to be doubled by 2024, compelling organizations to alter their business operations and practices to become more sustainable, e.g., adopt Green IS, in order to avoid facing the potential financial consequences.

Other laws and regulations imposed by governments typically include environmental protection laws, energy standards, and waste management, like WEEE, RoHS, EPA, LEED, etc. They are all meant to reduce the environmental impact of organizations. In order to ensure adoption, Green IS' needs to be aligned with these regulations and laws. This can have an impact on the design of the IS, the data models behind it, processes, and the use of data centers and servers. However, there is limited literature on the areas imposing the requirements of this research field. In this context, Sing & Sahu (2020) propose that in order to measure Green IS adoption by governmental regulations and laws, it is important to develop measures, guidelines, and universal standards for effective adoption in organizations, governments, and the broad society.

2.3.1.5 Ecological Forces

The fifth category presented in Sing & Sahu's (2020) literary review consists of ecological factors, specifically the Rate of Resource Renewal **[1]** and the Regenerative Capacity of Resources **[2]**. The former refers to how quickly a resource can be replenished after it has been consumed, and the latter refers to the ability of natural resources to regenerate and maintain their condition and abundance over time.

Paperless processes are one example of a measure that organizations could implement to reduce their environmental impact and their dependency on regenerative resources. Companies that switch to paperless processes save money on printing, filing, and storing while increasing efficiency through faster access to information and improved information security (Molla, 2008). This could be accomplished by using digital archives, online billing and payment systems, or electronic signature software like DocuSign, which could act as a driver for Green IS adoption by saving expenses on a more sustainable and stable system. Moreover, organizations should consider their reliance on resources with a limited rate of renewal, or regenerative capacity, in order to create more sustainable businesses that will benefit local communities, customers, and future generations (Imasiku et al., 2019).

2.3.1.6 Other External Forces

The sixth category of Sing and Sahu’s (2020) literary review contains three subcategories encompassing external factors such as the Media **[1]**, Market Pressure **[2]**, and Public Awareness **[3]**.

The media **[1]** is a powerful tool for shaping public opinion, influencing decision-making, and propagating narratives that drive social change. The literature on the impact of public opinion and social movements on government policy is extensive, dating back to the 1970s, with empirical literature detailing the impact of public opinion focusing primarily on environmental legislation and regulation rather than Green IS adoption. However, prior studies have found that the perceived benefits of adoption are a greater determinant of adoption than the sheer number of adopters themselves (Yacob & Peter, 2022).

This suggests that the media could be employed to influence public awareness **[2]**, which in turn affects market pressures **[3]** in terms of customer demands for environmental policies. This point is further substantiated by the literature, which states that "an increase in pro-environmentalism public sentiment shifts is a signal for policymakers to legislate pro-environmental policies to reflect public demand for environmentally friendly policies" (Dasgupta & De Cian, 2018, p. 83–84).

2.3.1.7 Motivational Factors

The final category of critical success factors from Sing and Sahu’s literary review (2020) is tied to the motivational factors that influence Green IS adoption and is subcategorized into four subcategories: Competitiveness **[1]**, Legitimacy **[2]**, Social Responsibility **[3]**, and Self-Motivation **[4]**.

We regard the two most important factors as competitiveness **[1]** and legitimacy **[2]**. The former refers to the competitive advantages that an organization could gain by incorporating green practices into their operations, which could lead to advantages in the competitive market due to lower costs (Ambec, 2017), increased efficiency, and a better public image (Thambusamy & Salam, 2010). If your competitors' market competitiveness increases as a result of implementing sustainable practices that are also in accordance with the upcoming rules and regulations, it will most likely be a driving force for similar organizations to consider adoption as well.

This point is further illustrated in the literature by Chen, who states that emphasizing the importance of making successful adoptions known to potential adopters will motivate them to shift their mindset and provide effective guidance in their decision-making (Chen et al., 2010). The latter, legitimacy **[2]**, speaks to the effects of demonstrating environmental commitment to the public. By adopting environmentally sustainable practices, organizations could enhance their reputation and public standing, which could in turn increase their credibility and assist in attracting new environmentally oriented customers, employees, and investors (Hu et al., 2016).

Social responsibility **[3]** and self-motivation **[4]** are factors that could play a part in influencing organizations to adopt Green IS, but the literature suggests that the role would be a minor one. This is due to economic benefits and regulatory mechanisms being the most influential factors in adopting green initiatives, as most businesses are concerned with achieving financial gain and complying with governmental regulations. However, there may be some non-profit or other egalitarian organizations that chose to adopt Green IS for those reasons.

2.3 Chapter Summary

This chapter details the relevant academic literature related to our purpose of exploring EMIS-software and the various factors that influence the initial adoption of Green IS in the context of SMEs. We draw from Sing and Sahu’s (2020) extensive literature review to provide us with seven principal categories that contain various critical success factors that lead to adoption.

In our opinion, the most important factors in this context are related to the economical, organizational, and technical aspects. It is vital for organizations to have a certain level of economic success in order to persist as businesses, and in order for a business to operate, it must adhere to the regulatory mechanisms that exist in that business's domain. Technical factors are also of great importance. Failure to keep up with the technological developments in a given industry could have serious implications and, in a worst-case scenario, cause a business to be left behind by its competitors.

However, despite some factors being more imperative than others, the prospect of adopting Green IS in organizations is a complex matter due to all the different facets that must be taken into consideration. The various factors influence certain individual aspects of adoption while also being interdependent on each other to some extent, creating an entangled, intricate picture.

3. Background

The ERRGP is based on certain social-economic perspectives and theories. In this chapter, we provide an overview of these perspectives and theories. We start by presenting the term “Economic Growth” in a historical context before giving a thorough explanation of the social-economic theories and perspectives that the ERRGP is based on. The ideas are derived from one of the latest publications of the psychologist and economist Per Espen Stoknes - "Green Growth - a Healthy Economy for the Twenty-First Century", published in September 2020.

The book describes perspectives on the historical societal events that have led to the current state of the global economy and emission rates, which are characterized by increased living standards, quality of life, and technological innovation, but also by the exhaustion of natural resources and a 90% increase in CO_2 emissions since 1970 (US EPA, 2016). Stoknes then outlines several key concepts related to different types of economic growth and addresses the many challenges of creating a sustainable economy through innovative business models, political initiatives, and technological advances. Ultimately, this has resulted in the development of the ERRGP. Software that could be adopted and employed by organizations as a way to achieve green growth, mitigate carbon emissions, and potentially spearhead the transition to a greener, healthier economy.

We start this chapter by explaining what is meant by Economic Growth. Then, we explain the term "*gray* growth," a perspective that explains the historical causes responsible for the current state of the earth's climate. Following that, we present the CAPRO-score, a measurement for carbon efficiency, and its importance related to the concept of Green Growth. We also give an account of what is known as *The Jevons Paradox* before explaining the concept of a *Healthy Economy*.

3.1 Economic Growth

People rarely associate the word “growth” with something negative in general society, other than in medical terms, such as a *growing* malignant tumor. When most people hear the word "growth", they think of growing trees or flowers, a growing economy, and so on. The idea that economic growth is desirable has been relatively undisputed for the last 150 years (Stoknes, 2020) and has formed the foundation of most enterprises around the world.

When the COVID-19 pandemic struck global society, the massive economic force of China saw an unprecedented drop in its GDP growth. In 2020, China's GDP increased by 8 percent (*Climate Change*, 2022). In 2022, the growth rate was only 3 percent. Even though the drop in GDP growth was foreseen, it was still a massive setback for China and is seen as a *failure*. But it was not all bad. China's and the world's economic setbacks caused by the pandemic had a big impact on global CO2 emissions. The colossal coal mines in China stopped running, and airplanes were left grounded across the world. Even the water that runs through the Venetian canals suddenly became noticeably clearer.

This did not have a direct link with the drop in global emissions, but it did have a correlation with human interference (without boats traveling in the canals, the mud from the bottom stayed at the bottom instead of swirling up to the surface), and it became a symbol of how quickly it is possible to reverse the effect humans have had on the earth's climate. We will now provide some historical context for the events that have led up to our current climatic crisis.

3.2 Gray Growth

The global economic model that we know today is based on technological advances that occurred in society during the industrial revolution in the 18th and early 19th centuries. During that time, the world was a very different place than it is now; the earth's population was much smaller, and the untapped natural resources were plentiful, with endless green forests, flourishing animal kingdoms, and vast amounts of untapped oil reserves and minerals available to anyone who saw the enormous wealth potential. However, this would not last. By the second half of the 19th century, the world's population had grown significantly, and the consumption rate of the earth's natural resources had already exceeded what the globe was capable of regenerating in a year. A term referred to as the earth's natural "biocapacity" (Stoknes, 2020).

Robert M. Solow was awarded the Nobel Prize in Economics in 1987 for proposing the economic growth model that dominated the nineteenth century. His theory holds that three major factors drive economic growth: the labor force, capital, and technological advances. His theory was adopted as the standard model in conventional economics. However, the one factor that Solow knowingly ignored but that his predecessors (Adam Smith and David Ricardo) both saw as essential was land, meaning the ecological system and its natural resources. Solow claimed that technological advancement was the "magic ingredient" behind the increase in capital and labor force (Stoknes, 2021). The effects of Solow's growth model blinded the coming generation of economists to the wasteful nature of their business model and to the earth's limited regenerative resources.

All of the events of the past have led to the current state of the world's economy and emission rates, which Stoknes describes as "Gray Growth", meaning increased revenue along with an unsustainable waste of the earth's resources. Stoknes implores us not to continue further down this path, as doing so will only further our downward spiral towards a point of exhaustion, where it will be very difficult to alter our course quickly enough to avoid irreversible damage to the climate and the earth's ability to regenerate its resources. Instead, Stoknes presents the concept of "Green Growth" which still allows for economic growth in the sense of financial profits, but a growth where the consumption of resources is maintained at a sustainable rate. Stoknes is not alone in his viewpoint; Herman Daly and other central economists share a similar opinion. He claims that if current trends continue in the same direction and at the same velocity, it will only lead to more "uneconomic growth", meaning that each unit of production brought to the market causes a negative net benefit (Stoknes, 2020).

Consider a city where traffic congestion is already a problem. Let's say the sale of cars and fossil fuels increases, which would contribute more money to the economy and lead to an increase in GDP (gross domestic product), traditionally viewed as a positive economic development. However, in order to truly assess the effects of this increase, the entire picture must be considered. Each new car that joins the already congested infrastructure will lead to more congestion and pollution. When the total costs of time wasted, fuel used, and sedentary implications are considered, the net impact of selling more cars has more negative consequences that outweigh the increase in GDP (Stoknes, 2020). In a situation like this, the GDP metric may lead people to believe that increased sales, regardless of the situation or other factors, automatically represent progress because increased sales are equated with *growth*. Another comparable example can be seen when looking at agricultural monocropping, which entails cultivating the same kind of crop on a land plot year after year. As a result, the soil loses nutrients and organic matter, becoming less fertile over time and possibly even causing erosion (*The Rise and Fall of Monoculture Farming,* 2021).

This is an example of short-term growth that does not sustain the practice that generated the commodity in the first place, contributing to gray growth and digging an ever deeper hole from which to climb. So, what can be done about it? The section that follows will introduce the CAPRO-score and the ERRGP, which is the EMIS-software that this thesis investigates, as well as detail the central ideas on which it is based, promoting sustainable growth in an organizational setting.

3.3 CAPRO: Carbon Efficiency

The central idea that the ERRGP is built on is to enable SMEs to collect and report their annual emission data in relation to their value creation, or revenue, in order to calculate a score detailing the organization's "carbon productivity" - also known as CAPRO. This score is meant to serve as a guiding tool that SMEs can use to steer their business operations and practices in a sustainable direction while achieving what is referred to as "Green Growth", which will be explained further in detail in the following section.

The CAPRO score is thought to provide a baseline for the given SME and will serve as a "moving target" to improve upon in the following year. Once the year has concluded, a new

CAPRO score is generated to serve as the new target for the coming year, enabling the SMEs to achieve continuous, sustainable economic growth. A prospect that, with the right information and incentives, is more than feasible (Stoknes, 2020).

We have already seen examples of countries achieving this type of growth in Nordic countries such as Denmark, Sweden, and Finland, all of which have maintained sustainable green growth since the 2000s (Stoknes & Rockström, 2018). Moving in the right direction, that is, toward sustainable long-term economic growth, is not enough. While this type of growth is desirable and something that all countries should strive for, Stoknes emphasizes the importance of the *rate* at which this type of growth is maintained. His theories of sustainable growth are based on the Paris Agreement, which aims to limit global temperature rise to 1.5 degrees Celsius while cutting greenhouse gas emissions by 40% by 2030. Failing to reach the 1.5 Celsius mark is associated with triggering far more severe climate change consequences, such as more frequent and severe droughts, heatwaves, and rainfall (*The Paris Agreement | UNFCCC*, 2023).

For that reason, while all countries should aspire for green growth, the *rate* at which the growth is maintained is the determining factor in meeting the Paris Agreement goals on time. The ERRGP addresses this concern and was specifically developed to facilitate a growth rate sufficient to reach this deadline. The ERRGP incorporates certain threshold numbers for emission reduction and revenue gain in order to set CAPRO-targets that will allow the end users to meet these targets within the timeframe specified. The specific threshold numbers, however, will not be mentioned in this thesis because we agreed to maintain anonymity in order to protect the identities of the company and the developers. The next section will detail what the concept of Green Growth encompasses in relation to the global economy and our collective consumption of resources.

3.4 Green Growth

In order to correct our present course, our economic model and views need to change, according to Stoknes (2020). We have to be able to view our economic practices as a whole, considering all the different aspects connected to the supply and production of products and services and the repercussions they have on the environment, our economic future, and the coming generations. According to 2018 data, our current annual consumption of the earth's biocapacity equals 1.7 Earths (Global Footprint Network, 2018). We are consuming more resources on an annual basis than the earth is capable of regenerating in the duration of that timespan, and this consumption rate is expected to double by 2050 (Stoknes, 2020). However, Stoknes and other economists have proposed alternative economic models that can mitigate the current consumption- and emission-rates, in addition to increasing our capacity to reinvest used resources to minimize waste while still maintaining a financial profit.

The idea of Green Growth is one of a sustainable economy that can thrive within the limits of what our planet can sustain for the foreseeable future. The concept is a result of the combined score along two primary dimensions: change in the organizational value created and change in the ecological footprint per year (Stoknes, 2020). From this, we can gather that green growth equates to the generation of more economic wealth while at the same time reducing the environmental impact of the materials used to create the wealth, in addition to reinvesting in nature to preserve this balance. As previously mentioned, there are already several countries that have achieved genuine green growth since the turn of the millennium, namely countries like Denmark, Sweden, Finland, and the UK. So, how can other countries with different sets of prerequisites duplicate this?

The general answer is, as stated above, to maintain a steady increase in wealth that does not come at the expense of our natural resources. In a more tangible example, this would translate to every SME in a country reaching and maintaining the annual threshold numbers for increased revenue and decreased CO_2 emissions. This would position the businesses in the upper left corner of the “growth compass” depicted below. Successfully maintaining this position year after year until 2030 will put us on track to meet the Paris Agreement's baseline goal of limiting global temperature rise to 1.5 degrees Celsius, which is exactly what the ERRGP software is designed to encourage and facilitate.

However, the solution to a complex problem is rarely a perfect one, and this is no exception. Improving the efficiency of production processes reduces costs and resource consumption, resulting in cheaper and more readily available products, which ultimately results in higher total resource consumption. This is referred to as an “economic rebound effect," and it is part of the growth paradox known as the "Jevons Paradox," which we further detail in the section below.

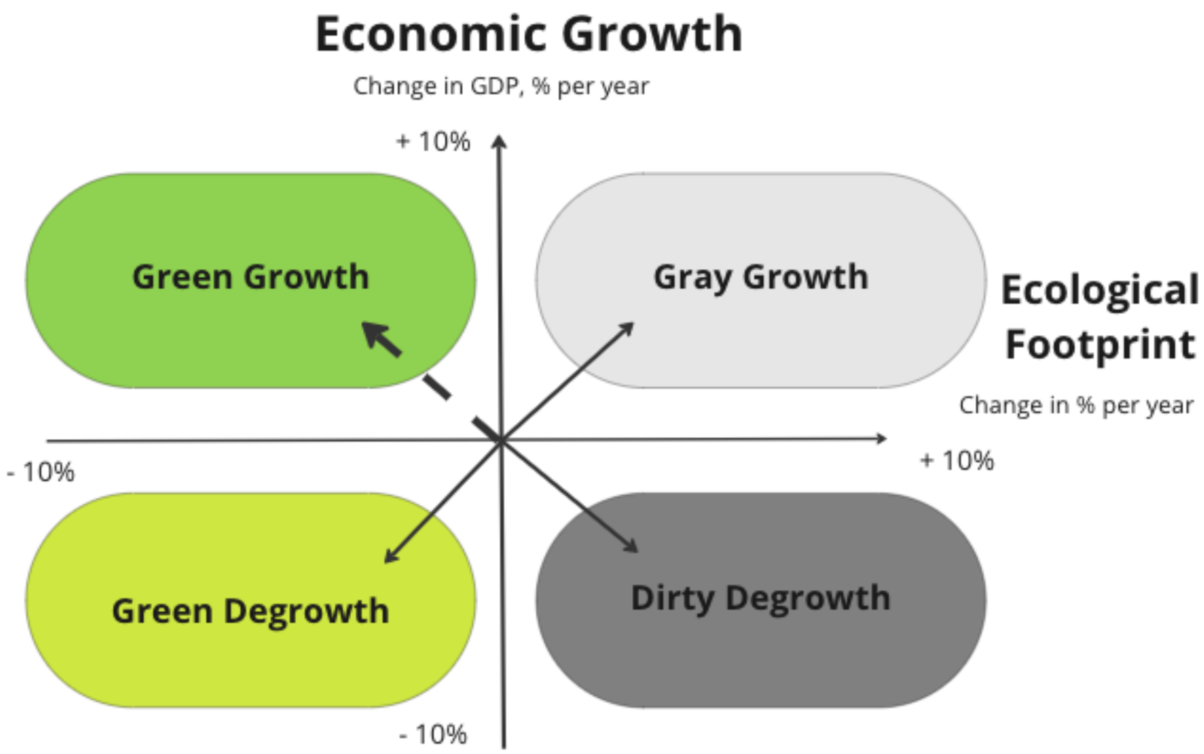

Figure 5: Illustration of Stoknes’s “Growth Compass”

3.5 The Jevons Paradox

The English economist William Stanley Jevons described a paradox in his 1865 book “The Coal Question." It suggests that increasing the efficiency with which a resource is used can lead to an increase in the overall consumption of that resource (York & McGee, 2016). Jevons used the coal and train industries to illustrate the paradox. The steam engine, invented by Thomas Newcomen in 1712, is a type of heat engine that uses steam generated by coal to generate mechanical power. The steam engine went through a lot of improvements over the course of the 18th, 19th, and 20th centuries in order to increase its efficiency, reducing the amount of coal needed for the same amount of energy created. However, Jevons noted that improvements to the steam engine did not result in a reduction in overall coal consumption. In fact, as coal became more widely available, its overall use increased.

The paradox can be explained by using energy efficiency and technological advances as analogies. Consider having a yearly energy budget of a thousand dollars. Last year, the thousand dollars enabled you to keep your house lights on for four hours per day. Since last year, technological advances have improved light bulb efficiency, and you can now keep the lights on for six hours every day for the same price (one hundred dollars). You spend the same amount on lighting as last year, but you use more energy.

According to the Jevons paradox, the effects of EMIS-software', such as the ERRGP, will ultimately lead to an increase in global CO_2 emissions rather than a decrease. However, the paradox can be mitigated through the use of government policies to discourage excessive energy consumption (York & McGee, 2016). This point is further substantiated by Stoknes, who states that in order to offset the economic rebound effects of improved process- and resource-efficiency, political incentives must be implemented in order for the transition to be feasible within the time frame set by the Paris Agreement.

Factors like renewable energy, carbon pricing, and a circular economy are all factors that can help mitigate some of the rebound effects, which were not available in the past. Other critical mechanisms, such as the controlled use of fossil fuels with steadily increasing fees and allowance trading or the implementation of green fees for resource use, are ways to reinvest some of the profits from improved efficiency back into the community. "Without such political incentives in play, the shift from gray to green is likely to be slow" (Stoknes, 2020). The chapter's final section discusses what a growing sustainable economy might look like, as well as emphasizing the importance of fostering the right type of economic growth in order to achieve an economy that can be sustained within the planet's ecological limitations.

3.6 A Healthy Economy

Stokes advocates for a *healthy economy,* which entails more than just aiming to increase the national GDP on a yearly basis. A healthy economy measures wealth by looking at the development of the nation's "broad fortune," as Stoknes describes it. The broad fortune he talks about is sectioned into three types of capital: *productive*, *natural*, and *social*. A country's future quality of life is less determined by the yearly flux of GDP and more by how well it is able to grow its capital stock (Stoknes, 2020), a concept that will be further detailed in the following paragraph.

A balanced fortune is described as one where two of the capitals increase while the remaining one does not decrease. Productive capital is measured in currency and is the result of people's ability to produce goods and services with monetary value. The second type of capital, natural capital, is the type of capital upon which a green economy is built. This capital is made up of the natural resources available to each nation, such as the fields, lakes, fertile soil, ocean, and so on. It is measured in area, biomass, and biodiversity, which we depend on to provide us with "free" resources and services. For this reason, it is crucial for us to maintain the natural capital in a healthy state. If the remaining portion of the unused biocapacity reserve is sufficiently large, then we can situate the productive capital well within the threshold of the earth and its interconnected ecosystems (Stoknes, 2020). The final type of capital is social capital, which consists of fundamental and long-term trust shown not only to other people but also to the government and affiliated institutions. This capital is conditional on investing in fair and inclusive laws and practices, as well as enforcing these rules in a justifiable manner over time to build public trust.

These three types of capital are all interdependent in a productive economy. Financial and productive capital rely on strong social capital, and productive and social capital rely on strong natural capital. There would not be much financial profit to benefit from in a society where one of the capital sources was poorly managed, e.g., forest fires or other climate catastrophes (Stoknes, 2020). Therefore, the key to a healthy economy is to maintain the balance between the different types of capital that make up a nation's capital stock. If we generate more income than our annual expenses, we can reinvest the net profits from our income into one of the sources of capital. With this kind of healthy growth, we will be able to increase our overall fortune year after year and generation after generation (Stoknes, 2020).

This is ultimately why the ERRGP that this thesis examines was created: to assist organizations in operating in a more sustainable manner in order to facilitate and promote a healthy, sustainable economy. The provision of a tool for organizations to monitor and report emission data increases social capital in terms of trust and transparency among the actors involved. Furthermore, the generation of a larger dataset allows law- and policy-makers to pass more informed and incentivized regulations, which will again benefit the organizations, resulting in increased productive capital that can be used to grow or maintain other parts of the capital stock.

3.7 Chapter Summary

This chapter provides the historical background and context for the development of the ERRGP software, which is designed to assist SMEs in tracking, monitoring, and regulating their greenhouse gas emissions and energy consumption in order to operate in a more sustainable manner. The chapter also details the various growth concepts that are fundamental to comprehending the reasons for developing this type of software and appreciating the value it could potentially confer on society. The most important concept raised in this chapter is the CAPRO-score, detailing an organization's carbon-efficiency, which could potentially represent a paradigm shift in the way we think about and develop software of a similar purpose and kind in the future.

4. Research approach

In this chapter, we describe our research approach. The empirical basis of this thesis is based on an 8-month research project in collaboration with a software company, a business consulting company, and the DHIS2 Design Lab at UiO. First, we provide an overall background for the project, the different actors involved, and how we decided on our research problem and focus. Secondly, we describe our research methodology. Thirdly, we describe the manner in which we collected our data. Our data analysis is then presented, before we finally discuss the limitations of our research approach.

4.1 Background

This research project is a part of the DHIS2 Design Lab at the Department of Informatics at the University of Oslo (UiO). The Lab researches how to support and promote innovation and design within the ecosystem of DHIS2 (District Health Information Software 2), which is an open-source software platform primarily used for health data management and analysis. The platform was developed by the Health Information Systems Program (HISP) at UiO and is currently used in over 70 countries worldwide. We are engaged in the lab as master's students. Our initial research theme was established within the Design Lab and further refined in collaboration with our academic counselors, the owners of the software we researched, and our reading of the current Green IS literature.

We will start this subchapter by giving an account of the actors involved in the development project and why the DHIS2 platform is used as the underlying infrastructure of the software. Then, we will explain the process of deciding our research focus.

4.1.1 The ERRGP

The ERRGP is an EMIS-software with the purpose of making “[...] it easy to manage and reduce your company’s CO_2 emissions” (ERRGP Website). The primary design of the system is to have the end user manually input emission data and give output back to the user in the form of goals and general overviews.

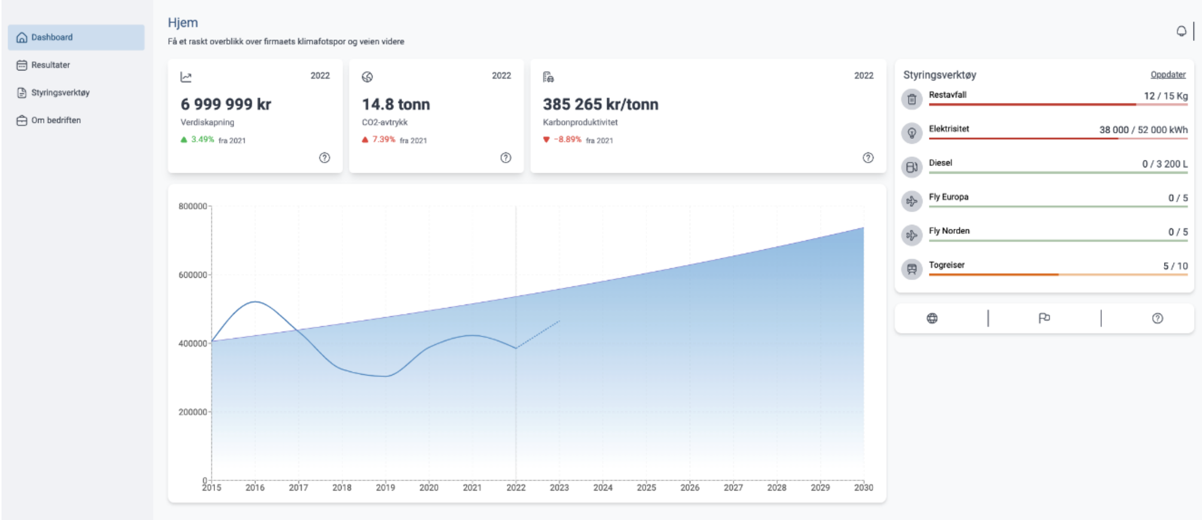

Figure 6: ERRGP dashboard

The dashboard gives an impression of what the software is most concerned with: value creation (verdiskapning), which is the first statistic shown. The next numbers display their CO2-emission (CO2-avtrykk) in tons, and the last shows their carbon efficiency (karbonproduktivitet/CAPRO-score). The graph illustrates the projected CAPRO-score for the foreseeable future. On the right, the system displays a snippet of the user's various emission sources.

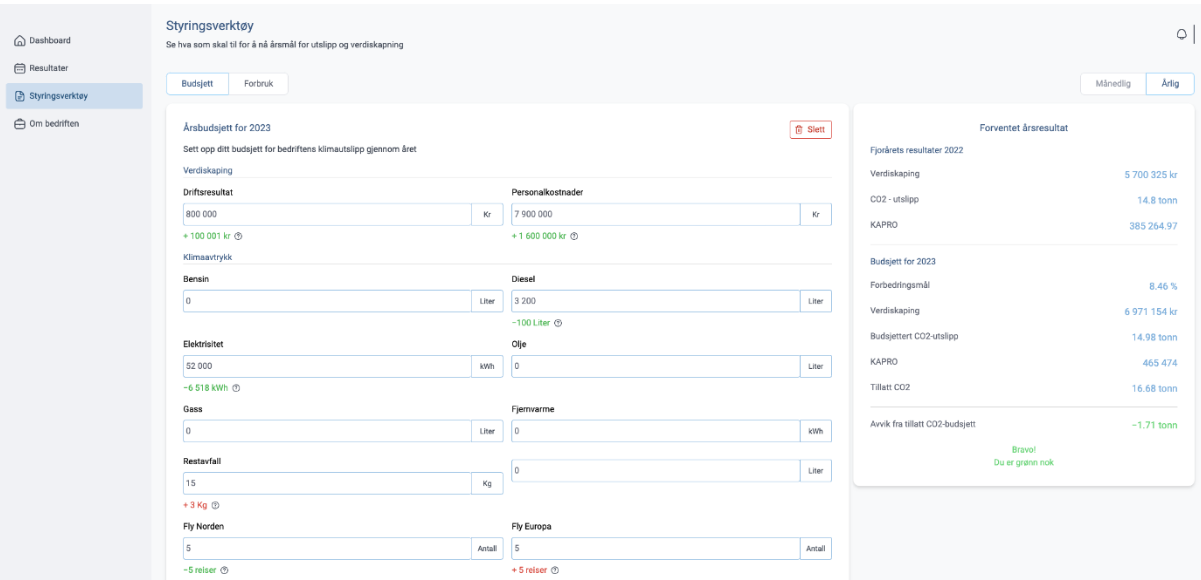

Figure 7: ERRGP display for manual inputs (Styringsverktøyet)

The emission data comes from manual input from the users. Technology is often meant to automate work, but Solid Software expressed that this has to be done manually for now, as the businesses would need to invest in other types of software and new hardware in order to automate it. As previously explained, cost is very important for SMEs, and the cost savings of doing it manually are perceived as too great for the SMEs to start investing in new software and hardware.

The system is designed after a design model by Solid Software, dubbed "Goal-Oriented-Design". The idea is to provide long-term goals for their end users. Carbon efficiency and sustainability are not trivial matters one can accomplish overnight. You have to start small and observe the compounding effects over time. We will elaborate on the design model later in the thesis.

Another selling point of the ERRGP is that end users will get a comprehensive perspective on environmental issues by having insight into all three environmental scopes:

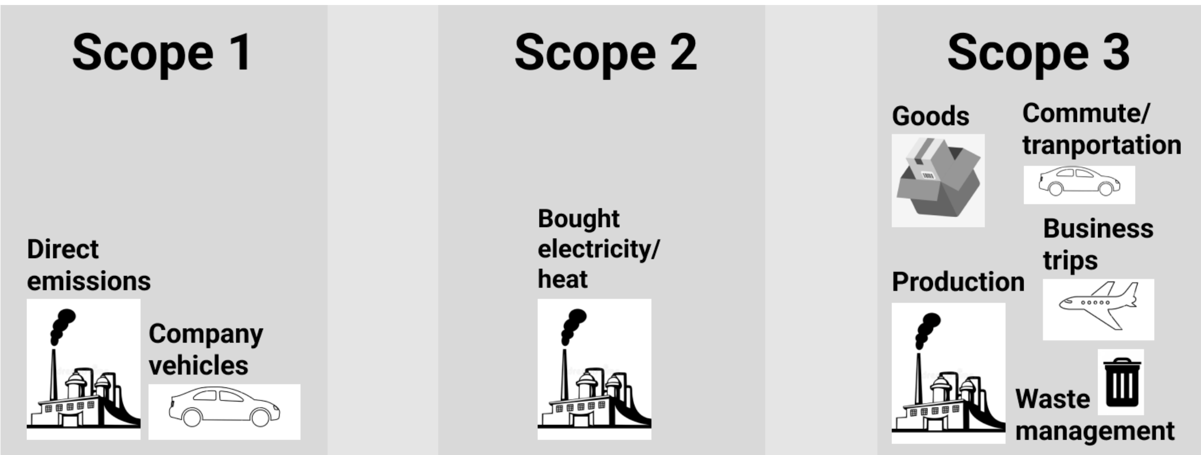

Figure 8: Environmental scopes (simplified)

The illustration of the three different scopes is simplified. The first scope only encompasses direct emissions caused by the end user, such as electricity used, fuel used for company cars, and so on. The second scope encompasses electricity and heat used by external vendors, such as the heating of storage facilities. The third scope is the most complicated. It encompasses the emissions from goods they purchase, emissions from business flights and transports done by external actors, how they manage their waste, and emissions from the production of the goods they sell - if their products are made in China, the emissions used for making these products overseas have to be calculated.

The ERRGP intends to use all three scopes in the software. SMEs are usually just a small part of a bigger production line, and it makes little sense to only include the first scope to calculate their overall emissions.

4.1.2 Actors Involved

We will now present the actors involved in the development project of the software that this thesis researches and how we got involved with them. They consist of the software consulting company referred to as Solid Software, the business consulting company referred to as Green Consulting, and the open source software platform DHIS2.

4.1.2.1 DHIS2

The District Health Information System 2 (DHIS2) is an open-source software platform developed by the HISP Center at UiO. DHIS2 is considered a global public good that transforms health information management around the world (*About DHIS2*). The platform is web-based and most commonly used as a health management information system (HMIS). It is the world's largest HMIS and is used by 76 countries around the world. DHIS2 software development is a global collaboration managed by the HISP Center at UiO, which is regarded as the core team of the platform.

HISP is a global network of third party complementors of the DHIS2 platform, comprising 17 in-country and regional organizations. The different HISP-nodes provide support, implementation, and platform extensions as consultants. The core team at UiO ensures the generic requirements of the platform are integrated into the core, and the HISP nodes develop custom software for clients, typically health ministries, around the world. The core of DHIS2 is completely open source and free to use for anyone, with some restrictions concerning copyrights and name use.

Solid Software decided to use DHIS2 as the underlying infrastructure for mainly three reasons: **[1]** it lowered the cost of development considerably; **[2]** it was a good business case for the DHIS2 ecosystem to try and create a new stream of revenue; and **[3]** it represents a new avenue for the DHIS2 ecosystem that is currently being explored on a larger scale (an environmental instance of DHIS2).

4.1.2.2 Solid Software

The software consulting company has enjoyed great success in the market for software consulting. They are a small company staffed by a few, but talented developers. The CEO of Solid Software has worked with DHIS2 and the HISP center for a long time, and the idea of using DHIS2 as the underlying infrastructure for a brand new Green IS came from him. We started our involvement in the research project by being onboarded as developers. We attended meetings, were assigned tasks in the requirement ticketing system called Jira, and wrote code to improve the software. The first task that we were given was to fix small bugs. This allowed us to get immersed in the software. Later, we developed new small parts of the software, such as certain user feedback requirements. We also developed automatic tests using the Python testing framework *Cypress*.

We wanted to experience the development process as developers while still trying to maintain an objective view and approach to understanding the processes of developing the software. We participated in one major sprint. When the sprint concluded, we started to work closer with the company behind the idea of the software, Green Consulting.

4.1.2.3 Green Consulting

Green Consulting is the company behind the idea of the ERRGP. They are a small business consulting firm that has consulted businesses for over three decades with, among other things, expertise in sustainability. The most fundamental requirements for the ERRGP are derived from the economic and psychological theories of Per Espen Stoknes and his book Green Growth (2020). We have studied information systems throughout our time at UiO, but we are novices when it comes to sustainability. We worked together with Green Consulting to understand our limitations when it comes to the world of sustainability in order to get the most out of our interviews with the pilot customers and to get better insight into the fundamental requirements of the ERRGP.

4.1.2 Research Focus

The research problem was modified several times as the data gathering process went along in discussion with our academic supervisors and the actors involved in the project. The first phase of the project revolved around identifying the tensions and prominent issues the development project faced and how we could contribute to the practical implications of the development of the software as well as the Green IS research field as a whole. The first phase of data collection left us with **[3]** different research topics that we deemed relevant:
[1] Motivational Factors, **[2]** Data Points, and **[3]** Green IS adoption.

The first topic was about mapping the biggest motivational factors for reducing emissions for the end users of the ERRGP. Because of the small pool of interview objects, we deemed this topic difficult to research. The second topic was Solid Software's idea. The research project would then have been an iterative process of developing prototypes for end users to evaluate.

The third option we presented was to narrow our research down to the end users' adoption of the ERRGP. Green IS adoption is a large subsection of the Green IS research field (Sing & Sahu, 2020), which is still in its initial stages (Khor et al., 2015). The ERRGP development project is in its early stages of deployment, which represents an opportunity to research early adoption by interviewing end users who have just recently started to use the software. Our interview subjects are all seeking to become more sustainable, and we discovered that they all share enthusiastic views on new technologies. We deemed these factors together to be a good foundation for our research. We would be able to use data from both data collection-phases, and our findings could potentially have practical implications for Green IS implementers in addition to contributing to the overall research field of Green IS. We eventually decided to focus our research on Green IS adoption, more specifically on the critical success factors for Green IS adoption (Sing & Sahu, 2020).

The opportunity to work so closely with an actual development project of an EMIS-software has been invaluable for us. The close connection with the developers and staff has made it possible for us to gain a rich understanding of the software and the project. There are fewer misunderstandings when you can simply ask someone straight away whenever there are uncertainties. We have also gotten to know the team, which in our mind has made the data more truthful because of the trust one can build by working together over an extended period of time. We also feel that the opportunity to observe the project in this manner has led to the discovery of issues and problems we may not have been able to discover otherwise.

However, there is one prominent issue we discovered with the close relationship as well. For the most part, we share some important motivations for the collaboration: as researchers, we want to learn more about Green IS and EMIS-software in order to assist them and other projects to develop Green IS that could help mitigate climate change. As product owners, Solid Software is interested in an objective view of the project in order to make a better product, which will ultimately achieve the same goal. However, we as researchers are loyal to the academic field of Green IS as well, which guides and steers us in our research. There could potentially be scenarios where the literature *tells* us to focus on a specific part of EMIS-software development that Solid Software is interested in, and vice versa. There have been times throughout the collaboration where we have tried to meet halfway: we need to be true to our academic purpose, and they expect something in return by letting us research their project. Fortunately for us, the collaboration has only been a positive experience. They have been enthusiastic the whole way, and we have not met any major roadblocks or issues that we haven’t been able to agree upon.

4.2 Research Methodology: Case Study

Our study of the ERRGP is a qualitative case study. Our intent is to gain an understanding of the people and organizations for which the software is meant in order to further investigate CSFs for Green IS adoption (Sing & Sahu, 2020). In order to achieve this, we believe that a qualitative study is appropriate. Case studies involve in-depth investigations of specific cases and are often used to understand the complexity and uniqueness of a particular case. The research method has made it possible for us to gain a rich and detailed understanding of the software and all the actors involved. Our goal is to identify software requirements that can support EMIS adoption. In order to reach this goal, we wanted to study the social complexity between information technology and the people who use it. Studies have shown that the social complexity within the theoretical universe of SMEs is immense (Strøm et al., 2021).

To understand this complexity, we focused on understanding the subjective perspectives and meanings that individuals ascribe to their experiences. Case studies have gained mainstream acceptance within interpretive IS research (R. Ponelis, 2015; Walsham, 2006). As aforementioned, we have little experience with sustainability and EMIS-software. For that reason, we deemed it necessary to learn about the tensions and issues firsthand by observing the development project as well as conducting interviews with the end users. We have therefore conducted a case study of the ERRGP to propose software requirements for EMIS-software to support EMIS-adoption.

4.3 Data Collection

The first part of our data collection was through participatory observation of the software company Solid Software, which lasted for a four month period. We got onboarded as developers, where we participated in daily and weekly activities - we attended standups, wrote and reviewed code, and participated in meetings. We immersed ourselves in the company while trying to maintain an objective view of what unfolded in front of us. The second part of our data collection was done by conducting in-depth semi structured interviews with five of the early adopters of the ERRGP (pilot customers) and the project leaders.

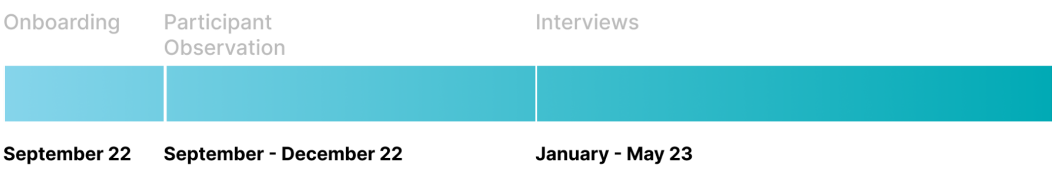

Figure 9: Timeline of the research project

4.3.1 Participant Observation

During the first period of the research project, the scope and research angle were unclear. Solid Software, and one of our academic mentors suggested we get onboarded as developers as a way to immerse ourselves in the project. We got a chance to become a part of the team and learn everything we could about the problem they wanted to solve, what obstacles lay in front of them, tensions, social and organizational structures, and more. For clarity's sake, we divide this part of our data collection into three different phases:

Phase 1: Understanding the ERRGP

When we were first introduced to the project, the boundaries for our research were not set. We only knew that this was an untraditional project in the DHIS2 ecosystem that targeted the private sector in Norway with a particular software that would help reduce carbon emissions. Our first objective was to learn as much as we could about the project. We started having meetings with Solid Software and Green Business, and they told us all about the project. We were given access to the software, the backlog, and other documents. It took a while to get properly integrated into the software, as the code base was more complex than we were used to. From our experience at UiO, most of our projects have been front-end projects that we've built from scratch. These applications have been pretty basic in comparison, with little integration across multiple technologies and sources of information. The ERRGP uses many different kinds of technologies we were unfamiliar with, and we had to spend a good amount of time at the start just to figure out dependencies and complexities within the code base.

This was an interesting experience as developers, but it also helped us learn about the overall complexity of the software from both the social and technical sides. We quickly understood that EMIS-software' are complex. They potentially have many different sources of information that they have to be able to extract, an amount that one can only assume will increase. They must also have the capacity to be frequently readjusted as their user base is so different in character, meaning that the systems cannot rely too much on generic requirements. It also means that this type of software has to be developed with little to no technical debt (Kruchten et al., 2012), as they will most likely have to adjust many functions and requirements as their user group grows and develops.

Activity	Description
Developing	We wrote code for the ERRGP.
Meetings	We attended meetings, such as general meetings, one-on-one meetings, and stand-ups.
Workshop	We visited the headquarters of Solid Software to attend a two day workshop. Here we worked on our research topic. The workshop concluded with a final presentation of our proposed research topic.

Table 1: Data collection activities.

Phase 2: Software Development

Our first involvement as a part of their team was attending their first big meeting after the summer. Here, the project leader summarized what they did on their last sprint and later went over the overall plan for the upcoming autumn. We got introduced to the whole team as well as their partner, Green Consulting. Later on, we agreed on our direct involvement in the following sprint. We were introduced to the technologies their developers employed, assigned tasks, and started to work autonomously. The tasks varied from adding new pieces of code to testing existing code. Throughout the four months, we had regular meetings with the project leader, as well as standups and other general meetings. During the participatory observation period, we took notes on what we saw, heard, and experienced through journals.

The greatest strength of this part of our data collection was the ongoing debates, discussions, and conversations we were able to have with the employees during the development period. We were lucky enough to work in the same building as the project leader. The direct access was important for us in order to get onboarded and looped-in quickly. Whenever we encountered coding-related problems, the project leader was not far away to help us.

Phase 3: Deciding on Further Involvement

After the sprint ended, it was time to decide how we should conduct the second part of the data collection and what our involvement with the ERRGP should look like. During the last sprint meeting, the project leader tasked us with coming up with possible research avenues we wanted to pursue with the ERRGP. He also came with some recommendations that Solid Software saw as valuable for them. We concluded the sprint and started to work towards defining our research goal. This was mostly done in collaboration with our academic mentors, together with reading the current Green IS literature (see 4.1.2 Research Focus). After some iterations, we eventually came up with the three suggestions described above. We then visited the HQ of Solid Software for a two day workshop. Here we presented the research avenue we were most excited about for both Solid Software, Green Consulting, and a representative of the DHIS2 Core Team. All parties eventually agreed that the chosen research direction was beneficial for all parties, and we got the green light. The next step was to prepare and set up the second part of our data collection.

4.3.2 Semi Structured Interviews

An important aspect of this development project is the professional relationships between all the actors involved. We did not want to disrupt or alter any professional relationships between Solid Software, Green Consulting, and their customers. There is also the aspect of a lack of expertise on our part. We are software developers with no formal experience with environmental sustainability in the context of business management, and we are not widely familiar with the common practices, structures, and cultures of SMEs in general. We worked closely with Green Consulting in order to become more familiar with the landscape of environmental sustainability and SMEs overall. Based on what we learned from Green Consulting and our reading of the current Green IS literature, we developed and iterated over an interview guide with guidance from Green Consulting, Solid Software, and our academic supervisor. When the interview guide was agreed upon by all parties, Green Consulting introduced us to their pilot customers, and we began with the interviews shortly after. They were conducted digitally, with one of us taking on the role of lead interviewer while the other took thorough notes.

We were able to conduct seven semi-structured interviews in total. Most of them were with different pilot customers, and some with different project managers. We wanted to include more pilot customers, but the remaining pilot customers were either unable or unwilling to participate. The interviews all lasted between 45 and 60 minutes. The overall goals of the interviews with the pilot customers were to **[1]** learn about the business in detail. This includes the qualities that make it unique, what the foremost challenges are at the moment, and what the market *looks* like. We also wanted to **[2]** learn about their relationship and history with technology: their technological dependencies, types of technology used, how different roles in the company use technology, changes in technology throughout the years, progress, and setbacks. Lastly, we wanted to **[3]** learn about their environmental strategy. We wanted to get their take on their own progress (without showing concrete numbers and statistics, but their impression of how they are doing), what separates them, from an environmental standpoint, from their competitors, how they understand the many complex aspects of environmental sustainability, what their sustainability goals are, how they measure success, system support, local versus global concerns, and the degree of societal and professional pressure they experience.

The goal of the interviews with the project leaders was to help us with the analysis of the interviews with the pilot customers and to get their take on adoption factors and other challenges related to initial adoption. We have summarized the interviews in the table below:

Participant(s) role(s)	# of people	Date
CEO, Ski Center	1	13.01.23

CEO, Mechanical Workshop	1	16.01.23
Project lead, Solid Software	1	25.01.23
CEO, Steel Constructors	1	27.01.23
CEO, Plastic Constructors	1	13.02.23
Project lead, Green Consulting	1	10.03.23
CEO, Solid Software	1	20.03.23
CEO and project lead, Solid Software	2	22.03.23

Table 2: Table of interview subjects.

4.4 Data Analysis

The analysis of our empirical data was an iterative process of reading literature, sparring with our academic supervisors, and analyzing the data in order to shape our final contributions.

4.4.1 Participant Observation

The first part of our empirical analysis involved structuring and understanding the data from the first data collection phase, the participant observations. When we started the research project, our initial goal was to identify challenges and research avenues worth exploring. The parameters for the research project were not set, and we started the participatory observation with an open mind. We attended meetings, worked on the software, read literature, talked with the employees of Solid Software and Green Consulting, and sparred with our academic mentors. We analyzed the data iteratively in order to identify the most valuable and feasible research avenues we could explore with the resources and time we had, in the following manner:

Organizing Notes

In order to make sense of the data from the first data collection phase, we began by going over every document we had: every note, every presentation, and the backlog from the software development. We familiarized ourselves with the total amount of data we had collected and structured the data according to certain broad challenges we had identified.

1. **Technical Challenges**

The meetings we attended, for the most part, were about the current technical challenges the project faced: what they've accomplished so far, what they wanted to accomplish, and overall technical difficulties.

2. **Environmental Challenges**

As we see it, the biggest challenge the project faces is how the ERRGP can tackle the immense challenges related to sustainability. The project continuously iterated over these problems, trying to translate these challenges into software requirements.

3. **Business Challenges**

In addition to worrying about the technical and environmental challenges, they also had to spend time trying to solve the business model in order for the project to become sustainable on its own. Both of these challenges were related to the business model itself: the companies have to create revenue in order to continue to develop the ERRGP. They also have to create a business model that is aligned with the boundaries of the DHIS2 platform.

We iterated over the challenges with our academic mentors and the project leaders before deciding on three possible research avenues for the second part of the data collection:

1. **Business Model**

- Solid Software is interested in creating a new revenue stream for the DHIS2 ecosystem and the company itself. They mainly felt that developing the ERRGP as a SaaS (Software as a Service) was their best option, meaning that they host the software and make it available to customers through licenses. Because DHIS2 is an open-source platform, this had various ramifications that made it challenging to achieve. However, as a business case, it made perfect sense. If they could achieve it within the boundaries of the DHIS2 ecosystem, they could ensure a revenue stream for both themselves and the DHIS2 platform.

2. **Data and Statistics**
   - Solid Software was also interested in how they could ensure continued motivation for using the system by projecting the right *type* of data in the right *way*. This avenue of research mainly consisted of understanding what kind of data to show the end user, when to show it to the user, and how to display the data to the user. The idea was that we could be in charge of a specific part of the ERRGP, namely the different data points and how to best illustrate them. The second phase of data collection would then be an iterative process where we developed prototypes of data visualization that we would show the end user and get feedback.

3. **Adoption**
   - As IS researchers, this topic made the most sense for our research. We are interested in researching the tension between technology and the people who use it, a complexity that is known as Socio-Technical complexity (Luna-Reyes et al., 2005). The overall idea behind this research topic was to gain insight into the end users of the ERRGP and to understand their current situation as far as how they perceive themselves as businesses. We wanted to research the social complexity that EMIS-software must account for in order to facilitate adoption.

Since we decided to focus our efforts on the adoption of Green IS, we returned to the data from the first data collection phase and analyzed it accordingly. We went over all of our notes, presentations, and information from this phase, with adoption as the main heading.

4.4.2 Analyzing the Interviews

We will now present how we analyzed the interviews of the pilot customers of the ERRGP. This has been an iterative exercise where we have gone back and forth between deciding the definite goal of the research project and analyzing the data in light of this. We have divided the analysis part of the project into three steps:

Step 1: Reading the Transcripts

All of the interviews were recorded and later transcribed. The first step in the analysis process was to browse through the transcripts. From personal experience, it is easy to get a different impression of an interview after you read through the transcript. There could have been things you misinterpreted during the interview that you later discovered afterwards. We took a few notes on our impressions during the reading of the transcripts to see if anything stood out. We did this exercise a couple of times. When we had a good overall impression, we began to read the transcripts more thoroughly and take more comprehensive notes.

Step 2: Labeling the Transcripts

The second step in analyzing the interviews was to label the transcripts. We made a rough coding scheme with several different categories based on the primary goals of the interviews and the research project as a whole. We then went over the transcripts and labeled everything relevant with the help of the initial coding scheme. We also labeled words and phrases that did not necessarily fit within the coding scheme, such as often repeated phrases and words, statements that we could directly link to the current Green IS literature, established theories and concepts from other academic fields, and other interesting statements. We then iterated over our coding scheme, grouping many of the initial categories together into a definite coding scheme:

Overall theme	**Description**
Business specifics	Every business is unique, and SMEs are often more so than bigger, more *traditional*

	businesses. They typically cater to very specific needs and often have a unique structure. We highlighted information about geographical location, type of business, industries they operate in, company structure, competition, revenue, turnover, etc.
Use of technology	Technology has become increasingly important for businesses in order to stay ahead of the competition and is often the element that separates the best from the rest. However, our assumption is that SMEs' own experiences with technology differ significantly from those of larger businesses. They sometimes don't have the same rivalry as larger companies, and their potential for saving time and resources with the use of technology is often minuscule due to their size. We highlighted information on the degree of dependency, type of technology, progress, setbacks, developments, and types of work supported by technology.
Environmental strategy	All of the information we gathered from the interviews is connected in one way or another. In that sense, all types of information are somewhat *equally* important. However, it was their various environmental strategies that drew our interest the most. Here we highlighted how they view progress, what makes them

	unique in relation to environmental obstacles, the purpose of their environmental strategy, their goals, the kind of employees who are responsible for their environmental strategies, existing system support, level of emissions, local concerns, global concerns, third-party vendor considerations, level of outside pressure, established standards, importance of reputation, and information sources.

Table 3: Transcript labels.

Our goal with the analysis of the interviews was to detect similarities that they share across industries, sizes, structures, etc. The analysis of the interviews greatly influenced our thesis.

Step 3: Discussions with Solid Software

After we had analyzed the data and grouped it into different categories, we wanted to discuss our findings with Solid Software to get help with our further analysis. We discussed the CSFs for Green IS adoption presented in Sing & Sahu's (2020) literary review. We then presented our findings from the analysis of the interviews in relation to the established CSFs. These discussions helped us put our findings in a practical setting as well as in relation to the current Green IS literature. We wanted to make sure that our interpretation of concepts from the Green IS literature was aligned with Solid Software's ways of understanding the different complexities within Green IS. This was valuable to our analysis, as the CSFs and the Green IS literature are vast. Linking our findings to the literature as well as current practice was an important exercise in the process of analyzing our data.

4.5 Limitations and Delimitations

All of the interviews were done digitally due to time and distance concerns. We had several concerns about doing the interviews digitally. It is easier to understand small social cues and, overall, have a more pleasant experience for all parties involved when conducting interviews in person. However, the pandemic proved that you can still conduct business and research digitally without compromising the business or the research. Some researchers even go as far as recommending other researchers improve themselves by conducting research digitally, as it opens up a wider range of research and often reduces the cost considerably (Lobe et al., 2020).

There are also some drawbacks to using participatory observation. The method is overall more time-consuming in the sense that the nature of observation is discovery. We had no way of knowing in which direction the observation phase would lead us, and it could very well have been a waste of time if it had not led to anything. There is also the matter of bias. As researchers, it's important that we have some level of objectiveness towards the study. This is difficult to achieve, and it has been a well-known issue for qualitative researchers for a long time (Schwartz & Schwartz, 1955). However, the nature of this study is to get close to the issues concerning Green IS adoption in the context of SMEs in order to get a richer and deeper understanding. Our goal is not to generalize a theoretical universe based on our sample size.

The software requirements proposed in this thesis are based primarily on interviews with various Norwegian SMEs and should be viewed in light of this. The SMEs themselves have only had a relatively short period of time to use the software. Some of our findings are based on the software's user experience, which is confined to this time period. We propose our findings as considerations relevant for anyone with the intent of developing software to help SMEs or enterprises in general become more sustainable. They are also proposed in relation to the current literature on Green IS adoption. There has been little research regarding how software can help solve the social complexity within Green IS, and this thesis's focus is mainly aimed at how to handle some of this complexity in relation to software. There are also various other technical attributes that EMIS-software must account for that this thesis does not address.

5. Findings

In this chapter, we present the most prominent challenges and conditions that EMIS-software development projects have to account for in the context of SMEs. We also present the Green IS adoption factors that were identified through our data analysis.

5.1 End User Challenges and Conditions

The SME market is complex, and we revealed several specific challenges and conditions that we deem important in the context of SMEs.

5.1.1 Specific Businesses

One thing that the majority of the pilot customers had in common was specialized expertise. A company that made bespoke steel structures for larger projects was one of the pilot customers we interviewed. They are experts in the field of steel construction. They make all kinds of steel constructions, from stairwells to "feristers" (steel constructions built to keep livestock within a geographical area).

"We have become something of an industry standard. Construction companies frequently hire us to solve complex problems that can be solved with steel construction. Our roots date back more than fifty years, and we have been honing our craft ever since."

– CEO, Steel Constructors

Their products are typically part of larger structures, such as museums, storage buildings, restaurants, and so on. Another company we spoke with is in the same position but in a different industry. They manufacture plastic products, primarily plastic pipes for use in plumbing construction. They may be perceived as even more niche than the steel constructors, as they create small plastic parts that are part of a larger installation, which again is a part of a larger building, for example.

"When you're as specific as we are, it can appear as if we have a sort of monopoly on advanced plastic tools. We do not have any direct competitors in Norway. We are most likely the only ones who make these bespoke products." *– CEO, Plastic Company*

Not every business we spoke with could enjoy this kind of monopoly. We also spoke with a car mechanic business. They repair cars, which is something a number of businesses do. One characteristic they have in common with the plastic company and steel constructors is that they provide a service within a larger line of production. To repair a broken car, you must first repair the bodywork and possibly replace the window or other parts. The mechanics do not make the parts, nor do they work on the body. They fix specific parts of the car in a larger line of the car-repair production line.

One exception to this is the ski center we spoke with. They are on the border between a medium and large company, with around 100 employees. They offer a variety of services to their customers, including downhill skiing and everything that goes with it (lift passes, ski rentals, etc.), hotels, restaurants, and bars, in addition to handling a lot of logistics. They are "specialized" in the business of catering to ski guests, but they consider the "big picture" much more than the other companies we interviewed. Most SMEs share the fact that they cater to very specific societal needs, and an EMIS-software needs to reflect this.

5.1.2 Outsourcing

As most of the businesses we interviewed specialize in a certain field, they are reliant on outsourcing parts of the business that also require a certain level of specialization. As an example, consider the steel constructors:

The Steel Constructors create very specific steel structures. However, their various constructions need to be shipped all over the country. They have decided to outsource this aspect of their operations to specialized logistics firms.

“We collaborate with businesses that are best within the field of logistics. We understand the steel craft, but we are not interested in becoming logistics experts. Specialization in a new field entails a high level of risk and new competitors. We concentrate on what we know best." – Steel Manager

Outsourcing is an important part of any business because companies rarely control the entire production line. We found outsourcing to be prevalent in the businesses we interviewed and that it needs to be accounted for in an EMIS-software.

5.1.3 Technology Dependency

The one thing that all of the pilot customers have in common is that they rely heavily on technology in all aspects of their business. The ski center expressed how technology “changed the way they do business entirely", and the plastic fabricator stated that they are 100 percent reliant on technology. For the construction companies, the plastic and steel constructors, the technology includes large machines for the most part. However, all of the pilot customers we interviewed also expressed a desire for ICT. They all felt that much of the work they have to do is not directly related to what their primary business is, which is becoming a smaller part of their daily work life with each passing year. Everything from electronic employee time stamps to digital payroll systems was covered. We asked each pilot customer to rate their reliance on technology on a scale of 1 to 10. Everyone answered with an 8 or higher, as technology is vital to their competitiveness.

Their experiences with using new technologies varied. For the most part, they all expressed that new technologies have been extremely beneficial to the business. However, there were some who had some negative experiences as well:

"Many years ago, we installed a card reader for our ski lifts. We purchased them from an international supplier who supplied the technology to many of Europe's largest ski resorts at the time. This has been our most significant setback, which we only realized too late. This technology arrived about five years before ICT became the majority of our installed base. We now have a website designed to cater to all of your needs, from booking your bus ticket to selecting your meals for the duration of your stay. It proved extremely difficult to integrate the card-reader system with the ICT we use." – CEO, Ski Center

Despite one of the most used technologies being a somewhat "failure", they have a general positive attitude towards new technology. SMEs often live on thin margins, and any technology that they adopt needs to reflect this by providing value.

5.2 Factors for Adoption

Through the interviews, we identified several factors for the adoption of Green IS'.

5.2.1 Government Incentives and Regulations

The SMEs we talked to all expressed that governmental influence was the leading cause of changes in their businesses related to sustainability. The biggest changes to the businesses we spoke with were often related to government incentives and regulations.

5.2.2 Cost Reduction

Except for the Ski Center which was a lot bigger than the other SMEs we interviewed, they all shared a concern regarding the cost of products. They expressed that they live on thin margins and that they have to do thorough due diligence before spending money on new products. We identified the need to lower the threshold for adopting Green IS by having low product costs relative to value as an important Green IS adoption factor for SMEs.

5.2.3 Interoperability

We asked every SME we spoke with about their perception of and history with technology. They all viewed technology as a vital part of their business. However, they have had some mishaps with technology concerning interoperability. The mechanical workshop we spoke with obtained the majority of their business through insurance companies. This gives the insurance companies heavy influence over how the mechanical workshop conducts business.

"The insurance companies have certain standards when it comes to billing. They impose a certain technology that our installed base does not communicate with, leaving us with an unnecessary amount of manual labor. When it is up to us, we will make sure that the new technology we adopt is interoperable with our installed base."

– CEO, Mechanical Workshop

The Ski Center had a similar story. At the time when they purchased technology for reading ski passes (cards the customer has to buy to get access to the ski lifts), there were only international suppliers. These systems proved to be unable to connect with the new technologies they adopted over time. Of all their experiences with technology, this was the only incident where they deemed it partly a failure. Now they make sure that the new technology they choose to adopt works with their installed base. These findings point to how the interoperability of new technologies is a factor for Green IS adoption.

5.2.4 Data Management

A factor that was identified is the need for reliable data management. The end user needs to be able to trust the system, as EMIS-software has the potential to change large parts of business operations. The data provided needs to be accurate, timely, and private. The risks of company data leakage are significant. The SMEs we interviewed expressed that they operate on thin margins and that such information could be used against them by competitors. Impeccable data management was identified as an important factor to enable the initial EMIS adoption, which the ERRGP provides on a certain level by incorporating DHIS2 as its underlying infrastructure.

5.2.5 External Influence

We asked every business we talked to about their environmental strategy. Their responses differed. Some have a well-established corporate strategy, such as the ski center. They told us about a large environmental program they have developed in collaboration with the local government and other businesses in the area. The Steel Constructors, on the other hand, lacked a clear environmental strategy. However, all agreed on one key external influence on their environmental strategy: external influence. The shift in their business towards sustainability was partly due to outside pressures. The most common influence came from their customers. The businesses we spoke with that are suppliers to larger corporations reported an increase in external influence on their sustainability strategy. Because larger companies are required by law to disclose their CO_2 emissions to the government, they are interested in obtaining environmental data from their suppliers in order to report a more complete picture. They attempt to persuade their suppliers to adopt more environmentally friendly strategies because their suppliers' environmental footprint affects them as well.

"Several years ago, we decided to become a "Miljøfyrtårn" ("Eco-Lightouse"), a certification that businesses can obtain to demonstrate their level of commitment to sustainability. We don't really see the point because it doesn't really help our business in any way, but having these types of certifications is increasingly becoming a requirement for our larger customers. We wouldn't have done this if it hadn't been for the new customer demands, it is a costly certification that does not fit with our business model."

– CEO, Mechanical Workshop

The steel constructors also told us about how their customers demand environmentally friendly products. The nature of steel construction is sustainability, as steel is one hundred percent renewable. You can re-use steel an infinite number of times without compromising the quality of the product (*Norsk Stålforbund*, u.å.). Nonetheless, they also became "Miljøfyrtårn" certified at one point in order to please their customers and attract new ones. They, too, expressed that this type of certification doesn't necessarily fit into the nature of their business, meaning they primarily became certified due to external influence.

"We recently got a new contract because we were able to document our emissions. They had a requirement regarding emission data, and we were the contractor with the most complete documentation." – CEO, Steel Constructor

5.2.6 The Need for Mutual Knowledge

It is somewhat self-explanatory that government incentives and regulations induce certain behaviors. If the government offered to buy a whole car park for a business in order for them to replace their gasoline cars with electric cars, they would certainly accept. And if the government decides that gasoline cars are illegal, businesses are powerless to intervene. They simply must cease driving gasoline-powered vehicles. However, one aspect of government incentives was noticeable for all of the businesses we interviewed: a lack of information for both parties to create appealing incentives and regulations that are appropriate for all businesses.

The first business we spoke with was the ski center. When we asked about government incentives and regulation, they quickly expressed that there was a knowledge gap between how they conduct business, the conditions under which they operate, and how the government and other interest groups try to regulate the business. According to them, most environmental certifications, such as "Miljøfyrtårn," do not always make sense. They have parameters that do not correspond to how they operate. According to the ski center's CEO, the changes they made to become "Miljøfyrtårn" certified did not necessarily make them more sustainable than they were before. It primarily altered how certain aspects of the business are reported. The same is true for the few regulations that SMEs are required to follow, as well as the incentives designed to help businesses become more sustainable.

They frequently did not correspond to the many business cases that different SMEs represent. We identified the need to mitigate the lack of knowledge between government entities and end users as an important factor in accommodating Green IS adoption.

5.2.7 Role of Employee Stewardship

We asked every SME we interviewed if they included all of their employees in their quest for more sustainability. Except for the ski center, there were only one or two people inside the businesses who dealt with sustainability on a regular basis. The managers we talked with felt that their employees did not have the time to deal with certain issues.

"These kinds of issues will be handled by our HR employee. Our guys are out all day working. We are not demanding anything more. " – CEO, Steel Constructor

Several of the businesses we talked to shared this view. It appears that the small margins on which these SMEs operate do not allow for the luxury of engaging every employee in the adoption of Green IS. The need to facilitate employee stewardship seems unnecessary in the context of SMEs.

5.2.8 Leadership

Leadership was identified as a critical success factor for Green IS adoption, especially in the context of SMEs. As presented in the section above, employee stewardship appears to be of little importance for the SMEs we interviewed. It falls on the leadership of these businesses to successfully adopt Green IS.

5.2.9 Social Responsibility

Every business we talked to was part of a larger community. They are often pillars of the community, as they provide jobs for the locals. This also influences how they view sustainability and their commitment to reducing their emissions. The Ski Center, for example, utilizes the surrounding free nature to turn a profit. The CEO expressed how vital it is for them to treat nature with respect.

> "We use the beautiful mountains of Norway, which belong to all of us. It's extremely important that we take good care of them in return. This is expected from us by the public, and it's a social responsibility we take very seriously.". – CEO, Ski Center

The other businesses we talked to shared much of the same sentiment. They often think of sustainability in terms of local effects, as they feel responsible for their local communities. This form of social responsibility was identified as a factor for Green IS adoption.

5.2.10 Internal Motivation

Some of the businesses we talked to expressed that the software's ability to trigger internal competitiveness is an important factor for adoption.

"The software gives us the possibility to document our emissions and see rapid improvements. This triggers an internal competitiveness we have found to be quite important for us to be able to pursue more sustainable business practices".

– CEO, Steel Constructors

5.3 Chapter Summary

In this chapter, we presented our findings from our data collection in **[2]** overall categories: **[1]** End User Challenges and Conditions and **[2]** Factors for Adoption. The qualities that many SME share are important to consider when developing software to support EMIS adoption. In the following chapter, we will discuss the implications of our findings in relation to normative knowledge regarding the use of software to support SMEs in becoming more sustainable and in adopting EMIS.

6. Discussion and Contribution

This thesis's purpose is to investigate an EMIS-software to better understand software's potential in supporting EMIS adoption. In this chapter, we will present ten software requirements for EMIS-software and discuss them in relation to the current established Green IS literature on adoption.

6.1 Software Considerations to Support EMIS Adoption

Our RQ states: **How can EMIS-software be designed to support EMIS adoption by small- and medium-sized businesses?**

We have summarized the software requirements we identified from our findings in the table below. The left column contains the various requirements, while the column on the right provides a short description of the corresponding requirements.

Requirement	Description
[1] Measure Efficiency	The CAPRO-score measures carbon efficiency. By using this measurement, businesses can facilitate economic growth while reducing overall emissions.
[2] Display available government incentives.	Current government incentives are often complex and non-compatible with SME business models. The software must interpret these and provide suitable incentives for the correct end user.
[3] Implement Data Recursiveness	Making environmental data available to the government could result in better

	government incentives, which in turn would generate more and better environmental data.
[4] Implement Employee Surveillance	Implementing employee surveillance can support Employee Stewardship by increasing the employees' awareness regarding the impact of their individual actions and behaviors.
[5] Ensure Accurate and Reliable Data	Organizations could obtain a competitive advantage by having accurate and reliable data as a result of using EMIS-software.
[6] Inform on Laws and Regulations	Providing information about current laws and regulations could be a valuable asset, especially for smaller organizations that do not have their own legal department.
[7] Inform on Ecological Opportunities	Providing organizations with information regarding renewable materials and sources of sustainable energy that could be beneficial to the organization.
[8] Create/use Industry Standards	Ensure a high level of data accuracy and reliability, which allows for transparency and could support the media's role in conveying an organization's commitment to sustainability.
[9] Implement External	Design the software to be compatible with acquiring information from third

Interoperability	party vendors, resulting in more accurate emission data.
[10] Implement Goal Oriented Design	Using a goal-oriented-design model encourages self-motivation by focusing on attainable goals for individual organizations and supports adoption by reducing complexity.

Table 4: Requirements for EMIS-software to support EMIS adoption.

6.1.1 Measure Efficiency

The SMEs we interviewed live on thin margins and are often unwilling to leverage their economic safety to become more sustainable. At the same time, there are few to no regulatory requirements or incentives for SMEs to report on their environmental footprint. As a result, the SME market has few incentives to employ software as a means to adopt Green IS. This necessitates a dual-design of the software, with the software aimed at both increasing revenue and reducing emissions. This could be accomplished by emphasizing carbon-efficiency as a metric rather than total carbon emissions.

6.1.2 Display Available Government Incentives

As explained above, there are few to no government incentives in place to persuade SMEs to become more sustainable. And where they exist, they are often complicated. The few incentives that *do* exist should be presented in the software. The software can interpret the various programs that the government offers and present those that are appropriate for a specific end user. The pilot customers of the ERRGP that we spoke with expressed that they would greatly benefit from such features, as there are rarely employees within these organizations who have the relevant expertise or time available to be aware of these incentives.

6.1.3 Data Recursiveness

In addition to presenting information on government incentives in the software, the software can also be designed to forward environmental data from the software to the respective government entities. The government could then use this information to create better and more tailored incentives, which would again benefit the end users in the long term. The SMEs we talked to have limited experience communicating with the government, but they all expressed a desire to do so. However, the government cannot simply conduct regular interviews with about 600.000 enterprises to gather such information.

6.1.4 Employee Surveillance

The SMEs we spoke with are businesses with a small number of employees that do a lot of work. The employees usually have their hands full with their own tasks, and according to our interview subjects, they feel they can't impose *new and additional* responsibilities on them. In order to make it easy for every employee to participate in the EMIS adoption, the software could implement *Employee Surveillance*. Some of the SMEs we talked to expressed that they have experienced internal competition as a strong motivational factor in the past. This might be achieved by collecting the employees personal emission data in order to compare the variance and induce internal competitiveness.

6.1.5 Accurate and Reliable Data

Our findings pointed to the fact that the SMEs were looking to get a reliable overview of their emissions so they could convey these to the public. In order for the overview to be reliable and trustworthy, it needs to be accurate and transparent. This could be achieved by using well known measurements and reliable databases, such as the ERRGP in using the DHIS2 platform as their underlying infrastructure.

6.1.6 Inform on Laws and Regulations

As mentioned, SMEs live on thin margins and only employ people that the business needs. They usually do not have a legal department or have lawyers on retainer. Usually, the CEO is the one in charge of ensuring that the business meets the different legal requirements and regulations. The CEOs we talked to expressed that they perceive it as a great value if the software could make information about laws and regulations easily available and intelligible, especially as environmental rules and regulations are perceived to be complicated.

6.1.7 Inform on Ecological Opportunities

Cutting costs is immensely valuable to the SMEs we talked to. They are always looking for ways to save on additional expenses. This could be achieved by using alternative forms of materials, or materials sourced from recycled products. One of the SMEs we talked to reduced their costs greatly by switching their water supply some years ago. The other businesses we talked to expressed that the value of EMIS-software would be greatly increased if it could be able to identify new ways to reduce costs in terms of ecological opportunities, such as obtaining materials from other sources than virgin materials (see Chapter 2 - Economical Section), alternative energy sources, and so on.

6.1.8 Create/Use Industry Standards

Sustainability is a complex subject, and there are many different views on *what* to measure, *how* to measure it, and *when* to measure it. EMIS-software should strive towards creating industry standards in order for the data to be applicable, e.g., in a competitive setting where a potential business partner requires insight into environmental data. One of the SMEs we spoke with was able to acquire a valuable new customer because the customer deemed the emission data from the ERRGP to be accurate and credible. We identified the use of and/or creation of industry standards as a software requirement for EMIS-software.

6.1.9 External Interoperability

It is pretty straightforward for businesses to track their own direct emissions, such as power consumed or gasoline used. However, this does not provide a complete overview of the overall emissions the business is fully or partly responsible for. They must also obtain emission data from the companies they do business with. In order to achieve this, the software can be rigged for external interoperability: ensuring that it has the possibility to collect data from multiple external sources.

6.1.10 Goal-Oriented Design

In order to restore the planet's environmental trajectory in the coming years and reach the 1.5 degree Celsius goal in time, significant efforts have to be made. The amount of work required to accomplish this goal can seem futile, leading many people and businesses alike to stop their efforts entirely, claiming it is useless as the task is perceived as insurmountable. The software could address this issue by using a goal-oriented-design. This would involve the software presenting end users with short-term goals that they can realistically achieve. Solid Software coined the term "Goal-Oriented Design" to describe this. This feature was perceived as beneficial and encouraging by the pilot consumers we spoke with, and they saw it as a significant motivator.

6.2 Supporting CSFs for Green IS Adoption

We now turn your attention to how the requirements we identified support established CSFs for Green IS adoption (Sing & Sahu, 2020). We have summarized the relationship between the requirements and the literature in the following table:

CSF Category	Requirement	Description
Economical	**[1]** Measure Efficiency	The CAPRO-score measures carbon efficiency. By using this measurement, businesses can facilitate economic growth while reducing overall emissions.
	[2] Display Available Government Incentives.	Current government incentives are often complex and non-compatible with SME business models. The software must interpret these and provide suitable incentives for the correct end user.
	[3] Implement Data	Making environmental data available to

	Recursiveness.	the government could result in better government incentives, which in turn would generate more and better environmental data.
Organizational	**[4]** Implement Employee Surveillance	Implementing employee surveillance can support Employee Stewardship by increasing the employees' awareness regarding the impact of their individual actions and behaviors.
	[5] Ensure Accurate and Reliable Data	Organizations could obtain a competitive advantage by having accurate and reliable data as a result of using EMIS-software.
Political-Regulatory Forces	**[6]** Inform on Laws and Regulations	Providing information about current laws and regulations could be a valuable asset, especially for smaller organizations that do not have their own legal department.
Ecological Forces	**[7]** Inform on Ecological Opportunities	Providing organizations with information regarding renewable materials and sources of sustainable energy that could be beneficial to the organization.
External Forces	**[5]** Accurate and Reliable Data, and **[8]** Create/Use Industry Standards	Ensuring a high level of data accuracy and reliability based on industry standards, enabling transparency, and supporting the media's role in conveying an organization's commitment to sustainability.

Motivational	**[1]** Measure Efficiency	In addition to supporting economical factors, measuring carbon efficiency also supports motivational factors for Green IS adoption, e.g., by disregarding company size differences.
	[5] Accurate and Realiable Data, and **[8]** Create/Use Industry Standard	EMIS-software can assist organizations in avoiding greenwashing and enhance their legitimacy by offering accurate information on which to act.
	[9] External Interoperability.	Design the software to be compatible with acquiring information from third party vendors, resulting in more accurate emission data.
	[10] Goal-Oriented Design.	Using a goal-oriented-design model encourages self-motivation by focusing on attainable goals for individual organizations and supports adoption by reducing complexity.

Table 5: CSFs for EMIS adoption with corresponding software requirements

6.2.1 Economical

The fact that businesses, and especially SMEs, are hesitant to leverage their economic future to become more sustainable is established as the most important factor for Green IS adoption (Sing & Sahu, 2020) and further substantiated in the field of social economics (Strøm et al., 2021).

The ERRGP was designed around two percentage markers in order to measure efficiency and assure cost reduction. The goal of EMIS-software is for the end users to reduce their overall emissions by a certain percentage while at the same time increasing their profits by a similar, or greater, percentage. This percentage marker is closely related to the CAPRO-score (see Chapter 3, Section 3.3). In order to reduce emissions while simultaneously increasing revenue, the ERRGP focuses on a metric of carbon efficiency, which implies generating more revenue per ton of CO_2 emissions each year. The percentage markers, along with the CAPRO-score were perceived by the pilot customers we interviewed as both achievable and understandable. Measuring Efficiency **[1]** could therefore be considered a software requirement that supports the **Cost Reduction** factor for Green IS adoption.

According to the current Green IS literature, **Government Incentives** are another important factor to ensure Green IS adoption (Sing & Sahu, 2020). The proposed requirement of displaying various available government incentives **[2]** supports the established CSF of **Government Incentives**. The other proposed requirement in this category, Data Recursiveness **[3]**, further supports this factor with the prospect of providing tailored, novel incentives for end users in the long run.

6.2.2 Organizational

Our findings also indicate several organizational factors that our proposed software requirements could support. One of these is **Employee Stewardship**, which refers to how an employee's active participation in new sustainability initiatives influences the adoption of an EMIS. This factor could be supported by implementing Employee Surveillance **[4]** in the software.

The proposed requirement of having Accurate and Reliable Data **[5]** has the potential to support the CSF relating to **Competitive Advantage**. One of the SMEs we spoke with told us how they have recently acquired new clients due to their ability to provide accurate and trustworthy data on their emissions, as made possible by using the software.

6.2.3 Political-Regulatory Forces

The software could also support **Political and Regulatory** CSFs by implementing the requirement of gathering and simplifying Law and Regulatory information **[6]**. The literature on sustainability, across several different research disciplines, is often concerned with how complex the issue of sustainability is. The laws that regulate sustainability are no different. The Green IS literature on adoption highlights the need to reduce this complexity as a CSF for Green IS adoption. EMIS-software could support this factor by simplifying this type of information and making it available to the end-user.

6.2.3 Ecological Forces

Ecological Forces are another CSF for Green IS adoption. The proposed software requirement of making information regarding ecological opportunities available for the end user **[7]** could support this factor. One of the SMEs we spoke with told us how they managed to reduce their energy consumption and water expenditures significantly by switching to another source of water supply. If the software was able to present similar opportunities to its end users it would increase its value significantly, according to the SMEs we spoke to.

6.2.4 External Forces

The literature on Green IS adoption also highlights **External Factors**, such as the media, as critical influences for organizations to adopt Green IS. By having Accurate and Reliable emission data **[5]** based on Industry Standards **[8]**, businesses can ensure that their emission reports are viable and in accordance with the current consensus. It is not sufficient that the emission data is correct if the standards by which it is measured do not satisfy the standards approved by the industry, media, or public opinion. The ERRGP aims to make the CAPRO-score the industry standard for measuring an organization's degree of sustainability.

6.2.5 Motivational factors

The proposed software requirement of Measuring Efficiency **[1]** also has the potential to support certain **Motivational Factors**. By measuring efficiency, every business is able to compete on equal terms. By just measuring total emissions, the larger corporations have a huge advantage. Assume that a small business with 20 employees cuts its overall emissions by 50%. If you solely consider the amount of carbon emissions reduced, this number would pale in comparison to a vastly larger organization that lowered their total emissions by one percent. However, by measuring efficiency, the smaller companies are perceived as potential winners in this scenario. This can motivate SMEs to become more sustainable by removing their size and overall impact from the equation.

EMIS-software could also support the **Legitimacy Factor** for Green IS adoption by mitigating the phenomenon of Greenwashing. The term “Greenwashing” refers to

“[...] misleading marketing or false reporting of a product or an activity as environmentally friendly or sustainable” (Halleraker, 2023). Greenwashing is not always the result of manipulative intent, and with the use of an EMIS-software, businesses could avoid the scenario of misleading their customers and the public by having reliable and accurate data available **[5]** based on industry standards **[8]**.

The External Interoperability **[9]** requirement also supports the CSF relating to **Legitimacy**. As an example, consider Norwegian salmon companies. Some of these companies ship their salmon all the way across the world to have all of the bones removed before shipping it all the way back again. As this part of their operations is not directly connected with the business itself (they are not the ones removing the bones), it is not necessarily accounted for in their overall emissions figures. By also gathering the emission data from the companies they hire to remove the fish bones, they can portray a more truthful picture of the emissions they are responsible for, thus increasing their legitimacy.

The ERRGP has designed the software to focus on achievable long-term goals that end users can strive towards, which they described as a Goal-Oriented-Design Model **[10]**. We identified this as a way for EMIS-software to support the CSF related to **Self-Motivation**. The pilot customers we interviewed expressed that sustainability can be highly complex at times and that having clearly defined goals would reduce this complexity and further motivate them to adopt sustainable business practices.

6.3 Summary

In this chapter, we present ten software requirements that we derived from our findings. The requirements are then summarized in two separate tables. The first contains EMIS-software requirements to support adoption, and the second ties these requirements to the CSF for EMIS adoption. We further discussed them in relation to the Green IS literature and how these requirements support certain CSFs for Green IS adoption.

7. Conclusion

This thesis has explored the potential of EMIS-software to support EMIS adoption in SMEs. Through conducting interviews with selected SMEs, ten software requirements were identified that can support the adoption of sustainable practices in these organizations.

The findings suggest that EMIS-software has the potential to address several barriers to Green IS adoption in SMEs, such as limited resources, a lack of knowledge and awareness, and difficulty related to tracking and reporting on sustainability. EMIS-software can enable SMEs to make informed decisions, improve their environmental performance, and demonstrate their commitment to sustainability.

Overall, this thesis contributes to the growing body of literature on Green IS adoption and provides practical insights for SMEs and software developers on how to leverage technology to support sustainability initiatives. By adopting EMIS-software that meets the identified requirements, SMEs can reduce their environmental footprint and contribute to the transition towards a more sustainable future.

There is extensive research on software in the context of environmental sustainability, but there is limited attention on how software can support the adoption of EMIS. The current literature has focused more on the various properties of the technological components of a Green IS and how they could be leveraged to reduce environmental impact, as well as how to measure and collect environmental data. Our aim is to provide insight into the social-technical complexity that EMIS-software has to account for. There are also several other considerations for developing such software that this thesis does not take into account, such as technical requirements that enable the requirements we propose.

7.1 Further Research Avenues

The findings from our research reveal several research avenues worthy of further exploration. However, there are two we would like to highlight as the most prominent avenues identified: **[1]** Data Recursiveness and **[2]** Goal-Oriented-Design.

7.1.1 Data Recursiveness

Our findings point to the need for EMIS-software to be able to offer environmental data to external entities, such as governments and other interest organizations. Accommodating such information flow has the potential to ensure long-term EMIS adoption, as governmental entities and SMEs can enhance their understanding of each other over time (see Chapter 6, Section 6.2.1). We identified this requirement by speaking with the end-users of the ERRGP, who all suggested that better information and support schemes would greatly benefit them in their quest for more sustainable business practices. This merits further investigation over time, as the value of this requirement can only be determined over an extended period of time. A research prospect like this demands engaged research, e.g., action research, involving two parties: the end users of a particular software and the relevant external entities.

7.1.2 Goal-Oriented Design

The ERRGP is designed to be Goal-Oriented in order to mitigate subjective data input and was identified as a requirement that can support certain motivational factors for EMIS adoption. However, Solid Software - the development team behind the ERRGP, has not yet been able to test this feature over an extended period of time. Motivation is also another important CSF (Sing & Sahu, 2020), especially for SMEs that currently have few incentives to adopt EMIS. By researching this over a longer timeframe, it could be possible to establish a stronger correlation between the design model and motivational factors for adoption.

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