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Abstract

In this thesis I will explore sustainable business ideas and their potential. The research was done to take a look at how university spin-offs can create innovative technologies that can contribute to a more sustainable industry. Two spin-offs associated with the University of Stavanger and Validé were studied by evaluating the ideas and conducting interviews.

In conclusion there are good scientific support for the spin-offs that were studied. There seems to be enthusiasm and support from the industry and Validé. The barriers are mostly related to regulations and technical requirements. As there are stricter environmental considerations there is an increased chance that the products will be more viable in the industry.

Preface

This thesis is written to fulfill the requirements for the Master's thesis at the University of Staavnger (UiS). The research was done to take a look at how university spin-offs can create innovative technologies that can contribute to a more sustainable industry. Two spin-offs associated with the University of Stavanger and Validé were studied by evaluating the ideas and conducting interviews. The research was conducted during the spring semester of 2022, from January to June.

There are several people who contributed to this thesis. First and foremost I would like to thank my university supervisor, Knut Erik Bang who gave me invaluable advice and inspired me through interesting discussions. I would also like to thank my supervisor at Validé, Anne Cathrin Østbø who gave me an insight in how the Validé works with its spin-off companies, and also put me in touch with the necessary people. I would like to thank Espen Lea and Niels van Teeffelen, who are the CEOs of Saferock and Tpyhonix respectively, who set aside their valuable time to contribute to the thesis.

I also want to thank Jeremi Ainos Joseph for proof reading. I also want to thank my family and friends for supporting me during this challenging, but rewarding time spent writing this thesis.

Nitharsan Suntharamoorthy.
Stavanger, 15.06.2022.

Contents

List of Figures

List of Tables

List of Abbreviations

TTO	Technology Transfer Office
IPR	Intellectual Property Rights

1. Introduction

1.1 Motivation for the thesis

In the globalized world we live in today, the ability to innovate does hold a great significance for a company's competitiveness. The ability to find novel solutions and improve existing solutions is important for economic growth. According to the global consulting firm McKinsey & Company, as much as 84% of CEOs believe that innovation is crucial for business growth, and that only 6% of CEOs are content with their innovation performance (McKinsey & Company, n.d.). There are also several Norwegian companies that shares this sentiment. Ingelin Drøppelin, the Division Director for Regional and business development at Innovation Norway, mentions that innovation plays a significant role when it comes to Norway's ability to adapt (Innovasjon Norge, 2021).

Abelia, a business organization of Norwegian knowledge and technology-based firms affiliated with the NHO (Confederation of Norwegian Enterprises), did a survey called Omstillingsbarometeret (Norway's Transformational Capability) to assess Norway's transformational capabilities compared to other countries. This survey concludes that the use of enabling technologies and the subsequent investments in it are in a negative trend. The same negative trend is also true for technology, digitalization and core competency. All these factors can be important for innovation, but there seems to be a negative trend (Abelia, 2021).

Innovation can come from many fronts. In the pursuit of new ways to solving problems, new ideas can show themselves in many places. The research communities in the universities are one of the many places where innovative ideas can take form. Several students and researchers are working on solutions to challenging problems, which can eventually result in new ideas. The innovation at the universities will therefore be interesting to look further into.

Forskningsinstituttenes fellesarena (FFA), which is an association of research institutes associated with both Abelia and The Resarch Council of Norway. The importance of new technology is also stressed as in Abelia (2021). Climate change, the need for transformation in both private and public sector and sustainability are considered the societal issues that need to be addressed (Forskningsinstituttenes fellesarena [FFA], 2021).

There are several challenges that lie ahead. The general public and the Norwegian industry seems to be more and more interested in green technology and sustainable ways to produce and use resources. The research projects at the universities can be beneficial to consider and be of significant assistance when it comes to meeting the challenges that lie ahead for the country. Considering this, it would be of interest to study these research-based spin-offs ideas from the universities and evaluate its benefits and consider the potential impact they can make on the Norwegian industry. When discussing the industry, the petroleum industry and the construction industry are the ones that are considered in the thesis.

1.2 Research statement

In this thesis a case study will be conducted of two university spin-offs from the Norwegian innovation company Validé, which is associated with the University of Stavanger. The spin-offs in question are Saferock and Typhonix. The idea behind spin-offs will be evaluated and its potential for contribution to the industry will be studied. To do this in the most effective way, a research statement along with several research questions have been defined. The research statement is as follows:

Can technology from university spin-offs such as Saferock as Typhonix be implemented in order to help increase the sustainability in the industry?

In order to better answer this research statement, a couple of research questions have been created:

-Is the idea behind the spin-offs valid enough for the industry to consider?

-What are the incentives behind an eventual implementation, and are there any barriers that makes implementation difficult?

1.3 Scope and limitations

The business ideas discussed in this thesis will be related to the Norwegian incubator firm Validé. The ideas will be related to research-based innovation at the University of Stavanger. Most of the spinoffs discussed in this thesis are in the beginner phase, which leads to a limited amount of data on market performance. Therefore, scenario analysis and an evaluation of the idea will be used to estimate its performance at an eventual launch and scaling of the spin-off.

Validé work with many different spin-offs relating to a diverse number of research communities, however in this thesis the focus is on the study of the spin-offs relating to the Norwegian industry. Sustainability will be a focus point. The author does hold an undergraduate degree in engineering. Therefore, it would be of interest to study the spin-offs that have the Norwegian industry as customers.

1.4 Outline of thesis

Chapter 1 – Introduction

Chapter 2 – Literature review

Chapter 3 – Methodology

Chapter 4 – Results

Chapter 5 – Discussion

Chapter 6 - Conclusion

2. Literature Review

2.1 Innovation

2.1.1 Definitions of innovation

This thesis has innovation as its main topic, therefore it's beneficial to understand what innovation is and what it entails. According to the Merriam-Webster dictionary, innovation means "a new idea, method, or device" (Merriam-Webster, n.d., Definition 1) and "the introduction of something new" (Merriam-Webster, n.d., Definition 2). There are different definitions of innovation relating to different subject fields in academia. Although the several definitions, the word is generally associated with novelty as it does in everyday language, and as in the definitions mentioned in the Merriam-Webster dictionary.

Taking a look at the definitions in academia it would be interesting to start with Arthur Schumpeter who is an influential economist who is known for developing theories about entrepreneurship. He mentioned that development, which he called innovation at the time, is the "new combinations" of current resources and other means of production (Schumpeter, 1934/1983, p. 65). He also explained the difference between an invention and an innovation, in which an innovation has the goal to be commercialized and are taken place within the economic sphere, as opposed to be taking place everywhere and not necessarily commercialized like an invention. This interpretation is also supported by Fagerberg (2003). Peter Drucker, a well-known figure in the management community described innovation as a tool for entrepreneurs to use in order to to take advantage of change, wherein lies the opportunity to establish new businesses or provide new services. He described innovation as a discipline, and that entrepreneurs should be able to identify good opportunities and recognize the principles that makes an innovation successful (Drucker, 1985/2006,

p. 19). This definition of innovation further stresses the idea that innovation is not just the invention, but also the ability to take use of lucrative opportunities and be able to commercialize it by establishing businesses and services. There are also more simplistic definitions as mentioned by Thompson (1965) where innovation is defined as: "By innovation is meant the generation, acceptance, and implementation of new ideas, processes, products or services" (Thompson, 1965, p. 2). This definition covers the possible different stages of the development of new products or services.

Baregheh et al. (2009) has attempted to create a common cross-disciplinary definition of innovation based on 60 definitions from literature related to different disciplines. This resulted in a definition of innovation that states: "Innovation is the multi-stage process whereby organizations transform ideas into new/improved products, services or processes, in order to advance, compete and differentiate themselves successfully in their marketplace" (Baregheh et al., 2009, p. 1334). The concept of novelty and the commercialization of an idea is emphasized in this definition as in the previous definitions. The process of doing this is also addressed as the "multi-stage process". Although Baregheh et al. (2009) articulated a general definition of innovation, they also supported the idea that each respective discipline should have their own definitions of innovation too.

Byers et al. (2019) defines innovation as: "Invention that has produced economic or social value in the marketplace" (Byers et al., 2019, p. 34). This definition is related to the Technology discipline, as the book is about technology entrepreneurship. Byers et al. (2019) do also seem to have a more practical approach to innovation, in other words focusing on the practical implementation of an idea. The definition seems to emphasize the economic and social value that an invention has, and the commercialization aspect of the invention.

This thesis has a focus on technology related innovations and the potential it

can have on the industry. The thesis is also more practical in nature, with case studies being done of different spin-offs. Therefore, the definition stated by Byers et al. (2019) is a fitting definition for this thesis. The previous definitions of innovation is although beneficial to have, especially the more general definition stated by Baregheh et al. (2009), as this helps to understand the concept of innovation from different perspectives. Byers et al. (2019) will be a resource that will be used frequently in this thesis regarding the analyses of the spin-offs, therefore their view of innovation is helpful to understand in order to better make sense of the analyses being done.

2.1.2 Types of innovation

There can also be argued that there are different types of innovation to take into consideration as mentioned in Byers et al. (2019). These are incremental innovation, modular innovation, architectural innovation and radical or disruptive innovation (Byers et al., 2019, pp. 34–37). This categorization does have a basis in Henderson and Clark (1990) which argues that considering innovation as either incremental or disruptive can be misleading, and the separate consideration of the components of an innovative product and the way they work together in a system. Henderson and Clark (1990, p. 12) presents a figure that shows the fours different types of innovation and how to differentiate each one by considering the core concept and the components that the innovation is made of.

Incremental innovation

Incremental innovation essentially improves an already existing design, and the improvements are done on the components while the core concept remain the same. You make a distinction between the whole design and how the the components of the innovation is set-up. The set-up is often referred to as the architecture of the innovation (Henderson & Clark, 1990). This can for example

mean a new iPhone, as the technology is from the previous models, but the new model might be equipped with a better camera or might have a better processing speed. This type of innovation relies on the current concepts and designs and tries to find new market shares for specific component or function improvement.

Architectural innovation

If the core design of a product remains the same while the component set-up changes, it is usually called architectural innovation. You need to have knowledge of the components and the overall knowledge of how the components work together in order to make the innovations successful (Henderson & Clark, 1990). Example of an architectural innovation can be if we use the example of the iPhone, it can be an Apple Watch which uses much of the similar components and technology, but it is set up in a different way.

Modular innovation

Modular innovation is when the core concept of the innovation is changed, while the connection between the components remain the same. The innovation is more focused on developing the modules and components (Byers et al., 2019, p. 35). A product going from analog to digital is an example of modular innovation (Henderson & Clark, 1990). This can be for example robot vacuum cleaners, as you are digitizing a product, but you are not really changing the architecture.

Radical innovation

Radical innovation is when the core design and concept is changed, along with how the components are linked together, in other words both the core concept and the architecture (Henderson & Clark, 1990). This type of innovation usually cause a great disruption in established industries and businesses. An example is for example Netflix, which caused a great disruption in traditional video shops (Pratt, 2015).

2.1.3 Innovation and Sustainable development

Sustainability is an equivocal term in the literature as there are many definitions and interpretations of the term (White, 2013). The term sustainable development is also used in similar context, and also similarly have equivocal definitions(Santillo, 2007). Unites Nations Educational, Scientific and Cultural Organization (UNESCO) explains that sustainability is the much broader long term goal, while sustainable development is more of the steps and processes needed to undertake in order to achieve that goal (United Nations Educational, Scientific and Cultural Organization [UNESCO], n.d.). The most common definition of sustainable development comes from the first time the term was presented in 1987 by the World Commission on Environment headed by Gro Harlem Brundtland. Sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development [WCED], 1987, Conclusion section, para. 1).

There are however some disagreements with this definition and the term itself. The concept can be a type of paradox because sustainability is looked upon as something that can be continued on indefinitely, even though development is based on the modifying a finite amount of natural resources. There can be an disconnect between the goal of economic development and the preservation of the environment (Jabareen, 2008). There is another term which is used quite regularly along with sustainability, which addresses the current so called "take, make, waste" economic model on finite resources, which is the term circular economy. Circular economy challenges the current economic economic model by making efficient use of resources and making sure that they are at the highest value and utility throughout their use. This can lead to better management of waste and value creation (SINTEF, n.d.). This can lead to less waste and a more circular economic value as the name implies.

Although there have been criticism of the term sustainable development, the concept of sustainable development is an internationally recognized one. The concept abstains from right-left polarization by having a constructive ambiguous term that can lead to dialogue (Dale & Hill, 2001, p. 3). The term can be considered a reconciliation of three crucial aspects of human activity: ecological, social and economical (Dale & Hill, 2001, p. 161). The integrative approach of taking into consideration economic growth, environmental protection and social development is also deemed to be essential when managing and planning for sustainable development (Jabareen, 2008). The concept of a three-pillar where there is a social, economic and environmental approach to sustainability has become a very popular concept (Prokop et al., 2019). Sustainable development have been further conceptualized into 17 goals by the United Nations (UN) in 2015 as part of the 2030 Agenda for Sustainable Development. The goals are adopted by all the UN Member States. The goals are intended to among many things protect the planet, get rid of poverty and make sure that that it benefits everyone on the planet (United Nations, n.d.).

Goal number 9 of the 17 goals is about advocating for sustainable industrialization, foster innovation and create infrastructures that are resilient. Technological progress and innovation are said to be important in order to tackle the economic and environmental challenges. One of the ways is through an increased efficiency of energy and resources used. This goal can make sure that the economic forces are competitive and dynamic which can secure more income and employment for more people (Nations, n.d.).

This goal is of interest in this thesis as we explore how the university spin-offs at Validé can be viable innovations that can be used in the industry to increase its sustainability.

2.1.4 Research-based innovation

Universities has an important role to play when it comes to different sources of innovation as there are several students and professors at the university who engages in high quality research on important topics (Byers et al., 2019, p. 36). Usually the company that get established as a result of the innovation at the University or at an incubator is called a spin-off. A spin-off or an spin-off unit can be described as an company which is established within a company, before it ventures out for it self. The former company oftentimes has an ownership share of less than 50% of the spin-off (Byers et al., 2019, p. 229). Needless to say, research is not only conducted at a university, therefore in order to specify, research spin-offs connected to university research is called university spin-offs or spin-outs. Research-based spin-off and university spin-off will be used interchangeably in this thesis and also referred to as just spin-offs.

University spin-offs are defined differently in the literature. Smilor et al. (1990) views that a company is a university spin-off when the founder is affiliated with the university in the form of being a student, researcher etc. when establishing the company, or recently left the university to further pursue the idea. It can also mean when the company is based on a technology or a technology-based idea that was developed at the university. The latter part of the definition is also further emphasized by Pirnay et al. (2003) who defines innovation as: "new firms created to exploit commercially some knowledge, technology or research results developed within a university" (Pirnay et al., 2003, p. 356). This definition also emphasizes the commercialization aspect of the technology or the technology-based idea. Both of the spin-offs studied in this thesis will be founded by people associated with the University of Stavanger as researchers, and the idea of the spin-off company is based on research conducted at the university. The spin-offs will also be technology related, mostly technology related to the oil industry and construction industry. Therefore the definitions

discussed above will be fitting for this thesis.

University spin-offs have significantly contributed to strengthening the link between academia and industry. These spin-offs resulting form research at universities have a great impact on economic and social development in a given region (Pattnaik & Pandey, 2014). Throughout the years there seems to be an increased interest in innovation activities at universities. In the US, university spin-offs have been a significant aspect of the economic landscape since the passing of the Bayh-Dole Act in 1980. In Europe there have been increased investments to universities in order to increase the entrepreneurial spin-off activity. Universities in Asia have also adopted policies in favor of university spin-offs and there has been an increase in university spin-offs. University spin-off are growing to be a global phenomenon (Shane, 2004, p. 1). Silicon Valley is the most famous tech hub in the world, where the contribution from Stanford University have been instrumental in its success (Trikha, 2015). In Norway, there are organizations such as The Research Council of Norway do provide financial support for research-based innovation. They have also mentioned that there is a significant interest among companies for this type of innovation (Forskningsrådet, 2021).

Once a researcher at an university has an idea that they want to commercialize, it is several ways to go about it. One of the most common ways to commercialize ideas based on university research is through a Technology Transfer Office.

2.2 Technology Transfer Office

Technology Transfer Office (TTO) is a company who commercializes research. An university usually has their own respective TTO that they are associated with. They assists in helping researcher gain investors, establish a company

and further develop the idea that they have. It is common at Norwegian universities that an invention or an idea by a researcher is considered by a TTO for commercialization potential. Validé is the TTO that is associated with the University of Stavanger, while Invent2 is the TTO that is associated with the Universisty of Oslo. Through their TTOs, Norwegian universities have altogether ownership in up to 526 companies and investment funds since 2011. It is not uncommon that Norwegian universities have an ownership stake in TTOs (Trædal, 2019c). According to Proff, The University of Stavanger has an ownership stake of about 11.953% in Validé (Proff, n.d.-h). It is not all Norwegian universities that have TTOs, and there are several TTOs or similar services associated with private research institutions. It is not necessarily ownership that is the only option for TTOs. Administrator at Inven2, Ole Kristian Hjelstuen mentioned that it is more common to sell licenses than to create spin-off companies. Hjelstuen mentioned however that establishing a company can be an option if the technology can be applied in more than one way. The CEO at Noinnova Asbjørn Lilletun expressed that ownership in a company is only considered for investment cases, rather than having an ownership stake because of the establishment assistance. Lilletun also considers TTO services as being one of many aspects of the company. This view is also shared by the CEO of Validé Anne Cathrin Østebø for Validé. Østebø also mentions that it is better to sell the ownership stakes at an earlier stage instead of holding on, in order for the company to reinvest in other projects (Trædal, 2019c). In addition to having TTOs there are discussions on the determining factors for its success.

According to a US study conducted by Di Gregorio and Shane (2003) during a period for 1994-1998 assessing 116 universities, it was concluded that policies regarding making equity investments in the start-ups, the inventor maintaining a low share of royalties and the intellectual eminence are factors that can increase number of new companies. Another study was conducted in the UK between 2002 and 2013 considering 870 spin-off companies from 81 universi-

ties, where the success it determined by an experienced external entrepreneur associated with the management team and the number of investors in addition to the TTO itself. Another interesting factor that was discovered, is that spin-offs originating in less industrially diversified regions are more likely to survive (Prokop et al., 2019).

In Norway there has been a discussion about how to measure the success of TTOs. The Research Council of Norway among other factors does measure the success by considering income they have collected for their spin-offs in their FORNY program. Østebø has expressed that it can be a challenge to measure by numbers the first years, as it takes time to collect necessary capital in the beginning. Although Østebø also mentiones that it can be difficult to determine the determining factors of success when looking at the capital collected at a later stage. Lilletun from Norinnova shares this view, and suggests that one can look at number of licensedeals made and how many projects turn into spin-off companies. Lilletun however agrees that raised capital is a good factor to consider as it be a kind of quality assurance when it comes to the private investments. Executive director at The Research Council of Norway, Anne Kjersti Fahlvik agrees with the fact that commercialization of research needs to have a long timeframe for development and high risk tolerance (Trædal, 2019c). Looking at developing spin-offs as a long-term endeavour is also expressed by Markman et al. (2005), who mentiones that universities looking for short-term cashflow thorough licensing are less likely to acheive long-term wealth creation though establishing ventures.

2.2.1 Critique of the TTO model

Different countries have different TTO systems. According to Lekve (2019), which is a report published through Simula Research Labratory, which takes a look at the connection between commercialization and high-quality research

by considering seven universities and a research organization in Western Europe. The report critiques the commercialization aspect of Norwegian TTOs, by mentioning that are several weaknesses related to it. One of the weaknesses especially stressed is the view that universities have a leeway to avoid responsibility by "outsourcing" the commercialization aspect. Lekve (2019) also suggests three policy changes for the current TTO model by dismantling the current TTO system, develop strategies for knowledge transfer, creating internal units for commercialization and have a diversified system of commercialization. There are however several people who disagree with this report.

One of the calculations done in the report is by considering the income of the spin-offs, which can be a challenging way to measure its success especially in the early phases as expressed by Østebø, Lilletun and Fahlvik (Trædal, 2019c). The CEO of NTNU Technology transfer, the TTO associated with Norwegian University of Science and Technology (NTNU), Stein Eggan also commented on the report saying that the critique is too simplistic. The TTO is more than just establishing spin-offs, and that the TTOs are just one part of a greater collaborative network. Eggan also mentioned that the need to cultural change that promotes more innovation is already something that has been a discussion in the public sectors, and that it can't be reduced to just changing the TTO model (Trædal, 2019b).

CEO at Inven2 Ole Kristian Hjelstuen also disagrees with Simulas calculations of looking at the income of the spin-offs in relation to the ownership share the TTO has, commenting that it is difficult to measure the value in the beginning and that the measurements needs to be over a larger timeframe as the companies can have great potential. In addition it is also possible to look at the stock value to see that the companies are worth a lot more when considering the stock market and also the market for unlisted exchange and looking at the issue prices. Hjelstuen also mentions that the commercialization aspect is

not properly compared, and that other methods such as benchmarking could have also been used (Trædal, 2019b). Knut Jørgen Egelie who is employeed at NTNU Technology transfer mentioned that the system does not need to dismantled, but it is the organization of the system that is more interesting to take a closer look at. Egelie also mentioned that there are several Europan countries that have the same system as Norway, so the TTO model is not necessarily a Norwegian phenomenon. Also adding on that the flow of knowledge between the society and university in addition to the relationship between the industry, university and TTO that are more interesting factors to consider (Trædal, 2019a).

Egelie is one of the authors of a recent study Egelie et al. (2019), which had a focus on biotechnology projects where 162 contracts between universities and industrial partners were assessed. The relationship between commercialization and the openness around research were some of the aspects studied. One of the conclusions in the study is that it is not necessarily the Intellectual Property (IP) rights themselves that restrict the use of the technology, it is rather the management of the IP rights that play a role. Another conclusion from the article is that openness and access should be a scoring factor when assessing contractual agreements. Àccording to Trædal (2019a), Egelie mentions that the functions of TTOs in the commercialization process is important. Competent TTOs can create more open access to research data and a more competent management of research results and IP rights. This can stimulate more research and better development of technology.

Another point of critique for the current TTO model is mentioned in a study conducted by Holgersson and Aaboen (2019). studying TTOs and the management of IP. The study concluded that there is a overemphasized focus on patenting, licensing of new inventions and creating spin-offs which can be a simplistic approach to IP management. Holgersson and Aaboen (2019) ar-

gues instead of having an output focused approach, the universities can have a more broader strategic approach by finding ways to utilize research results in different ways. The article also argues that there should be ways to consider increasing the total welfare, rather than having a focus on private value. One of the authors Professor Holgersson also mentions in Trædal (2019a) that the research in the private sector considers more actors, diversified methods of IP and contracts and how some inventions can be connected to each other.

In light of the report Lekve (2019) published, several influential members associated with the innovation enviroments at the universities do agree that there are rooms for adjustments in the current TTO model (Trædal & Vartdal, 2019). Pro-rector for Innovation at NTNU Toril Nagelhus Hernes suggests that the TTOs should be more tightly knit to the research communities at the universities, which can lead to increased competency, capacity and also gaining access to information about innovation in the research communities. The University of Oslo also considered the same approach as NTNU as mentioned by Per Morten Sandset who is the Vice-rector for Research and Innovation at the university. Sandset also metnioned that they wish to give more incentives in the way of increasing the ownership share of the researchers. Iselin Nybø, the former Minister of Research and Higher Education seems to have the understanding that there needs to be more incentives and better framework for innovation. Some of the suggestions Nybø has is commercialization leave or commercialization activity as part of the doctorate degree. Another aspect Nybø considers is the culture for innovation at universities and ways to promote it. Nybø stresses the fact that research that leads to commercialization is important for creating a more sustainable society. Former Minister of Trade and Industry Torbjørn Røe Isaksen also expressed that there should be a proper system in place for the company after the initial establishment and commercialization phase, by considering among many other things private investments and TTOs (Trædal & Vartdal, 2019).

There are several ways to improve the TTO model existing currently at the universities. There seems to be an agreement however is that the university spin-offs can contribute to a lot in society if the commercialization process is done correctly. To better understand how the Validé works with the different spin-offs it can be interesting to take a further look at the incubation and acceleration process.

2.2.2 Incubation and acceleration

One of the many services a TTO provide is the incubation services. Incubation can be considered services such as networking, coaching, capital and office spaces which are meant to support the company it its growth and help it become successful (Staff, n.d.). Validé also shares the same view of incubator as they mention that they take in about 50 incubator companies each year and provide them with capital, expertise and networking in an established incubator community. Validé's incubator contracts is up to two to three years (Validé, n.d.-b). O'Gorman et al. (2008) argues that TTOs with a incubation facilities are beficial in breaking down barriers to commercialization. Providers of external resources can get in contact with the researchers which is a great benefit. The external network that the spin-off develop can determine the effectiveness of the incubator.

Another service that a TTO can provide is an accelerator program. Business accelerator is very similar to incubators when considering the services they provide, however they are a short-term program (British Business Bank, n.d.). Validé offers ITSA Start and ITSA Growth as the accelerator programs. ITSA Start is a five intensive program for business development particularly for new companies. While ITSA Growth is more focused on the already establish companies where there is focused on growth during a five month program. Accelerator developed as a new model of incubation which is very knowledge

intensive. It is shown to encourage entrepreneurship (Pauwels et al., 2016).

2.3 Evaluation of business ideas

In order to understand the impact and idea can have it is important to be able to correctly evaluate that said idea. There can be several people that can come up with an idea that might sound inspiring, but the idea needs to be viable and have the possibility of being commercialized. There are several factors to take into consideration when evaluating a business idea.

One of the fundamental aspects of innovation and entrepreneurship is the fit between product and market (Duke University's Fuqua School of Business, n.d.). There is no incentive to invest in or buy products from spin-offs if it does not yield any benefits for the investor or bring the consumers any benefits. There is a five-step process described in Byers et al. (2019) that is mentioned to be followed by most entrepreneurial teams in order to eliminate the ventures they do not believe in and rather invest their time and energy on the ventures that they believe will be successful. This five step-process consists of assessing the capabilities, novelty, resources, return and commitment. The steps that are described by Byers et al. (2019) seem to be supported by literature on business idea evaluation. There is a five-step process described in Byers et al. (2019, p. 41) that is mentioned to be followed by most entrepreneurial teams in order to eliminate the ventures they do not believe in and rather invest their time and energy on the ventures that they believe will be successful. This five step-process consists of assessing the capabilities, novelty, resources, return and commitment. The steps that are described by Byers et al. (2019, p. 41) in Table 2.8 seem to be supported by literature on business idea evaluation.

The precursor to innovation is novelty, the novelty aspect is something that is in the definition of innovation itself, so it follows that a successful innovative

idea is novel. A high novelty aspect of an idea was also considered positive alongside high resource-efficiency and a mild worst-case scenario, when entrepreneurs evaluated opportunities for innovation (Wood & Williams, 2014). A theoretical framework developed by Frederiksen and Knudsen (2017) with a basis in creativity literature and innovation literature, presents novelty alongside usefulness and market potentials as criteria for assessing innovation potential. The novelty evaluation criteria do not consider novelty for its own sake, as the usefulness of an idea is stressed in Frederiksen and Knudsen (2017). Research conduct by Cooper and Kleinschmidt (1993) conveys that one of the most important factors for a new product is that the product is unique and superior to the other product (Cooper & Kleinschmidt, 1993). The same idea is conveyed by Byers et al. (2019, p. 41) by considering the value the idea brings to the customer, if the idea that culminates in an innovative product that is worth paying for.

The novelty step in Byers et al. (2019, p. 41) mentioned the proprietary qualities a product has. One of the ways to ascribe ownership to a product or an idea is through patent. A business idea can be considered an intellectual property, which is the ownership of valuable intangible property (Byers et al., 2019, p. 342). While a patent gives the inventor the rights to bar others from creating, using or selling their invention for a limited time frame. For an invention to be considered for patent, it needs to be both novel and useful. In order to gain a patent on an invention the inventor must go through a process which starts with an application where the product and its functions are described clearly and concisely. A patent does hold the characteristics of a personal property and is recognized as such (Byers et al., 2019, pp. 244-245). It is possible to conclude with this understanding that a patent can give the inventor greater market shares and opportunities for making profits on their invention, in addition to increase their competitive advantage as a result. It is therefore important for inventors to have patents in order to emphasize the novelty of the invention

and secure the opportunity to make money on their invention.

In Norway, Norwegian Industrial Patent Office (NIPO) is the authority on patents in the country. It is a government authority under the responsibility of the Ministry of Trade, Industry and Fisheries (Norwegian Industrial Property Office [NIPO], 2021). PATENTSCOPE (https://www.wipo.int/patentscope/en/) gives access to international patents, applications from the international Patent Corporation Treaty (PCT) applications can be viewed. PATENTSCOPE as is provided by World Intellectal Property Organization (WIPO) (Organization [WIPO], n.d.-a). The PCT has 156 countries that are considered PCT Contracting States, with Norway being one of the countries (World Intellectual Property Organization [WIPO], n.d.-b). WO patents are patents that are issued by WIPO (UpCounsel, n.d.).

In order to research the patents related to the spin-offs, PATENTSCOPE is used as it contains an extensive list and a recognized database known around the world.

In addition to the spin-off being worth paying for from the consumer side, Byers et al. (2019) also describes financial return, which is on the investment/supplier side, as being a step in the evaluation process. In this step the cost of the product is being questioned, if the product can be sold at a cost that can generate profit, and if the return on investment is acceptable considering the risk of the investment. Frederiksen and Knudsen (2017) considers market potential as a criterion for successful innovation, where this criterion is meant to assess the possibility of attracting sales and generating profit. The ability to commercialize and idea, in addition to its novelty are considered pathways to success in innovation literature according to Frederiksen and Knudsen (2017). This can be understood in a way to see if the product will be financially sustainable, which is a question raised in The Duke Entrepreneurship Manual (Duke University's Fuqua School of Business, n.d.). The Duke Entrepreneur-

ship Manual also considers the resources the venture has. This is also its own step in the evaluation process stated in Byers et al. (2019). If the team has the necessary resources, whether financial, physical, human resources etc. that can match with the needs of the venture. Shane and Venkataraman (2000) also discuss that entrepreneurship involves a collaboration where several different resources are combined to create the new innovative product or service. In addition to having the resources necessary, the effective use of the resources is also important for success. This point is stressed further by Wood and Williams (2014) where resource efficiency is considered one of the three aspects that are evaluated to consider an entrepreneurship opportunity. Resource efficiency is described as the optimal use of the resources given, which is important considering that the resources could be used effectively to utilize another business idea if it is indeed a more optimal use of the said resources (Wood & Williams, 2014). In the resource step mentioned by Byers et al. (2019, p. 41) human resources are also mentioned among others.

When considering human resources, the capabilities of the team is often considered. When launching a product in the market, it is given that the team should have the right competence in order to understand the market and its customers. Frederiksen and Knudsen (2017) also mentioned one of the three assessment criteria for an innovative idea to be usefulness, and one aspect of it is if the product meets the need of the target group. Therefore, the team must have the right competence in order to achieve this. The capabilities aspect is considered as an own step in the evaluation process described in Byers et al. (2019). The opportunity being consistent with the capabilities, knowledge and experience of the team members are evaluated in this step. The question of having the right team with the sufficient expertise is also considered in Duke University's Fuqua School of Business (n.d.). The importance of having the right capabilities and experience is further stressed in Shane (2000), where it is suggested that entrepreneurs recognize opportunities rather

than search for them, so prior knowledge and experience is therefore very important for the entrepreneur. Ardichvili et al. (2003) also argues that prior knowledge along with social networks and personality traits are antecedents for an entrepreneur's ability to be alert to opportunities. The importance of social networks is also emphasized by the author Steven Johnson in his book *Where Good Ideas Come From: The Natural History of Innovation*. Johnson argues that innovation thrives in collaborative networks and that it is an important aspect of innovation. In addition to having the right capabilities and team, personality traits and motivations also seem to be of importance. The personality traits aspect which is mentioned in Ardichvili et al. (2003) considers creativity and optimism is important for successful opportunity recognition for entrepreneurs. In an experimental study done by Krueger and Dickson (1994) shows that entrepreneurs with a higher degree of self-efficacy see more opportunities in risky ventures. In Duke University's Fuqua School of Business (n.d.), regarding the question of having the right team, the drive and motivation of the team is also considered. Byers et al. (2019, p. 41) assesses the passion and conviction of the team to take on the venture as its own step, named commitment.

Considering the literature and the arguments that it conveys, the five-step process to evaluate business ideas in Byers et al. (2019, p. 41) does seem to be a reasonable assessment method to use in this thesis. The spin-offs will be assessed according to the five-step model, which will be further expanded, and the spin-offs will be analyzed thoroughly.

3. Methodology

In this chapter the methods used to conduct the research for the thesis will be presented. The justification for the research methodology to solve the research problem will be discussed and the validity and reliability of the research will also be addressed.

3.1 Research approach

The research problem at hand was to discuss how the university spin-offs at Validé could contribute to a sustainable industry. The objective was to see what the necessary conditions were for the spin-offs at hand could compete with the more established products in the industry, and if they could compete at all.

This approach to the problem is more of a methodological approach to solve a specific problem. Therefore the research conducted in this thesis can be considered applied research rather than basic research. Applied research focuses more on using empirical methods to solve a specific problem, while basic research is motivated more by curiosity and seeks to expand on existing knowledge (SourceEssay, n.d.).

The wording of the research problem also indicate that it aims to explore how the spin-offs can be a viable options in the industry and the prerequisites. This indicates that the research will be more exploratory in nature rather than explanatory. Explanatory research does tend to focus more on describing why a certain issue or phenomenon is the way it is, while exploratory research is more about exploring an issue that is unclear and the topic needs to be investigated (Hasa, 2021). Although there is an overall exploratory research for this thesis, there are some issues that will be explained in an explanatory manner to explain the results and how they correlate with the research problem.

This investigative and exploratory approach also indicate that the research ap-

proach suitable for this thesis is the inductive research approach. The inductive research approach is about collecting data and empirical observations, finding connections and patterns and then theorize around it. The deductive approach to research starts off with a theory, creating hypotheses from the theories and then testing them. The inductive approach goes from a focus of being specific to general, while the deductive approach does the opposite as the focus goes from general to specific (DeCarlo, 2019, Chapter 6.3). The inductive approach was adapted in this thesis as the author did not have any prior knowledge about the cases studied and about the literature study. Therefore the topic was further investigated and the results analyzed to find patterns.

3.2 Research methods

The methods used in doing the research will be discussed in this section. The methods consists of literature study and an interview study.

3.2.1 Qualitative and quantitative methods

There are primarily qualitative methods with quantitative study methods used in some instances. Qualitative methods are used to collect and analyze non-numerical data, while quantitative methods are used to collect and analyze numerical data and other measurable data (Hoover, 2021).

Qualitative methods are used to understand the interview analysis, as it is a very fitting method for the semi-structured interview which was conducted (Hoover, 2021). A qualitative method was also used to understand the motivation and passion the CEOs and the employees had for the respective spin-offs. These types of answers can be hard to quantify, and requires a more comprehensive understanding.

Quantitative methods were used to understand the financial information and the numbers related to sales and CO2 taxes, as these are numerical information and statistical results. This method can be used to understand the correlating between different variables.

Both qualitative and quantitative methods are used to understand the data collected and gain an understanding and find correlations in the results.

3.2.1.1 Primary and secondary data

When considering the data and the resources at hand, it is important to know the difference between primary data and secondary data. Primary data is considered to be data gathered directly from the main source by the researcher. Primary data is also known as raw data, collected for the first time by the researcher. This type for data can be gained through methods such as interviews, surveys and tests. While secondary data on the other hand is considered to be data that is already gathered by other researchers. Information that is second-hand. This type of data can be gained through journal articles, books and reports (Anuradha, 2021).

Most of the research done in this thesis consists of secondary data as the topic of innovation and university spin-offs is already an established one with extensive literature. The results was also gained from understanding previous numerical data and statements that are already established. The data was gathered and analyzed to eventually draw conclusions. In the interview analysis however, primary data was used as the interview was conducted by the researcher and the answers given were from the main source/interviewee in real-time during the interview. Certain information may be secondary data reiterated throughout the interview. Apart from the interview method, most of the data in this thesis consists of secondary data that are analyzed in light of the research question.

3.2.2 Literature review

The theoretical basis for this thesis is from extensive literature review of the relevant topics. The sub-chapter of innovation is divided into definitions of innovation, types of innovation, innovation and sustainable development and research-based innovation. It starts off with the definitions of innovations to understand innovation better and what it entails and then the types of innovation is presented in order to better recognize this in the spin-offs presented. Since the topic of this thesis takes into account the topic of sustainability in light of innovation, the term sustainable development and the innovation aspect of it is introduced. Then the research-based innovation topic is presented to better understand this aspect of innovation. The sub-chapter of TTO takes into account the different opinions regarding the TTO model and the incubator and acceleration model is then presented in order to understand the services that the TTOs provides. The last sub-chapter of business idea evaluation explores the different ways to evaluate business ideas and the model to use for this thesis is explored and why this model is suitable is explained through literature review.

In order to access the relevant academic literature, recognized online databases Scopus and Oria was used. Scopus (https://www.scopus.com) is an online database that provides academic literature in the forms of books, journal articles, reports etc. from different publications. If the account on Scopus is verified through the university then it is possible to gain access to a varieties of materials. Oria (https://www.oria.no) is the online databases connected to libraries associated with Norwegian universities. Using the database through University of Stavanger with the student user gains access to a variety of materials. Scopus was used as most of the articles in the database are peer-reviewed, which makes sure that they are of good scientific quality. Oria is used for the same reason as it is possible to see if the material is peer-reviewed as the respec-

tive articles are labeled as such. Most of the materials are also academic literature in order to gain the proper theoretical understanding of the topics. There are however online news sites such as Khrono (https://www.khrono.no) used to understand the different opinions of recognized individuals in academia. Khrono is a online news site for research and higher education published through the university OsloMet, which makes the information regarding opinions from academia more reliable.

The information in the remaining news sites and websites was considered and researched in order to assess the trustworthiness before using the resources. Sources from recognized organizations such as Innovasjon Norge, Enoca and The Research Council of Norway was used. The website related to the spin-offs was used to gain information straight from the company. Proff was also used in order to gain financial information about the spin-offs, as Proff is a recognized Norwegian website for such purposes.

3.2.3 Interview study

Two interviews were conducted with the CEOs of both Saferock and Typhonix. This was done to gain some information and insight that are not stated elsewhere. The interviews was also a way to understand the real-time progress of the company and their opinions and motivations. The interview is not the primary research method used in this thesis, but there are interesting insights to be gained from the CEOs regarding the current market and the way forward for the spin-offs.

There are mainly three types of interview methods used: structured interview, semi-structured interview and unstructured interview. Structured interview follows a set of questions in a specific order. Unstructured interview has topics at hand, but the questions are not predetermined. Semi-structured inter-

view are kind of a meeting ground between the structured and unstructured methods. The topics and questions are prepared before the interview, but the questions can be asked in different ways. The unstructured method increase flexibility of the interview, but there can be a risk that the reliability is not as strong as the structured method. The semi-structured interview method are among the most popular methods (University, 2022).

Semi-structured interview was used as it possible to ask certain follow-up questions and have a type of flexibility around the questions and topics. There was not a lot of information known about the current events and the future projections of the company, therefore a semi-structured interview gives the flexibility to ask follow-up questions previously not written down. The information about the interviewees are given below:

Table 3.1: Information about the interviewees

Name	Company	Role
Niels van Teeffelen	Typhonix	CEO
Espen Lea	Saferock	CEO

Before the interviews were conducted, the CEO of Validé Anne Cathrin Østebø was contacted in order to plan the interviews. An e-mail was sent to Østebø with information about the interview and the preliminary questions. This e-mail was then forwarded to the CEOs of the respective companies, with some information about the interview and the master thesis from Østebø. The CEOs later wrote back and agreed on the interview. The interview was conducted through Microsoft Teams, where a time frame of 45 minutes to one hour was set. The interview e-mail with the preliminary questions can be found in Appendix A below.

The interviews were recorded in order to make it easier to gather information and analyze it afterwards. This was communicated when the interview began,

before the questioning started, and both interviewees consented. The recording was later analyzed and then the relevant information was later written down. The information from the interviews was also paraphrased rather than directly quoted in this thesis as the interviews were conducted in Norwegian. The paraphrases are supposed to get the essence of the answer and close to the original answers given in Norwegian.

3.3 Research quality

When conducting research it is important to make sure that the research is as trustworthy as possible to ensure good quality and follow ethical conduct. Terms such as reliability and validity are often used when assessing the research conducted. Reliability is about the level of which a research method can be done multiples time with consistent results each time. This can indicate the trustworthiness of the sources and the methods used. While validity on the other hand refers to the level of which the research methods solves the problem it is meant to solve (O'Brian & Orn, 2018).

3.3.1 Reliability

In order to make the research as reliable and of as high quality as possible, several measures have been taken. Recognized online databases such as Scopus and Oria were used and peer-reviewed journal articles are prioritized as mentioned in the section above. Peer-reviewed articles ensure good quality of the research. In addition to emphasizing peer-reviewed articles, highly cited articles are also preferred. This can indicate reliability as there are more individuals that agrees with the information and use it in their respective studies. The date of publication was also considered, since research and opinions on a topic can change over time. Relevant search words with search word and the

abstract sections and conclusions sections of articles were examined in order to consider the relevancy. Search term techniques such as Boolean operators and quotation marks for exact searches were used to best utilize the databases. The sources were checked and researched in which they were double-checked with other sources in order to determine the credibility. Well-known organizations were prioritized in order to find the most credible information.

The interview was semi-structured so it can be harder to replicate the interview exactly as conducted the first time. The interviewees were given pre-written questions for preparation before the interview which can increase the predictability for the interviewees so that they can prepare answers. This can increase the reliability of the answers. In addition the interviews were conducted in Norwegian, which can make the answers differ slightly when translated and paraphrased, but care has been taken to get the essence of the answers and paraphrase closely to the the original statements in Norwegian.

Since the spin-offs assessed are relatively new, especially Saferock which was established in 2019, the conclusions drawn in this thesis might change as the years go by and the companies establish themselves more on the market. Several variables such as politics related to CO2 taxes and international trade can influence the industry and the respective spin-offs.

3.3.2 Validity

The validity of the research can be hard to determine as the research question does require a quantitative answer. Therefore research methods and measures to make sure the research is of high quality, can increase the validity as the theoretical background that is used to come to a conclusion that is more correct. Relevant journal articles and information from relevant organizations where emphasized to make sure the material is connected to the research topic.

There are some challenges that came up during the research. Since the Saferock spin-off is in its early stages and have not started producing can be difficult to gain data on industry opinions on the product. Although research papers and lab studies have been used to assess the potential production qualities of the product. The financial information is also not as extensive as the company was established in 2019. The Typhonix company has several products that are out on the market which makes it easier to assess the spin-off. There could be some financial information and certain future projections that could have been added on, but overall the research was done in a way which considers the research problem at hand.

4. Results

In this chapter an idea evaluation will be conducted in order to examine the viability of the spin-offs. An interview will also be conducted to gain insight from the CEOs of the spin-off companies. The interview will be examined it its own subsection, but the information gained from the interview will also be used in the previous subsections.

4.1 Evaluation of Saferock

Saferock AS is a research-based spin-off company established in 2019. The product that the company is based on was invented through research by the researchers Mahmoud Khalifeh and Helge Hodne at the University of Stavanger. Saferock is a type of concrete, where instead of using traditional Portland cement as an ingredient, a geopolymer mixture based on stone from industrial by-products from the mining industry is used (Validé, n.d.-a). The combustion of limestone during the cement production process contributes to a significant part of the CO2 emissions during the entire concrete production process, where cement is the most important ingredient. Saferock avoids this by avoiding limestone, and instead use their geopolymer-based product (Enova, 2022). The conventional concrete today is the ordinary Portland cement, which is estimated to account for about 6-7% of all human-made global carbon emissions (Saferock, n.d.-a). The company aims to increase the speed of the transition to sustainable building materials in the industry (Saferock, n.d.-b). Another problem that Saferock tackles is that the industrial by-products from the mining industry are used instead of being wasted, which can lead to contamination (Validé, n.d.-a). The product solution is manifold and consists of among other things on-site production, decreasing time use and emissions from transport (Saferock, n.d.-c). They started off in the oil industry where they got supported for the research (Validé, n.d.-a). Their technology however is also attractive in the construction industry. Saferock has gotten support from

Enova for the establishment of a pilot plant, to produce concrete based on the Saferock technology (Enova, 2022).

4.1.1 Capabilities

The idea came from PhD studies that researchers Mahmoud Khalifeh and Helge Hodne associated with Department of Energy and Petroleum Engineering at the University of Stavanger were working on. The product is a result of eight years of research (Universitetet i Stavanger [UiS], 2022). There are 21 research articles listed at Saferock (https://www.saferock.no), so the public has access to the research behind the product. The first and earliest article Khalifeh et al. (2014) is peer-reviewed and published in *Cement and Concrete Composites* and shows the potential utilization of a specific type of geopolymer in well-cementing operation. The article has been cited 40 times according to Scopus (https://www.scopus.com). The most recent article is Eid et al. (2021) where the impact of drilling fluid contamination and its effect on rock-based geopolymers is discussed. The article is also peer-reviewed and published in the *SPE Journal* and cited 4 times thus far. There seems to be ample amount of research based on peer-reviewed research articles which solidifies the product that comes from the research. The scientific articles listed are open access, which also signifies the transparency of the company in addition to signaling that the research is of quality by the fact that it can be assessed by everyone.

The team at Saferock excluding the founders consists of twelve people. The CEO is Espen Lea, the CFO is Morten Kompen and the CCO is Stian Alessandro Ekkernes Rossi. There are three senior advisors, where one senior advisor has specialised in Quality Assurance and another senior advisor has specialised in Concrete Technology. There are three research scientists and one research assistant. One of the research scientists is also a Postdoc. There are also HR Business Partner and a R&D Manager on the team. This overview can

be seen at their website Saferock https://www.saferock.no.

The CEO Espen Lea has experience in the petroleum industry, where he has worked for one of the world's biggest oil field services companies. The senior advisor Arild Saasen, who is also a Professor at the University of Stavanger, does likewise have industry experience (Validé, n.d.-e). Espen Lea is also Chairman of the Board at Well Intercept AS, and also CEO and Chairman of the Board at Geopolymer Holding AS in addition to his role as CEO at Saferock (Proff, n.d.-a). This signifies the leadership experience of the CEO in addition to his experience in the petroleum industry.

Considering the experience of the team members, in addition to the many years of research behind the concept of the product, the team seems to have the right capabilities, knowledge and experience.

4.1.2 Novelty

There is a great need for concrete to begin with, considering that concrete is the most frequently used substance on the earth, second only to water (Watts, 2019). The cement's role during the concrete making process does contribute to the majority of concrete's carbon footprint. The concrete industry makes up 8% of global emissions (Ramsden, 2020). Considering this, there is a great need for sustainable concrete as this can reduce the global CO2 emissions and make way for a more sustainable industry. There is great importance put on sustainability and for companies to be more environmentally friendly, so green technology and sustainability is something that can be of interest, as mentioned in the introduction of this thesis. There can be financial incentives to reduce CO2 emissions such as carbon pricing, which is getting more and more recognition. The carbon prices under the EU Emissions Trading System (EU ETS) have been continuously increasing since 2016 (S&P Global, 2020).

Geopolymer-based solutions such as Saferock is something that has been discussed among scientists and companies alike. Scientific review articles such as Amran et al. (2020) and Singh et al. (2015) which discuss the recent developments in the field. There are also several geopolymer-based products for cement and concrete that are out on the market already. It is a relatiely new technology. At the moment the competitors of Saferock seems to be established cement companies such as Norcem.

4.1.2.1 Patent

The search has been done in PATENTSCOPE by typing in the names of the researchers Mahmoud Khalifeh and Helge Hodne under the search field for name. The search has three patents under PATENTSCOPE. The earliest patent Khalifeh and Hodne (2016b) was published 01st of June 2016, while the next recent patent Khalifeh and Hodne (2016a) was published 3rd of March 2016 while the most recent patentKhalifeh and Hodne (2021) was published 10th of June 2021. The published date is assumed to be the date the patent is granted and recognized. The three patents mentioned and the information related to them is listed in Table 4.1 below. It seems like Saferock does have an ambition to reach out to the international market eventually, but for now the only patents available are filed WO and not filed in patent offices in other countries. Since the company is relatively new, it can mean that they are primarily focused on the Norewgian market, which was was also mentioned by the CEO Espen Lea (Validé, n.d.-e).

Table 4.1: PATENTSCOPE patents for Saferock

Name of patent	Applicant(s)	Inventor(s)	Patent number	Publication Date
METHOD OF MINERALIZATION OF CO2 IN INORGANIC POLYMERS (GEOPOLYMERS)	The University of Stavanger	Mahmoud Khalifeh and Helge Hodne	WO2021110571	10.06.2021
APLITE BASED, CEMENTITIOUS GEOPOLYMERIC MATERIAL	Mahmoud Khalifeh	Mahmoud Khalifeh and Helge Hodne	WO2016032341	03.03.2016
NORITE-BASED CEMENTITIOUS GEOPOLYMERIC MATERIAL	Mahmoud Khalifeh	Mahmoud Khalifeh and Helge Hodne	WO2016003289	07.01.2016

4.1.3 Resources

Financial resources

Saferock has gained financial support from several fronts. The oil industry has given their support since 2012 for the research and development of the product according to the CEO Espen Lea (Validé, n.d.-e). Validé have invested in the company, and Validé Technology Transfer Office has taken part in the patent and commercialization process. They have an incubator deal with the company. Saferock is also part of the ITSA Growth program under Validé which helps inventors in the growth phase. Programme for Regional R&D and Innovation (VRI) has given funds to research the product requirements for approval (Validé, n.d.-a). VRI is an initiative from the Research Council of Norway which aims towards regional research and innovation in Norway (The Research Council of Norway, 2007). Regional Research Fund (RRF) have also funded Saferock's cooperation with the mining company Titania, this co-operation will allow Saferock to do preliminary tests for product approval. The architecture firm Snøhetta has a contract with Saferock regarding a pilot project (Validé, n.d.-e). Saferock has also gained 11,5 billion NOK in support from Enova for their pilot plant (Enova, 2022). Their pilot plant will be made in cooperation with the concrete producing company Velde. Lysefjorden Investering AS are also working with Saferock, as they are planning on using the concrete made from the pilot plant on their own projects. In order to build the pilot plant as planned the private equity requirement for Saferock is to acquire about 20 billion NOK altogether (Stensland, 2022).

Physical resources

Saferock have the opportunity to take use of the labs at the University of Stavanger as they are associated with the university, and also take use of the office spaces available at either the university or Validé. Their headquarters are in Sola municipality in Rogaland, while their office is in Oslo as mentioned on

their website Saferock (https://www.saferock.no). As stated in the financial resource section above, Saferock has gotten plenty of support from their business partners. The mining company Titania provides them with the raw materials needed for production, while the concrete making company Velde will help them create the pilot plant factory for the concrete production process. Their collaborations are beneficial with regards to their pursuits, as their spin-off is heavily focused on the industry.

Human resources

Saferock is a research-based spin-off, so the team have great academic understanding of the product. As mentioned in the Capabilities section, the CEO Espen Lea has experience from the Petroleum industry and do hold leadership positions in several companies and the senior advisor Arild Saasen is a Professor at the University of Stavanger. The product is based on peer-reviewed scientific studies and the team has experience from the university working in the scientific field relating to the product. Therefore, the team seems to have the right competence and experience for this spin-off.

4.1.4 Return

In addition to the financial capital gained as mentioned under the financial resources section above, the company have a record of their financial gain throughout the years. According to Proff (n.d.-c), their operating revenue is 38 000 NOK in 2020, while their earnings before income taxes is set to be -750 000 NOK. The liquidity ratio is said to be very good with a value of 5,61. The profitability is not satisfactory with a vale of -29.1%. The solidity however is good where a value of 37.1% is ascribed. Their total assets rose from 132 000 NOK in 2019 to 4.940 million NOK in 2020.

The liquidity ratio describes the ability of a company to pay off the debt that

they hold currently, without the need to collect capital from external sources. The assets of the company are easily convertible to cash (Hayes, 2021a). Saferock's liquidity level is good so they have a good ability to pay offs short-term debt and their assets can be converted to cash easily. In this way Saferock is trustworthy regarding paying off short-term debts and the day-to-day financial obligations that might show up.

The profitability calculation on proff.no is based on Return on Assets (ROA) calculation (Proff, n.d.-d). Return of Assets value gives an idea how the company generates revenue from the assets, the net income over the assets in total gives the Return of Assets value (Hayes, 2021b). It can indicate the ability of a company to make profits from the assets that they hold. Saferock does hold a negative value in this aspect. This can be because the spin-off is relatively new without a pilot plant in action yet. Therefore, it can be difficult to determine the profitability with the numbers from 2020. The pilot plant was planned in 2021.

Solidity is regarded by Proff (n.d.-d) as the equity ratio, where the total equity over total equity and debt. This value describes how much of the assets that consists of equity, financed by the company alone. Saferock seems to have a positive value where 37.1% of the assets come from equity. The solidity can give an idea on how well a company can handle certain financial losses such as that might come their way (Debet Regnskap Ordbok, n.d.). Since Saferock has a good solidity, they might be better at handling unanticipated expenditures and financial losses than companies with a lower solidity score.

The ability to make a profit is also a central part of this step in Byers et al. (2019) five-step assessment process. However, since the spin-off is relatively new with no production at the moment this can be difficult to determine. Therefore, a scenario analysis will be conducted in order to determine the economic viability of the spin-off and to determine the ability for Saferock to obtain profits.

4.1.5 Commitment

In terms of motivation and passion for the spin-off, the CEO Espen Lea seems to be positive as he mentioned that Saferock has great potential considering the market growth for sustainable building materials (Enova, 2022). Investor and board member in Saferock Jostein Tysse mentioned that the need for capturing CO2 would be greatly reduced, as the production of the cement would is almost emission-free (Validé, n.d.-f). The inventor Mahmoud Khalifeh seems to be optimistic about the product as he mentioned that we can still keep building, while the planet is taken care of (UiS, 2022). There seems to be motivation and passion about the spin-off considering the interviews and opinions expressed in the news articles about the Saferock. Therefore, it is safe to assume that there is great motivation and passion behind the idea.

4.2 Interview with the CEO of Saferock

An interview was conducted with the CEO of Saferock, Espen Lea, in order to understand the current status and the future prospects of the spin-off and to gather information and opinions about what it must take to be a good sustainable alternative to the current established products. The preliminary information and questions sent to the CEO can be found in Appendix A. The analysis of the interview will be done in a seperate subchapter. The following subsections present the information from the interview.

4.2.1 Interview answers

4.2.1.1 The spin-off and the market

Lea mentioned that the they are currently focusing on the production of cement, and their cement have been tested in the context of oil wells. The use of geopolymer cement for oil well purposes is just as viable as using traditional Portland cement. More research is to be done on use of this concrete for constructional purposes. The spin-off considers moving on to the construction industry, and are planning on producing concrete with the geopolymer cement. The technology is licensed to the University of Stavanger, which works on the geopolymer cement in petroleum industry application. While the comapny aims to use the cement for concrete applications. The production of concrete has not started, and they are on their way to getting funds for building a pilot plant for concrete production. The pilot plant needs to be off and running before tests and statements about geopolymer concrete can be made. Their current competitors are established cement companies, such as Norcem. The difference between traditional cement in application is that the geopolymer cement requires an activator, which is already a shelf product. Traditional cement products are mixed with water. It is not the case that an increased quantity of the geopolymer cement is required to do the same job.

The product is not out on the market yet. Lea mentions that they can compete on price considering that the price for traditional cement has increased in the last 12 months. In the labs, lower scales are used such as gram which is more expensive. The units costs can decrease if the production is scaled. The product does have multiple purposes as there can be other applications and markets of concrete apart from the structural use, such as concrete for fillings. Lea also mentions that there are several companies that are interested in the technology.

4.2.1.2 Barriers and challenges

Lea mentions that the regulatory requirements and the technical specifications can be a barrier. There needs to be production at a greater scale in order to work with these barriers. The current standards are standards associated to specific products such as Portland cement, which excludes their cement at the moment. The regulatory and technical requirement aspect is the greatest barrier at the moment.

Lea also mentioned another small barrier which is additives to the concrete when using geopolymer cement, as the same one used for traditional concrete cannot be used. Lea considers this a small barrier as the product needs to develop and the additives will be developed after a while, as it needs a systematic approach and the company needs to consider which applications it needs to focus on first and then expand the application of the product.

4.2.1.3 Incentives for implementation

The technology utilized almost exclusively industrial byproducts. Byproducts that can for example end up in landfills. The production of this type of concrete is much sustainable than traditional concrete. It is also estimated that the price for the product is competitive.

The CO2 fees are increasing for every year, and the technology is an alternative as the product releases less CO2 than the current products.

4.2.1.4 Future prospects

Lea expresses that there is no problem related to the demand of the product, as there are several companies that are interested. Once the regulatory requirements and technical specifications are met the production can start at a great

scale.

4.2.2 Analysis of answers

The information gained from the interview shows that the CEO Espen Lea seems optimistic about the spin-off. The technology seem to have many uses, in which a systematic approach is taken to get through barriers related to regulation and technical requirements. The scientific viability of the product at the current stage are shown through research which were discussed in the section 4.1.1 of this chapter. The production of concrete has not started yet, so there are limited information to gain on that aspect. The regulatory and technical requirements seems to be the greatest barrier for the spin-off at the moment. The price of CO2 emissions have greatly increased in the last few years. Norway has since 2008 been part of EUs quotasystem for CO2 (EU ETS), and since December 2020 the price of CO2 emissions have increasingly hit new price records (Øvrebø, 2022). If the CO2 prices continues to increase and the requirement for commercialisation for Saferock is accepted, it could lead to Saferock products being more in demand for companies in the industry.

4.3 Evaluation of Typhonix

Typhonix AS is a research-based spin-off company established by Trygve Husveg in 2006 with the help of Validé (then known as Prekubator). The idea and the technology behind the company stems from Husveg's PhD dissertation. The technology is called "Typhoon Valve System", which is a low-shear valve system that are going to reduce the shear forces and turbulence in oil wells during production. Mainly solving the issues during the separation process and transportation process. High water producing oil wells are said to last longer with the technology, and a 20-30% reduction in new facilities needing to be built.

Their product is an alternative for the production equipment used today, and they are claiming the technology will lead to a cleaner and more cost-effective production. Since 2011, they have also developed other products in addition to the low-shear ventilation system, namely low shear centrifugal pumps and multi-phase sampling equipment (Validé, n.d.-c).

4.3.1 Capabilities

The doctoral disputation was done at the University of Stavanger in 2007, and Husveg studied topics such as hydro cyclones over the last four years of his studies (Lea, 2007). Husveg has authored several scientific articles, including Husveg et al. (2007) which is a peer-reviewed article titled *Performance of a deoiling hydrocyclone during variable flow rates*. The article is published in *Minerals Engineering*. The article discuss hydrocyclones, and how it can separate oil and water in the acceleration field of the hydrocyclone. Laboratory experiments done are also discussed. Husveg's most recent article Husveg et al. (2022) published in *SPE Production and Operations* presents experiments surveyed by an independent third party regarding low-shear valve installations. Another recent article Husveg et al. (2020) published in *SPE Journal* presents new valve technology to combat polymer degradation. Both of the articles are peer-reviewed as they are both available in Scopus. This ensures that the science and research behind the technology is peer-reviewed and valid in terms of scientific quality. The articles mentioned are also authored by people who are employed in Typhonix.

Rune Husveg who is one of the authors of both Husveg et al. (2022) and Husveg et al. (2020) was hired as a Researcher for Typhonix in 2015 (Typhonix, 2015b). He had a disputation for his doctorate degree *Tracking Maximum Produced Water Treatment Efficiency Using a Variable Speed Coalescing Centrifugal Pump* at the University of Agder in 2019. The topic of the PhD is closely

tied to the work Typhonix does, and they did collaborate with him as his PhD is an industrial PhD (Universitetet i Agder [UiA], n.d.).

Mari Stokka who is one of the authors of Husveg et al. (2020) is working as a project manager at Typhonix (Typhonix, n.d.-b). Stokka has also written a Master's thesis titled *Improvement in polymer water flooding efficiency using a low shear choke valve* at the University of Stavanger. The topic is closely related to the work of Typhonix, and the thesis was done in collaboration with Typhonix and Trygve Husveg was the external supervisor (Stokka, 2013).

The CEO of the company is Niels Cornelis Martinus Van Teeffelen (Proff, n.d.-f). Van Teeffelen is also one of the authors of Husveg et al. (2022). In addition to being the CEO of both Typhonix Pumps AS, Typhoon Valves AS and Nvt Invest AS where he is also the Chairman of the Board (Proff, n.d.-b). Typhonix Pumps AS and Typhoon Valves AS is related Typhonix AS considering they share the same adress as Typhonix AS, when accessing their respective sites on Proff. Typhonix Pumps AS and Typhoon Valves AS are the subsidiary companies of Typhonix AS (Proff, n.d.-e). Van Teeffelen got hired as an engineer manager in 2014. He has broad extensive experience in the oil industry regarding process technology. He holds an MsC in Mechanical Engieering. He has worked for several companies including Equinor (then known as Statoil) where he worked with among many other things offshore produced water treatment. The CEO of the company at that time was Ole Jørgen Engelsvoll (Typhonix, 2014). The former CEO Engelsvoll spent over ten years at Ullandhaug in the technology development environment. He was also the CEO of Typhonix over ten years and holds a master's degree in ecenomics and international marketing (Validé, n.d.-d). The Chairman of the Board of Typhonix is Stig Hognestad (Proff, n.d.-e).

It seems like the employees presented has experience relating to the field, while the CEO has work experience added on to the theoretical knowledge. The

former CEO had a more business related experience, and has the experience dealing with development of technology. The current CEO has more experience relating to the oil industry itself. This competence could be invaluable in the establishing stages of the company. Rune Husveg and Mari Stokka has both worked with theses relating to the topic that Typhonix works with and are employed by Typhonix currently. Considering the peer-reviewed scientific papers by Trgve Husveg, and the papers in which employees and the CEO has contributed, it seems like the company is based on thorough research and good competence. The CEO has extensive experience in the industry. Considering it all, it seems like the capabilities of the team and the company is adequate to take on the venture.

4.3.2 Novelty

There are several indicators that express the fact that Typhonix's technology is something that is unique and needed. Norway is a pioneering country when it comes to oil production as they are a significant supplier of oil to the global market. Oil has also played a great role in developing the modern Norway. There is a non-profit foundation called ONS, which is a gathering place for international companies and people in the energy community. The foundation has developed an international network of people not just from the industry, but also from several research institutions, academia and authorities. They collaborate with well-known companies to arrange global events and network meetings. They also put importance on innovation, integrity and forward-thinking (The ONS Foundation, n.d.). In 2018 they had a conference in Stavanger, and Typhonix won the *ONS Innovation Award 2018* for small and medium-sized enterprises (SMEs). (Validé, n.d.-g). This conveys that ONS regards the spin-off as important, and that there is a novelty aspect related to the spin-off.

Typhonix deals with the problem of emulsion during production, which is a demanding issue when it comes to oil production (Abdulredha et al., 2020; Kokal, 2005). The produced water (water mixed with inorganic and organic materials) discharged in the ocean after treatment causes negative environmental effects. It is one of the largest source of pollution from the oil and gas industry (Fakhru'l-Razi et al., 2009). Therefore the issue dealing with reducing produced water and the waste caused by oil production is a relevant issue, so there will be interested industry customers to look more into the solutions.

4.3.2.1 Patent

The search has been done in PATENTSCOPE by typing in the name of the company Typhonix AS as front page search option first, and then the name of the researcher Trygve Husveg was also searched using the names option. It seems like most of the patents searches then are connected to Typhonix, therefore the Typhonix AS search is used. The search leads to an extensive list of about 49 patents (WIPO, n.d.-c). This can be because the company is established much earlier than Saferock and the field of industry requires more extensive patents in order to create the products. It is also worth to notice when observing the results WIPO (n.d.-c) that not all the patents are WO patents, patents issued through WIPO. Several patents are issued by other countries in their respective patent offices. Considering this, instead of listing the extensive list of patents, the three most recent patents that are WO patents are presented. The most recent WO patent Jouenne and Husveg (2017) was published 22nd of June 2017, while the next to recent patent ´Husveg (2016) was published 24.11.2016 and the third oldest WO patent Husveg (2014) was published 06.11.2014. The patents with the relevant information is given in Table 4.2 below.

It seems like Saferock does have an ambition to reach out to the international market considering the patents issued in other countries including the WO

patents. This can also be because they have been established for a while with products already out on the market.

Table 4.2: Recent PATENTSCOPE WO patents for Typhonix

Name of patent	Applicant(s)	Inventor(s)	Patent number	Publication date
POLYMER FLOW CONTROL DEVICE	Typhonix AS and Total A.S.	Stéphane Jouenne and Trygve Husveg	WO2017105250	22.06.2017
CHOKE VALVE SEPARATOR	Typhonix AS	Trygve Husveg	WO2016186511	24.11.2016
FLOW AND FLUID CONDITIONING PRESSURE REDUCING VALVE OR DEVICE	Typhonix AS	Trygve Husveg	WO2014178723	06.11.2014

4.3.3 Resources

Financial Resources

Typhonix has gained the necessary financial support in different ways. The Research Council of Norway has granted Typhonix financial support of 4.8 million NOK as one of the 46 companies that gained financial support for their research-based innovation (The Research Council of Norway, 2021). Typhonix has also gained financial support from The Research Council of Norway on earlier occations, such as when they got funded 9.6 million NOK for their *Choke-Seperator* for their ChokeSeperator technology (Typhonix, 2015a). Typhonix have been awarded funds through the PETROMAKS program of The Research Council of Norway (Typhonix, 2013). Later they have also been funded through the PETROMAKS 2 program (Typhonix, 2016). There are also several companies apart from The Research Council of Norway that have partnered up with Typhonix with regards to projects. Such as the project for developing a low shear process pump for water application where companies such as ENI Norge AS and ConocoPhilips were a part of (Typhonix, 2011). Total E&P Norge AS was also apart of a Typhoon Valve pilot project, along with companies such as Equinor, ENI, Shell and ConocoPhillips, Mokveld BV (Typhonix, 2010). Typhonix's partners are companies such as Equinor, TotalEnergies, Shell, OMV, Vår Energi, Neptune Energy, ConocoPhillips and The Research Council of Norway (Typhonix, n.d.-a).

Then you also have the siginificant help from Validé as an incubator in establishing the company. Validé is still one of the many shareholders in the company holding a share of 27.878% of the company. Other shareholders are Færing AS with 37.063%, Moltedalen AS with 23.392%, STS Technolohy Transfer AS with 10.099% and other shareholders having a 12.567% share (Proff, n.d.-e).

Physical resources

Typhonix have office facilities in Bryne, with their visiting address mentioned on their website. They also have their own laboratory facilities called the Typhonix Test Centre which was opened in 2010. They have several test rigs at their facilities such as produced water test rig, emulsion test rig and polymer test rig. The facilities are equipped with several different flow loops and other instruments required for the different tests they conduct. This gives the impression that the spin-off has the right resources in order to implement and test their ideas (Typhonix, n.d.-c).

In addition to their own laboratory facilities, Typhonix also collaborates closely with Mokveld for their production. The Low shear Typhoon Valve System is produced in collaboration with Mokveld (Mokveld, n.d.). In addition to this Typhonix have collaborated with several other companies on their project, which means that they probably have had access to their respective physical resources too when necessary during the project.

Human resources

The team seems to be academically inclined as they are a research-based spin-off with several employees having a background in academia. The CEO has worked in the oil industry for several years as mentioned. This competency is invaluable when working with product related to the oil industry. The science behind the technology is based off of a disputed doctorate degree and peer-reviewed scientific articles. Considering all this, the team seem to have the right experience and theoretical knowledge matching with the spin-off. Several other companies have also collaborated with Typhonix on projects, so their many years of competence and experience have been available to them too. These are important factors that contribute to the success of the spin-off.

4.3.4 Return

In addition to considering the financial resources of the company, it can be beneficial to look into additional financial information. Their operational revenue for 2020 was 7 565 000 NOK, while their earnings before income taxes was -1 211 000 NOK. Their liquidity ratio is described as very good with a score of 2.41. Their probability ratio is described as not satisfactory with an assigned value of -6.5%, their solidity ratio however is described to be very good with a value of 55.9%. Their total assets had a decrease from 16 748 000 NOK to 9 490 000 NOK, from 2019 to 2020. Their total assets had an increase however from 8 875 000 NOK to 16 748 000 NOK from 2018 to 2019 (Proff, n.d.-f).

The liquidity level is stated as very good, which means that they can pay off short-term debt and they have assets that can be converted to cash in an easy manner. This can leave a good impression on future investors, as the company has a good ability to pay off short-term debt and take care of the day-to-day financial obligations.

The profitability level is not satisfactory. It is calculated as Return on Assets (ROA) as done with Saferock (Proff, n.d.-g). This can be interpreted as the company not being able to generate revenue from their assets as a satisfactory level. This can be because they have major investments.

The solidity is calculated as the same for Saferock. It is the total equity over the total equity and debt (Proff, n.d.-g). Typhonix has a value characterized as very good. It seems like that about 55.9% of the company's assets are financed by equity. This can be understood as that the company has the ability to handle unanticipated expenditures and financial losses.

The company's ability to make a profit is important aspect of this sub step as mentioned in Byers et al. (2019). The technology is relatively new with

products out on the market. The ability to make a profit and the economic viability will be further considered in the scenario analysis.

4.3.5 Commitment

The motivation and passion for this spin-off can be seen expressed by Rune Husveg, who finds it exiting to work on the water and oil separation process (Eikeland, 2019). Typhonix has also expressed gratitude for companies and organizations such as Validé and The Research Council of Norway for believing in them (Validé, n.d.-c).

4.4 Interview with the CEO of Typhonix

An interview was conducted with the CEO of Typhonix, Niels van Teeffelen, in order to understand the current status and the future prospects of the spin-off and to gather information and opinions about what it must take to be a good sustainable alternative to the current established products in the petroleum industry. The preliminary information and questions sent to the CEO can be found in Appendix A. The analysis of the interview will be done in a seperate subchapter. The following subsections present the information from the interview.

4.4.1 Interview answers

4.4.1.1 The spin-off and the market

Teeffelen mentioned that there are no direct competitors when it comes to the valve technology. The low shear centrifugal pumps do have competitors, such as the positive displacement pump. Typhonix offers better robustness which can lead to longer lifetime of the product. Both the valve and pump technology

do clean the produced water of oil contents better than conventional products.

When considering the valves, Teeffelen estimates that Mokveld, the producers of the valves, operates at a price about 1.6-1.8 times the market price for the current products. There are although specialized valves used for operations and competitors that have specialized valves also have an increased price compared to standard valves. The benefits of the valves comes to the results they give in the cleaning process. Results have shown that using the valve technology only two steps of cleaning are needed compared to three when using conventional valves. Teeffelen mentioned that in two projects, their technology have been preferred, rather than adding on a third cleaning step. If there are challenges in an existing reservoirs it can be easier to change a valve than implementing other measures. There can be new production methods that can cut costs in the future. 3D printing are currently used on some of the components, if there is a possibility to increase the use of such technology, which can reduce costs and delivery time for both valves and pumps. Their technology can also deal with bottlenecks and increase the oil water separation process, which in turn can increase the capacity. Reduction in the use of chemicals is also a benefit.

Teeffelen also shares the opinion that the production of the technology is economically viable for the company in terms of profit and bottom-line.

4.4.1.2 Barriers and challenges

Teeffelen mentioned that the biggest barrier is the attitude of the industry, as the industry is a very conservative one. It can be difficult to get technologies qualified and implemented. The industrial partners require references, but at the same time the technologies need to be implemented in order to gain references in the first place. Teeffelen mentioned that it can take up to ten years to get the products accepted. There are some operators that have began to use

the technology, while others wait for more references. Typhonix has today about 40-50 installations of their products. Equinor and Shell are some of the companies that has been open for implementing the technology. Field data that shows that the products are robust and not vulnerable can be important for further expansion. Teeffelen mentioned that they are starting to get a good list of references for the valve, and the pumps are on their way to getting some important references.

4.4.1.3 Incentives for implementation

The current government emission limit or stricter government emission limits on oil can make the product more viable for companies to take use of the products. Teeffelen mentioned that the technology can be a economically viable solution as the valves are needed in the first place regardless, so their technology is an improvement of the current valves.

4.4.1.4 Future prospects

Teeffelen mentions that the technology can be considered a standard technology in the future as it gives good results. The pumps compared to competitors have longer lifespan, less maintenance and more robust.

4.4.2 Analysis of answers

The CEO of Typhonix seems to be optimistic about the spin-off, and expressed that the technology could be considered a standard technology in the future. There have been established and recognized companies such as Equinor and Shell who has used the products, and more field data is gathered in. This can open up for greater recognition of the technology and more companies will then be willing to use it as, as one of the barriers expressed is the conservative

attitude towards new technology. New production methods such as 3D printing can help reduce the costs. The valves are needed anyway, so the change of valves is not a difficult adjustment for the implementing company. They have tested the technology in two projects where the Typhonix technology has been preferred over the conventional standard. The section 4.3.1 discusses the research behind the technology.

Articles such as Husveg et al. (2022) shows the results from testing, which was documented by an independent third party. Four installations were done where three were choke valves and the last one was control valve. The oil in water concentrations was reduced by an total average of 70,45 and 60 % at the choke valves and it was reduced by 23% at the control valve.

The implementation of the technology can also be incentives by government regulations on emissions. Norway is part of OSPAR and are obligated to follow the guildelines, therefore are obliged to follow the rules set by the organization (OSPAR, n.d.). The increased attention on climate emissions through the UN Sustainable Development Goals and the increased price of CO2 as mentioned in Øvrebø (2022) can lead to companies focusing more on sustainable ways to reduce oil emissions, which can increase the demand for Typhonix's technology.

5. Discussion

In this chapter the research statement and the research questions will be considered and answered.

5.1 Research question 1

Is the idea behind the spin-offs valid enough for the industry to consider? When evaluating the spin-offs both of them seems to have solid foundation in research and has gained good support from recognized organizations. In terms of novelty, both spin-offs has acquired patents which protects their idea. The duration of a patent is generally around 20 years, which gives the company great potential to implement and take use of the product. Considering the theory around types of innovation, both technologies can be considered modular innovation which core concept changes, while the use and implementations remains the same as the other established products. The financial and return aspects of both industry have some positive and negative aspects with it. Saferock is a recently established company which makes it harder to determine. Both spin-offs seems to be supported by the industry. However, there are some barriers that both spin-offs must overcome.

5.2 Research Question 2

What are the incentives behind an eventual implementation, and are there any barriers that makes implementation difficult? The barriers for Typhonix is mostly related to attitudes in the industry. However, there are several results from field data that has been gathered in and the company seems to be on an upward trajectory when it comes to gaining more traction for their products. Saferock is in its early stages, as the production of concrete has not started yet. Their barriers at the moment are regulatory and technical requirements. The cement used for oilwell purposes on the other hand seem to be viable

according to the research.

The incentives for the use of the technology related to the companies are increasing CO2 prices and a shift in the industry to focus more on sustainable productions. Typhonix is gaining traction, while Saferock still needs the production plant up and running before making any statements regarding the concrete. The CEO has mentioned that there is interest in the company.

6. Conclusion

In conclusion there are good scientific support for the spin-offs that were studied. There seems to be enthusiasm and support from the industry and Validé. The barriers are mostly related to regulations and technical requirements. As there are stricter environmental considerations there is an increased chance that the products will be more viable in the industry.

6.1 Further research

There are some improvements that can be done for the research conducted, which can be used to conduct more research on this topic. It can be of interest for example to take into consideration more spin-offs to create an extensive comparison. It can also be done analyses on spin-offs already successful in the market and "reverse-engineer" the process and look for factors that made them successful.

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A. Preliminary interview information and questions

The following text is part of an e-mail which was forwarded to the CEOs of Saferock and Typhonix by the CEO of Validé Anne Cathrin Østebø, who put the author in touch with them:

Hei. Jeg heter Nitharsan Suntharamoorthy og jeg går mitt siste semester på studieprogrammet industriell økonomi. Temaet jeg har valgt å skrive om for masteroppgaven er forskingsbaserte spin-offs. Jeg tenkte det ville være interessant å ta for meg innovative produkter basert på forskning og undersøke om disse produktene kan være et godt bærekraftig alternativ til produkter som allerede er etablerte i industrien".

Spørsmål og tematikk som blir tatt opp i samtalen: -Hvordan produktet kan være mer bærekraftig enn det som allerede ute på markedet -Produksjonskostnader og salgspris for produktet eller estimater av dette, og hvordan det er sammenliknet med konkurrentene -Eventuelle barrierer i kommersialiseringsprosessen (Tekniske krav som må oppnås etc.) -Skaleringsmulighetene for produktet -Eventuelle resultater og tall fra bedrifter som har tatt i bruk produktet, med tanke på reduserte kostnader, utslippskutt, ressurser spart osv.

Ønsket tid: Når det tidligst passer for vedkomne. Et sted mellom uke 21-23.

Samtaletype og varighet: Digitalt møte (Microsoft Teams, Zoom eller Skype) med ca. 45min-1 times varighet.

Med vennlig hilsen

Nitharsan Suntharamoorthy