MEEMAS-1 21H Master thesis in Energy, Environment and Society

Crisis Induced Innovation- the case of Artic Healthcare:

How can a crisis be a driving force for innovation?

The department of Media and Social Sciences

Spring 2022

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Stavanger, 29.07.2022

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University of Stavanger

Master's degree in
Energy, Environment and Society

The department of Media and Social Sciences

Master Thesis

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Semester:	Spring 2022
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Master thesis title:	**Crisis Induced Innovation- the case of Artic Healthcare:** *How can a crisis be a driving force for innovation?*
Subject words/ key words:	innovation, crisis, emergency, Covid-19, coronavirus, pandemic, sustainability, climate change, plastic, plastic waste, face masks
Pages:	115 (77 + References and Appendix)

Stavanger, 29.07. 2022

Acknowledgments

We would like to thank everyone who have helped us during the work on this thesis:

Firstly, we want to thank our supervisor Reidar Staupe-Delgado for the guidance, support and availability throughout the process.

Secondly, we would like to express our appreciation for Sjur Paulsen for being encouraging since day one and for helping us to put this thesis together.

We would also like to say thank you to all the participants of this research for their time and willingness to share their experiences with us.

Finally, we want to thank our families, friends and partners for always being there for us showing great support, understanding and patience.

Kinga & Roger

Abstract

Through this case study we examine the phenomenon of Crisis Induced Innovation, with the purpose of exploring and further understanding the true nature of an emergency and how the driving forces across the market dimensions function. We approached this topic with some level of caution, as it is our first instinct to view a crisis as something inherently negative. The topic of our research covers the Covid-19 pandemic as a driver for change across the many different market dimensions, which we have elected to explore using theories within the fields of socio-technical dynamics, emergency frames, innovation management, and rhetorical situation. The overreaching objective that has been driving our academic focus is to understand how a firm may capitalize on radical changes in market conditions and make an adaptive move last beyond the crisis that caused the radical changes. Important notions of our research have been to understand how the dynamic of acutely heightened demand would affect the company in questions as the market returns to normalcy.

Our analytical approach towards this phenomenon were based on the notion of Crisis Induced Innovation being the result of complex causal relationships that can be traced across market dimensions through the utilization of relevant framework. Our predictions to start was that Artic Healthcare, the company that served as a case study example for this purpose, started their operations in the beginning of the pandemic, and elected to utilize the rapid changes to speed up innovation processes.

Among our findings is that Crisis Induced Innovation, as a dynamic effect, is subjected to be affected by its surroundings the same way it affects others. As we employed the MLP with a focus on temporal dynamics, it became obvious that time was an essential element of how the phenomenon evolves. However, we were not able to fully study these temporal dynamics and gain an understanding of how far these pressure points can give an effect, as the case in question reached a point in which progression stopped due to lack of funding for the innovation case we studied. Despite this setback, we have been able to analyse how the phenomenon affects the other dimensions through the employment of the multi-level perspective, we have examined temporal dynamics through the employment of innovation management theories that evaluates process speeds, and we have explored the complex nature of the phenomenon by evaluating it from multiple frames simultaneously, which is presented in our discussion.

Table of contents

List of figures:

List of tables:

List of abbreviations:

CII- Crisis Induced Innovation

CO2e- The carbon dioxide equivalent

CoV- Coronavirus

Covid-19- Coronavirus disease

FT-IR- The Fourier- Transform Infrared Spectroscopy

GHG- Greenhouse Gas

H1N1- swine influenza

MLP- The Multi-level Perspective

NSD- the Norwegian Centre for Research Data

PLA- Polylactic Acid

PP- Polypropylene

PPE- Personal Protective Equipment

SARS- Severe Acute Respiratory Syndrome

WHO- World Health Organization

1. Introduction

It is now more than two years ago that the daily lives of people all over the world were turned upside down. Over the course of centuries, we have developed social and economic systems that are built on the principles of intimacy, where our lives are spent working in offices, shopping at grocery stores, spending our leisure time at the movies, malls, and parks. Our modern world is a global one, where means of transport such as cars, trucks, trains, ships, and planes allow people and goods to roam the planet seemingly unhindered, allowing many of us access to previously unreachable destinations and exotic goods and services. Throughout our days we interact with family and friends as well as strangers, directly or indirectly, and our methods of interactions are intimate, using spoken language and physical contact alike. Suddenly, as if out of nowhere, a virus entered.

Through this body of work, we contextualize and analyze the case of Artic Healthcare, one of many companies that has responded to this emergency. Over the course of the Covid-19 pandemic, they have supplied the market with single-use surgical masks, and in their efforts, discovered a unique opportunity to accelerate the transition from fossil-based plastics to biobased, biodegradable alternatives. This thesis aims to examine how the Covid-19 pandemic and the widespread use of Personal Protective Equipment, which have had immense social and environmental impacts, also acts as external drivers for Crisis Induced Innovation.

The virus spread to the far corners of the world at an unprecedented speed, piggybacking human interaction and global transport systems. Despite the first cases being publicly reported a mere few months earlier, the World Health Organization (WHO) dubbed Covid-19 a global pandemic in March of 2020 (WHO Europe, 2022). Just as our social structures are based on close-knit interactions, so did the infection spread, exploiting our way of life with what would prove to many dire consequences. Moving through droplets, the viral infection spreads with relative ease not only through sneezes and coughs, but even our conversations, handshakes, and breaths (WHO, 2022).

Facial masks quickly became a sought-after commodity, not only in the public health sector, but also in other industries as well as among private individuals. Rising demands quickly resulted in an unprecedented scale-up of production of facial masks at various levels of quality, a process that involved collaborations between nation states and companies to ramp up capacities. This call to arms, which involved existing actors as well as the establishment of

new cause-dedicated companies, allowed the global production to supply the world with 129 billion masks a month at the height of the pandemic (University of Southern Denmark, 2021).

Among the newly established companies dedicated to meet this demand, we find Artic Healthcare, which was established in March of 2020 with the purpose of supplying the Norwegian market with high quality surgical masks. While there is an obvious need for these products in times of crisis, there are many that fear they will come at a grave cost. Artic Healthcare, alongside many other organizations and individuals, are growing concerned regarding the trends of consumption and subsequent disposal of single-use masks that we have seen over the past two years, noting that it not only illuminates, but also exacerbates, an already critical issue: plastic waste.

Ever since the development of the first fully synthetic polymer over a hundred years ago, plastic has had an ever-growing impact on our societies and the objects around us (ScienceHistory, 2022). Plastic can be found in some form or another in pretty much everything, from sturdy auto parts to sophisticated cell-phone components, as well as food packaging and shopping bags (Nielsen et al., 2020, p. 1-2). As amazing as this miracle material seems on the surface, its challenges are revealed upon closer inspection onto how it is made and what happens after it is disposed of. The majority of plastics are derived from petrochemicals and currently accounts for roughly 9% of the global consumption of oil and gas, emitting 400 million tons of CO2 annually (Nielsen et al, 2020, p. 3). Unfortunately, the environmental impact of plastics is not merely limited to production, but also improper waste disposal.

In natural environments, there are several types of impacts associated with plastic waste. In connection to plastic waste on land, embedded toxins deriving from production additives are known to negatively affect soil quality, and in aquatic environments plastics are known to be harmful to marine life, both through physical damage and toxic leakage. We have all seen pictures of littered beaches and sea-turtles choking on food packaging, but what is more difficult to notice is the impact of microplastic and smaller particles. As plastic breaks down into smaller pieces, its level of impact changes. Microplastic is known to enter food chains, which also can end up on the dinner plate of unknowing humans (Moore, 2022).

The scale to which the environment is polluted with plastic was long difficult to estimate, and even more difficult to communicate, but a startling discovery made in 1997 can do that for us.

Commonly referred to as the “Great Pacific Garbage Patch”, it is an area of the Pacific Ocean situated between California and Hawaii, in which you will find a patch of floating waste at a near unimaginable size, but often compared to the size of Texas (Bauer, 2019). The reason why we are talking about plastics and its impact on the natural environment, is exactly because the majority of PPE available, including single-use facial masks, are partly or nearly entirely made up of plastic materials (Aragaw, 2020, p. 2).

Artic Healthcare, as many others, perceives the PPE-related waste associated with the Covid-19 pandemic as not an isolated trait that will disappear as the world returns to normal, but rather as a symptom of a larger issue. The pandemic has visualized what many will understand to be a systemic flaw in how we utilize our resources, and through this insight found internal motivation and external driving factors to bring forth innovation. This creative space, in which innovation is conceived by societal and environmental necessity, is what lies at the center of our research project. While there has already been produced a significant amount of research on climate change, plastic waste pollution and the Covid-19 pandemic, we believe to have identified a point of research that can illuminate a phenomenon that few others have touched. Focusing on the unique position of Artic Healthcare, we have designed a case study in which the company serves as a natural laboratory wherein we can identify and study Crisis Induced Innovation in the context of the Covid-19 pandemic and the environmental impact of single-use surgical masks.

1.1 Scope of the thesis

Due to the Covid-19 pandemic, the demand for single-use protective equipment has increased drastically; masks, gloves and sanitizers are for many an integral part of everyday life. Numerous firms have responded to this crisis, however, not all companies producing such equipment focus on sustainable and environmentally friendly solutions.

Artic Healthcare is a provider of premium medical protective equipment, such as Type 2R surgical masks, and has been operational since responding to the Covid-19 pandemic in 2020. Like many others, they started with the purpose of correcting an acute shortage of essential medical supplies, but soon after noticed that a lot of the products currently available to the market are non-recyclable and based on non-sustainable value chains. This is particularly true for single-use facial masks, which are usually made up of polypropylene, and reached a consumption level of several hundred billion in 2021. To avoid further pollution of natural

ecosystems, Artic Healthcare has taken the initiative to start an innovation project alongside several partners, with the end goal of replacing the polypropylene structure of their type 2R surgical masks with a biodegradable alternative.

For our thesis we employ a case study centered on Artic Healthcare to explore societal and environmental impacts of the pandemic, and how this particular company has maneuvered through it. Our overall objective is to better understand how a firm may capitalize on radical changes in market conditions and make the adaptive move last beyond the crisis. Seeing as Artic Healthcare was founded with the purpose of providing essential medical supplies in a time of acute shortages, what will happen when the acute shortage dissipates, and demand returns to normal? This is a case study in which we examine Crisis Induced Innovation as a strategy to circumvent the consequences of crisis induced demand returning to normal, a tactic that might allow a company born of necessity to continue growing despite the world returning to normalcy. Pursuing this line of research, we need to understand the internal and external conditions that propels Crisis Induced Innovation, and how this phenomenon can solidify a short-term market response into long term success. More specifically, this thesis investigates challenges that Artic Healthcare faces as they make the transition to become a more sustainable and environmentally friendly provider of single-use surgical masks. With these objectives in mind, we need to approach the subject from literary as well as investigative standpoints, meaning that while there is a lot of information already published on the topics of Covid-19 and innovation, the unique aspect of this case study also demands first-hand information that we must gather ourselves. Our qualitative approach to data collection is structured along four research questions that we believe will provide information that is valuable regarding our specific objectives:

1. How did Artic Healthcare come up with their concept following the outbreak of Covid-19?
2. What short- and long-term demand does Artic Healthcare set out to fill and what are the associated risks of these efforts?
3. What steps have Artic Healthcare taken to ensure long term viability and what challenges are associated with the transition from acute response to operational longevity?
4. How does Artic Healthcare plan for the future market demand for Crisis Induced Innovation product in times of relative normalcy?

For this thesis, the Multi-Level Perspective (MLP) functions as a grand theoretical structure wherein we employ theoretical frameworks for analysis. The MLP is a tool with a vast range and operates by examining the topic of study by division of three separate dimensions: landscape developments, socio-technical regime and niches. This tool allows the user to map out actors and how they relate to the socio-technical regime, landscape developments and how they put pressure on regime dynamics, and niche developments that challenge the stability of the regime. It is in this context that we employ theoretical frameworks, which includes analysis of the rhetorical situation in which Artic Healthcare operates, the emergency frames that constitute the ongoing emergencies in the landscape, and innovation management. It is in this theoretical nexus that we believe Crisis Induced Innovation can best be defined, observed, and understood, allowing us to gain insight into why Artic Healthcare is behaving as they do in this current situation and how Crisis Induced Innovation can be understood at distinct levels of analysis across the three dimensions of the MLP.

Accounting for limitations connected to this study, there are some that need to be addressed. This is a single case-study in a distinctly unique situation, and any findings can hardly be generalized on a grand scale, although we do hope to gain valuable insight concerning driving mechanisms that regulates Crisis Induced Innovation, which could be used as allegorical evidence or inspiration for further research. There are also limitations to be connected to both the number of interview subjects, as well as these subjects' connection to the case. Firstly, the number of interview subjects have been limited by two factors, these being a relatively small number of people connected to the company and innovation project which serves as our natural laboratory, and that some of the planned interviews fell through due to lack of availability of the subject. The second limitation associated with the interview subject is their personal connection to the case in question, in which all three of the subjects represent actors involved in product development, meaning it can be argued that they have something to gain by portraying themselves, their organizations, or knowledge in a way that gains value. The one-sided aspect of interview subjects was not directly planned, but we limited our scope early on, in an effort to better focus our area of research. These limitations being accounted for, we are still under the impression that any findings can produce immense value, as the company and the project itself is not the direct topic of primary study, but rather the unique phenomenon of Crisis Induced Innovation.

1.2 Delimitation

Throughout this thesis we explore a wide range of topics and approaches to these topics, but so in a varying degree of depth and detail. In order to better frame the purpose of this project, it can be favorable to perform a delimitation, in which we touch upon which elements will not be focused on in this thesis. Beyond the purpose of better presenting our area of focus, it is our hope that this might motivate future work by other researchers in the fields that we circumvent.

Through this body of work our primary focus is to shed light on the phenomenon that is Crisis Induced Innovation, the intricate market factors that drive it, and how it is connected in practice by analyzing the findings of our case study. Our work is based on data collection and analysis, through the methods of interviews and document analysis, which together with our contextual literature review findings serves as input data for our theoretical frameworks. Through our literature review we explore the topics of plastic, plastic waste and environmental impact, biomaterials, Covid-19 pandemic, pandemic related waste, and Crisis Induced Innovation. The latter in this list of topics is our primary area of focus, whereas the others are explored in varying degrees of depth and detail till we reach a satisfactory level of context for our analytical processes.

The candidates that we talked to through this process were all representatives of actors directly or indirectly involved on the producing side of the innovation project spearheaded by Artic Healthcare. Our initial scope included two more interviews, representing organizations within the fields of public health innovation and product distribution, but the subjects in question were not available. Early on in the process we elected to delimit our group of area representatives, removing private consumers and consumer-oriented stores with relevant product lines, such as groceries and pharmacies. This was done with the purpose of narrowing our analytical focus. That being said, we realize that getting a more specific insight into consumer behavior and market trends before, during and after the pandemic is invaluable to this type of research, but as we decide to narrow our focus this might inspire other researchers to investigate these perspectives in future studies.

1.3 Structure of the thesis

Moving forward in the thesis, we explore literature in chapter 2, where we dive into available research findings that are of particular relevance to our work. This serves multiple purposes,

in the sense that it provides background information, context for our analysis, and vital insights that are necessary for the implementation of our frameworks. The literature review covers two main topics, these being plastic and environmental impact, and face mask usage and Covid waste. Next, we move on to chapter 3, which starts off with an introduction to our analytical approach, providing a visual model consisting of main elements associated with Crisis Induced Innovation and the causal relationships between them. It is important to note that this analytical approach is based on assumptions made from the literature review, and a corrected version is supplied when presenting our conclusions. Then we introduce the theoretical frameworks applied in our research, with descriptions of how each model is applied and its intended purpose. The four main theoretical frameworks utilized for our analysis are the MLP, the rhetorical situation and its life cycle, emergency frames and innovation management. Chapter 4 encompasses research strategy and methodological approach, giving descriptions of strategies and scientific basis, data collection and reduction processes, and critical self-evaluation of our approach. In chapter 5 we present our findings from data collection along with research results. The most relevant findings are included in chapter 6, which entails application of our theoretical frameworks and discussions. In this chapter we perform a step-by-step analysis, utilizing the previously selected frameworks, with the input data for our analysis being relevant findings from our data collection and literature review. The thesis culminates in a conclusion, chapter 7, in which we provide a summary of key findings, final remarks, a discussion on the quality and missteps of our work and recommendations for which areas of this topic and field might be suitable for future research.

2. Context and literature review

In the literature chapter, the review of existing literature has been performed in order to identify the present state of knowledge and the potential gaps. The literature review does not produce any new knowledge but focuses on already existing research evidence that can be found, for example in gray literature and peer-reviews (Sovacool et al., 2018, p. 18). For this study a systematic review was chosen, where a comprehensive and unbiased summary of the state of knowledge on the issues relevant to our research was performed (Sovacool et al., 2018, p. 22).

2.1 Plastic and its impacts

Over the last few decades there has been a growing focus on plastic and its effect on the environment, both in media as well as among decision makers and their voters. However, not everyone knows what plastic really is, where it comes from, how it is used nor the effects of its presence.

Plastic refers to a group of materials made up of polymers and has had an ever-increasing impact on our society as well as the natural environment upon which it is built, ever since the first fully synthetic polymer was introduced more than a hundred years ago. Leo Baekeland developed the first fully synthetic polymer in 1907, Bakelite, to create a substitute for natural electrical insulators. To his surprise, the newly invented material was not only a good insulator, but also showed other promises due to its durability, heat resistance, and of course its potential to be produced at a large scale. The product was marketed as "the material for a thousand uses" and started a quest, shared by many, to develop further innovations that would have the potential to replace, and improve, existing materials and their functions. As with every other technology, societal needs were a great driver for the technological developments that allowed plastic to become as widespread as it is today, and for plastic the second world war was one such driving force. As the United States increased their industrial efforts during the war, there was a strong driving force behind the utilization of plastic materials to preserve scarce natural resources. One such implementation was the military usage of nylon, developed by Wallace Carothers in 1935 as a synthetic alternative to silk, and was used in the production of ropes, body armor, parachutes and more (ScienceHistory, 2022). The industrial focus on plastic continued well after the war, and further innovations were made both in terms of new synthetic materials as well as how they were made, which not only increased the scope of the purposes to which plastic could be used, but also the cost to make them.

Polypropylene (PP) was discovered in 1954 by Guilio Natta, a material that was quickly adopted by the market and is still widely used today. Its popularity is mainly due to its low weight relative to its density, at 0.9 g per cubic centimeter, and high temperature resistance, which allows it to be treated in a broad range of ways without suffering losses to its mechanical properties (Maddah, 2016, p.1). Production of PP was first instigated in 1957 and quickly rose to prominence due to its low price and high level of flexibility when molding. There are many different types of polypropylenes, all with different compositions tailored to individual utilities, and they fall into two main categories, commodity thermoplastics and engineering thermoplastics. Commodities encompasses the type of plastic that the average

consumer would recognize as “plastic”, for instance food packaging, while engineering thermoplastic is a favorite in the petrochemical industry (Maddah, 2016, p 2-3). The application for PP is incredibly broad, and due to its ability to be tempered within a wide arrange of ways you will find it in everything from synthetic fibers and fabrics to automotive parts (Maddah, 2016, p. 8).

The many different variations that plastic comes in, derives from various petrochemicals, each specifically designed for its intended purpose. For instance, polypropylene and polyethylene are made using olefins, while polymers such as polyamide and polystyrene are made from aromatic hydrocarbons. In the production of plastic, the first stage product usually comes in the form of spherical pellets, which are shipped off, melted down, and recreated in the image of our own imagination and technical capabilities (Emmerick & Schwartz, 2020, p. 2). Plastic has contributed to one of the greatest economic, technological, and societal revolutions in recent history, having had tremendous impact in not only how we structure our own modern societies, but also how we live and move through it. Plastic can be found in every major and minor aspect of our life alike, and the smaller the details they entail, yet often more important of a role they play. From airplanes and vehicles to smartphones and food packaging, plastic has revolutionized how we move, how we talk, what we eat and when and where we eat it (Nielsen et al., 2020, p. 1-2). But it carries a heavy toll: for every great gift that this seemingly magnificent material can provide through its resourcefulness, there is a backside with an ever-growing cost. Plastic is the gift that keeps on giving long after the party is over, the guest that stays long past his welcome. In recent years people have become aware of troublesome developments linked to the associated CO2 equivalent emissions and the disintegration of plastic waste and its subsequent unseen pollution of our environment.

2.2 Carbon footprints

Plastic is tightly associated with petrochemistry and fossil fuels, and with good reason, given that 99% of plastic feedstock is fossil based and accounts for roughly 9% of worldwide oil and gas consumption, of which 5% goes to feed and 4% to the energy required for production (Nielsen et al., 2020, p. 3). Plastic production and incineration were per 2019 responsible for emitting 400 million tons of CO2, which is an annual process. While the production of plastic currently accounts for roughly 9% of oil and gas production, this number is expected to increase sharply over the next years, with plastic production expected to double over the next

decades and its energy demand to grow to encompass 20% of oil and gas production by 2050 (Nielsen et al., 2020, p. 6).

The carbon dioxide equivalent (CO_2e) emitted by polypropylene (PP) is assessed to average at 1.34 kg of CO_2 per kg of PP. Although, it is important to mention that this is not an attribute solely to the material itself, but also to its conception. The choice of energy sources when producing PP affects CO_2e, which can be exemplified by comparing where it is produced. For instance, in the GCC region, which encompasses Saudi Arabia, Kuwait, United Arab Emirates, Qatar, Bahrain, and Oman, the global warming potential associated with the production of PP pellets is measured at 1.95 kg of CO_2e, while in Japan the same type of pellets has been measured at 1.4 kg CO_2e (Alsabri, 2022, p. 2247). This brings forth the importance of realizing that it is not only the plastic itself that might have a negative impact, but also how you make it.

Life-cycle analysis conducted by Zheng & Suh (2019) show that the plastic produced in 2015 alone will amount to 1,8 Gt of CO_2 equivalent. Polypropylenes, alongside the other plastics in the polyolefin group, accounts for nearly half of the global plastic consumption and is a significant producer of CO_2e. From 2010 to 2015, there was a 4% annual growth in plastic production, and if that trend continues the corresponding CO_2 equivalent could reach 6,5 Gt by 2050 (Zheng & Suh, 2019, p. 5-6).

As we see, there is a significant amount of CO_2 pollution associated with plastics, which begs the question: Can the biodegradable Type 2R surgical mask that Artic Healthcare aims to develop in their innovation project be made exclusively with biomaterials, and if so, how would that affect the associated CO_2 emissions?

2.3 The plastic debris finds its way in nature

Pollution related to plastic waste has proven itself to be an environmental threat measured in CO_2 equivalence, but just as plastic has multiple purposes, it has many degrees of impact. It is estimated that between 19 and 23 million tons of plastic waste, roughly 11% of the produced plastic waste in 2016, entered aquatic ecosystems (Borelle et al., 2020, p. 1515). If you limit the environment to just the ocean, current estimations state that it is contaminated by roughly 9.5 million tons of plastic waste annually, of which 8 is macro plastic and 1.5 is microplastic. There is a plethora of damages that can occur as plastic waste enters nature, especially in aquatic environments. It is believed that at least 700 different aquatic species are directly

being affected by plastic pollution, such as ingesting or being entangled in waste, but that is not where the impact ends, but rather where it begins (Lau et al., 2020, p. 1455). Plastic pollution also impacts humans both indirectly and directly. Plastic tends to accumulate on beaches and shores as well as blocking drainage and hydrological systems. Conservatively, mismanaged plastic pollution carries a price tag of at least 13 billion US dollars annually, in the form of costs and loss of revenue following economic impact on fishing, tourism and shipping (Lau et al., 2020, p. 1455). It is estimated that the accumulated plastic waste pollution has reached 6.300 million tons on a global scale, the majority of which, 79%, is situated in landfills. Despite most of the waste ending up on land, the ocean and other aquatic environments are being polluted at an alarming rate (Windsor et al., 2019, p. 1208).

Due to the versatile nature of plastic in its composition, size and shape, its environmental consequences are difficult to predict. We do not fully understand the scope or to which degree it entangles itself in our biosphere. From medium to large debris that directly and visibly affects distinct faunas and environments to its degrading nature in which smaller scale bits and pieces interlinks with life at more complex levels, and with even more complex repercussions (Windsor et al., 2019, p. 1208).

Hydrological catchments play an important role in understanding the intricacy that is plastic waste pollution, as it allows plastic particles to journey to every corner of the globe seemingly unencumbered. In similar ways as other particles, plastic uses waterways at levels of size as a method of transportation, but with one important distinction. In opposition to natural occurring debris using these systems of transportation, plastic exists in such an array of size, shape, mass, and surface texture, that each piece is to a certain degree unique and difficult to predict, meaning that we cannot fully understand or predict how plastic behaves and moves. This makes the situation radically more difficult to mitigate. In addition to waterways, plastic waste, especially particles, moves along with wind and other weather occurrences, traveling across sky and surface terrains, intertwining with nature in unpredictable manners (Windsor et al., 2019, p. 1209). It is estimated that between 4,8 and 12,7 million tons of plastic waste are transported to marine environments per year through natural currents, which proves why it is important to understand these systems and their relation to plastic waste (Windsor et al., 2019, p. 1211). In addition to moving alongside its environment, plastic is known to be retained by fauna and natural systems, usually in the form of smaller particles, resulting in waste integrating in food and nurture chains. Although the direct consequences of this is not fully understood, we understand that this creates entirely new methods of transport and

transformation, allowing the particles to flow through fecal matter, predatory ingestion, and decomposing biomaterial, just to name a few. In example, plankton has been observed with surface damage resulting from interaction with microplastic, illustrating that even at its smaller dimensions plastic waste mismanagement directly impacts its environment and co-inhabitants. In addition to direct physical damages, plastic particles can have a toxic effect depending on the impeded chemicals (Windsor et al., 2019, p. 1212-1213).

As large as the annual amount of plastic being produced is, it is merely a fraction of the potential plastic waste pollution that we might see in the future if we move forward without making a change. Most of the plastic in existence, despite being popularized already in the 1950s, was produced after 2004, which gives an indication to how fast plastic waste moves (Schmaltz et al., 2020, p. 1). The analysis conducted by Borelle et al. (2020) shows that the amount of waste could reach as much as 53 million tons by 2030, even with the implementation of relatively ambitious production, waste management and recovery strategies. If 2016 levels of plastic pollution and the driving forces behind them are left unchecked, prognosis based on estimated population growth and personal consumption trajectories reveals an eerie scenario in where as much as 90 million tons annually could enter the worlds aquatic ecosystems by the same timeframe (Borelle et al., 2020, p. 1515-1516). These findings are supported by other researchers as well, Lau et al. (2020) has conducted an analysis operating with a timeframe that stretches to 2040 and concluded that if we continue with a “business-as-usual” mentality regarding plastic waste production, consumption, and waste management, plastic pollution might reach 80 million tons, with 30 million tons finding its way into aquatic environments (Lau et al., 2020, p. 1455). The results across these studies are merely marginally different, showing a bleak road ahead.

Achieving a substantial reduction of plastic emission requires urgent transformative change across the dimensions of production and consumption, waste management and recovery strategies, and adequate technological developments that would make meaningful actions feasible. Unfortunately, despite seeing new developments in sustainable alternatives, there is a growing trend of virgin plastic production due to cheap and easy access to petroleum that renders recycling value chains fiscally undesirable. In the face of this trend, coupled with an ever-increasing consumption and projected population growth, current waste related management strategies are rendered inefficient to the point that already established efforts will have little impact in preventing the world's plastic pollution from reaching the world's aquatic environments. To mitigate the worst-case scenario of projected growth in plastic

waste pollution, Borelle et al. (2020) has concluded that we must reduce consumption of conventional plastic by at least 10% in high-income nations, develop closed-circuit waste management systems that accounts for at least 90% of the plastic waste produced in high-income nations and 30% in low, and develop recovery-systems that can collect at least 10% of waste debris. If we are inclined to reduce plastic waste pollution, the targets are exceedingly more ambitious, detailing that it would require a reduced consumption by 25-40%, that we account for 60-99% of waste produced, and recover 40% (Borelle et al., 2020, p. 3). In addition to having to adapt our efforts to deal with the ever-increasing amount of plastic being used, and subsequently discarded, we also must deal with the plastic waste already existing. Plastic, like everything else, has a functional lifespan that ends with deterioration. Polypropylene for instance, has an average lifespan of 20 years (Mannheim & Simenfalvi, 2020, p. 1517). This means that there is a limited amount of time wherein you can solve the problem as you see it, given that the plastic bag or surgical facial mask floating in the ocean might be reduced to smaller scale particles if we wait too long to deal with it.

Not only does these numbers illustrate the very realistic fear of environmental contamination, but the biosphere is already contaminated to the point that the presence of plastics in natural ecosystems is recognized as a trait of the “Anthropocene era” (Alsabri et al., 2022, p. 2247). Plastic pollution is everywhere, at one scale or another, whether you can see it or not. We have all seen pictures of plastic ridden beaches, or animals wrapped in its deadly grip, but it does not stop there. Plastic is in the oceans, the air, soil, our drinking water, and food, even in us. As great as the challenge seems today, greater it will grow. Plastic pollution is expected to more than double over the course of the next 20 years (Nielsen et al., 2020, p. 2), and if our current systems of waste management cannot keep up today, what will the world look like tomorrow? This problem raises an important notion, that maybe it is not enough to rethink our approach to plastic, maybe we need to rethink plastic itself.

2.4 The sustainable potential of plastics

Over the past century we have experienced great scientific and technological developments that have not only radically affected how we view life, but also how we live it, allowing many of us to enjoy vast luxuries at seemingly low costs. Alas, how we view the cost for our way of life has changed as we now start to see the creeping consequences of our actions, or what some would describe as inaction. As shown earlier, the impact of our past and current practices is vastly more severe than previously estimated. While plastics have served purposes

of immense value for more than a hundred years, the issue of plastic waste is a relatively recently emerged issue, and the reason for this is the exceptional growth in production and consumption in recent years. As of 1950, the annual consumption was roughly 1.7 kgs per person. 57 years later, that number rose to 100 kgs per person, and today the number has surpassed 140 kgs per person on average (Filiciotto & Rothenberg, 2021, p. 57). In a collective effort to bring about sustainable changes, there has been an ever-increasing focus on the building blocks of our societies, replacing the synthetic, petrochemical polymers that we use to create our worlds with biobased and biodegradable options, aiming at attaining a circular economy by challenging every aspect of the life cycle of plastics, ranging from production, application, and waste management (Rameshkumar et al., 2020, p. 75). The majority of products that could be made with biodegradable polymers falls under the category of commodity plastics, which accounts for the majority of industrial plastic production worldwide and amounts for roughly 250 million tons annually. That is one of the reasons that the EU launched a new strategy concerning plastic production and management in 2018, since a lot of these single-use and short-lived products ends up in dumps or directly in the environment, and the longevity of these traditional materials allows them to accumulate in nature for decades with, as we have illustrated earlier, great consequences (Haider et al., 2019, p. 51). The European Union, among many other nations and organizations, recognizes the waste issues associated with plastic as a problem that must be taken seriously, and views bioplastics, both in the sense of raw materials and composition as well as end-of-life biodegradability functions, as part of the solution.

The notion of biobased and biodegradable plastic is not a new one, and is merely the usage of natural occurring materials, or synthetic replication meant to mimic the functions of such materials. The earliest developments of plastic materials were all derived from, or at the very least inspired by nature, while it was the price, availability and functional mechanics of petrochemicals that drove the change to oil and gas-based solutions. In fact, utilizations of biobased plastics were common even a hundred years ago. Examples of this is Ford developing car parts using soybeans. Whereas biobased plastics utilizes natural materials as substitutes to conventional solutions, allowing for lesser levels of environmental impact and carbon footprint, biodegradable plastics are not necessarily biobased. Biodegradable plastics refer to a materials' attributes, in this case its disposal phase at the end of its life. This attribute usually requires specific conditions and timeframes to happen, meaning that waste management still is a factor that we need to account for (Rujnic-Sokele & Pilipovic, 2017, p.

132). That being said, the development of bioplastics and biodegradable solutions is not merely a matter of environmental impact and a green conscience, but also one of a more practical nature. Current levels of plastic production demand roughly 4% of the global oil and gas production for materials alone, a number that is expected to reach 20% by 2050 if the current levels of annual production increases carry on unhindered. This of course raises environmental concerns, but another level of discussion should be had on the availability of resources. Petrochemicals deriving from oil and gas are finite because we exploit these sources at a rate far faster than it is naturally produced, and if continued will at some point run dry. This means that the current and future endeavors of developing green and sustainable alternatives to plastics also should be viewed as a matter of practical necessity (Rujnic-Sokele & Pilipovic, 2017, p. 133).

When speaking of bioplastic, we are entering a unique and timely proven confusing field. People often use the terminologies of bioplastics and biodegradable plastics interchangeably, despite this not being the case. Bioplastic refers to a category of plastic that uses biomaterials as feedstock, utilizing renewable sources instead of traditional petrochemicals stemming from oil and gas, and is not necessarily biodegradable. Biodegradable plastics on the other side are referring to plastics that are made up of a unique polymer structure that can be recognized and consumed, or broken down, by enzymes in natural environments, although are not necessarily made up of biomass (Rujnic-Sokele & Pilipovic, 2017, p. 133).

Concerning bio-based feedstock for the production of plastic, there are a plethora of positive effects associated with the transition from oil-based solutions, but there are both positive and negative effects associated with biobased solutions themselves. Among the positive effects, which are particularly important in today's conscious climate, is the conservation of limited resources such as petroleum in favor of renewable sources for raw materials, reduction of GHG due to the associated CO2 that accompanies traditional plastics production, and the utilization of agricultural and forestry waste that otherwise would not have as effective usage. The perceived negative effects however are concerning enough that it deserves mention. Among the most troublesome is the competition with food production in the agricultural nexus, in the sense that we have a limited space of fertile land and some worry that production of bio feed would outcompete traditional food production due to more favorable returns for farmers, intensified industrial agricultural practices increasing use of fertilizers, deforestation, and increased food costs that would threaten areas already affected areas troubled by food

insecurity or low income that could cause food insecurity (Rujnic-Sokele & Pilipovic, 2017, p. 133).

As of 2018, the global production of bioplastic across the world amounted to roughly 2,11 Mt, but experts are expecting this capacity to grow immensely over the coming years, as plastic production and management play a vital role in our efforts to develop a more sustainable society and reach our climate goals. Among the ongoing trends in commercial development there has been a greater focus on plastics that utilize naturally occurring polymers, such as cellulose derivatives and thermoplastic starch. This is mainly due to their properties which allows for usage in the packaging sector. An example of a material that has seen growing interest in both industrial and academic circles is polylactic acid (PLA), a starch derivative that has proven to hold similar properties as that of polypropylene (PP) and polystyrene but is proven to be biodegradable (Rameshkumar et al., 2020, p. 75). Among existing product categories that are traditionally made of plastic, there are several that would gain an advantageous effect by replacing the traditional plastic material with biodegradable materials, especially single-use and short-lived products. Examples of these are many, but the most prominent, in which we have already seen examples of biodegradable versions, are waste bags for organic waste, products in the food industry such as single use cutlery, cups, and bags, and food and beverage packaging (Rujnic-Sokele & Pilipovic, 2017, p. 135).

Following this subchapter on bioplastics, the reader is introduced to the Covid-19 pandemic and the associated waste issues, with a special focus on single-use facial masks. In the context of our focus on Artic Healthcare and their ongoing innovation project, we must ask the question: Can single use facial masks such as the Type 2R surgical mask be made with bioplastics and the function of biodegradability, and if so, what kind of materials can they use?

2.5 The novel coronavirus disease (Covid-19)

The first information about the novel Coronavirus disease (Covid-19) was received by the World Health Organization (WHO) in the end of 2019, when an unknown case of the virus was discovered in Wuhan City in China. Not long after, in the beginning of 2020, the news about the existence of this infectious disease was confirmed and quickly reached the whole world. According to the World Health Organization (WHO), Covid-19 is a part of a large family of coronaviruses (CoV) that causes illnesses that typically range from a common cold

to other more severe diseases (WHO Europe, 2022). The virus can easily spread from one person to another through coughing, sneezing, speaking or even breathing and people infected with it can experience it differently. It was noted that older people and people suffering medical conditions are more likely to develop serious illness that in the worst case can lead to death (WHO 1a, 2022).

The rapid spread of the virus resulted in a significant increase in the number of new cases daily globally. By March 2020, the virus had been declared a global pandemic by the WHO, when more than 118 000 cases had been reported in 114 countries and 4291 deaths had been recorded (WHO Europe, 2022). The seriousness of the virus required immediate implementation of emergency measures by governments in order to reduce the further spreading. Due to the novelty of the virus and relatively limited experience in responding to pandemics of such an extent, implementation of these emergency measures posed a great challenge associated with uncertainty regarding their adequacy and effectiveness. Nevertheless, pressured by the speed of the pandemic, by April 2020, most of the countries responded by applying a full lockdown, forcing people to stay at home and most of the public places to temporarily suspend their businesses. Moreover, many governments implemented restrictions connected to traveling and social activities and people were advised to amongst others keep social distance, avoid crowded spaces, wash hands, and use protective equipment such as gloves or face masks (Fadare & Okoffo, 2020, p. 1).

These novel preventive efforts served only as a temporary solution to tackle the problem and it was definite that more effective measures should be implemented. However, the great challenge in doing so is the uncertainty of the situation. Many recent studies on pandemic do focus on reviewing the current facts, however more attention should be brought to what is forthcoming. Hence, the important question should be asked here: “What will the pandemic look like going forward?”

2.6 The era of disposable face masks

Before the outbreak of the pandemic, the use of disposable face masks by the general public was typically viewed as something unusual, maybe except for the countries such as Japan, where face masks usage among civilians has been a long-established practice for over 100 years (Anyiam- Osigwe & Schmitz, 2021). Rather, masks were typically recognized as a part of personal protective equipment (PPE) utilized by workers from the health-care industry. However, this has changed during the outbreak of severe acute respiratory syndrome (SARS)

in 2003 and swine influenza (H1N1) in 2009, when the use of face masks became more common also among non-medical professionals (Fadare & Okoffo, 2020, p. 1).

After the hit of Covid-19, face masks have become widely recognized as an effective form of protection that reduces the number of times a person touches the mouth, face and nose with unwashed hands and can lower the chance of infection and slow down the spreading of the virus (Fadare & Okoffo, 2020, p. 1). Accordingly, disposable face masks became an integral part of everyone's everyday life as the overall face covering recommendations quickly turned into being mandatory in many countries, pressuring people to accommodate to this "new normal".

In the first months of the pandemic, the existence of the virus was a shock to everyone that caused confusion and uncertainty leading to reckless behavior among people such as panic buying and hoarding of face masks. In consequence, disposable face masks became a scarce product and the demand for them increased drastically as they became essential not only to the health-care professionals but for the entire population. As claimed by WHO, in the first months of the global pandemic, the health industry experienced a shortage in PPE due to the above-mentioned rising demand, panic buying, misuse and hoarding caused by the society. As a result, health-care workers were left ill-equipped with limited supplies of PPE putting their own and others' lives at risk. WHO estimated that 89 million medical masks were needed each month to respond to Covid-19 at the time of writing (WHO 1b, March 2020). This situation required an urgent response from governments and industries to expand the global production of face masks. As a result, major producers like China scaled up their output significantly with the daily production amounting to 14.8 million as of February 2020 (Fadare & Okoffo, 2020, p. 1). Throughout the months, more and more face masks were being produced and utilized all over the globe. Recent studies have revealed that approximately 129 billion face masks were utilized every month during the height of the pandemic, which is equivalent to 3 million face masks a minute (University of Southern Denmark, 2021).

There is no doubt that all the above contributions demonstrated how strongly face masks have influenced our lives during the pandemic and how they have become one of the most desired products at the time being. However, now it is critical to consider what the demand and consumption of face masks will look like when the pandemic slows down? Will the great interest in face masks remain going forward, or will the necessity and demand be totally forgotten once the pandemic ends?

2.7 Disposable face masks as a part of Covid-19 waste issue

The stupendous amount of disposable face masks being utilized everyday globally entails a critical issue of their disposal. Most of the personal protective equipment including disposable face masks is produced using polymeric materials such as polypropylene, polystyrene, polyester, or polyurethane, commonly known as plastic. Disposable face masks usually consist of three layers such as a fibrous material inner layer, middle layer with melt blown filter part and an outer layer with nonwoven fibers which are colored and water resistant (Aragaw, 2020, p. 2). Moreover, "the melt-blown filter is the main filtering layer of the mask produced by the conventional fabrication of micro- and nanofibers, where melted polymer is extruded through tiny nozzles, with high-speed blowing gas" (Fadare & Okoffo, 2020, p. 2). Recycling of face masks is difficult due to delicate composition and risk of transmission; therefore, its incorrect disposal can pose a serious threat to the environment (Chowdhury et al., 2021, p. 4). *Figure 1* presented by Fadare & Okoffo (2020) shows how such face masks and their layers look at different stages of their degradation in the environment.

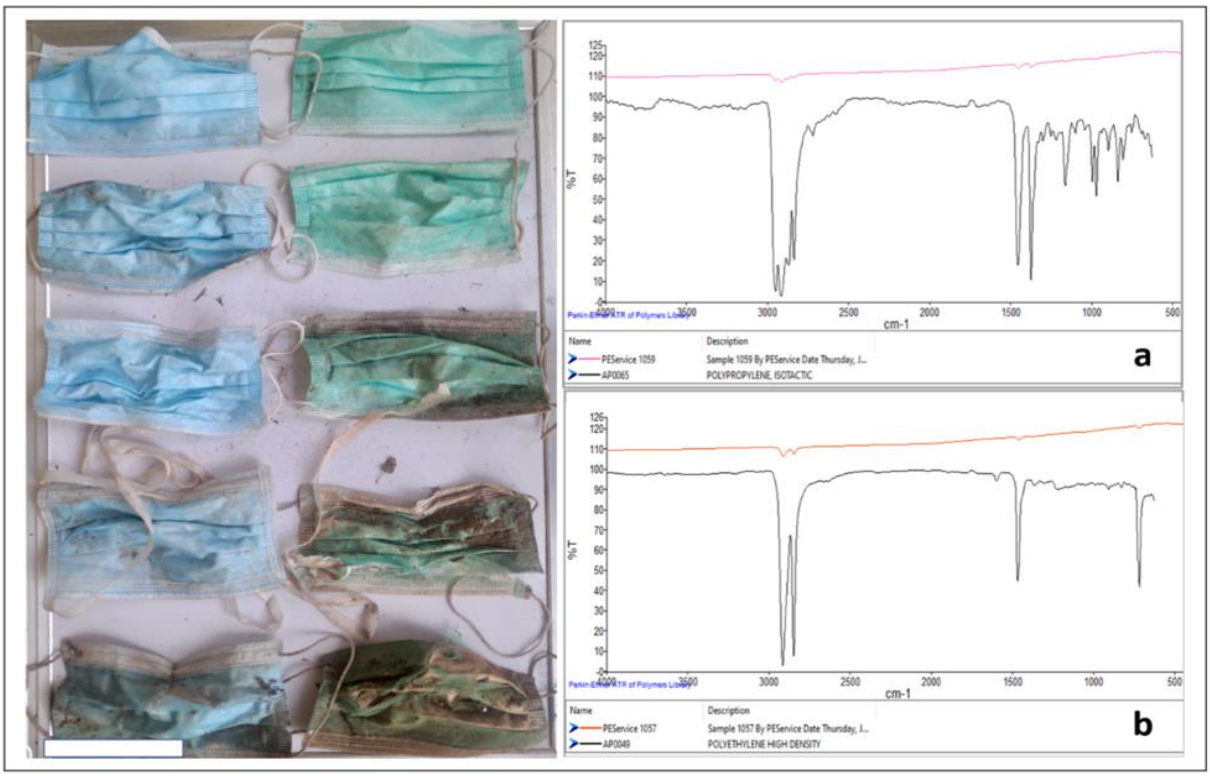

Figure 1. Face masks at different stages of degradation in the environment.

From "Covid-19 face masks: A potential source of microplastic fibers in the environment" by Fadare, O.O & Okoffo, E. D, 2020, *Science of The Total Environment, 737*, (140279), p. 4. (https://doi.org/10.1016/j.scitotenv.2020.140279). Copyright 2020 by Elsevier.

Plastic pollution and its impact on the environment have been a challenging issue difficult to overcome for many years now. Unfortunately, global pandemic and the enormous amount of the so-called "Covid-19 waste" have only worsened the situation. These single-use PPEs are usually disposed of as any other waste without any proper recycling procedure, adding more plastic waste to the terrestrial and aquatic environment (Hasan et al., 2021, p. 2). Hasan et al. (2021) developed a figure (*Figure 2*) that highlights this problem in Bangladesh, presenting estimated waste production of different types of PPEs (Hasan et al., 2021, p.4).

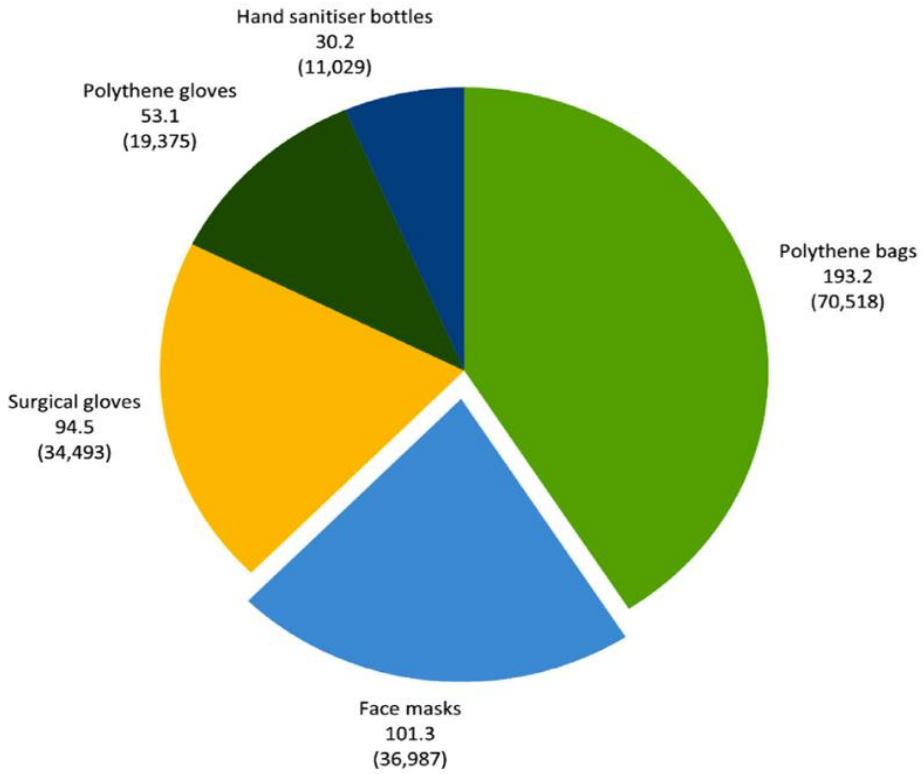

Figure 2. Estimated non-degradable waste production in Bangladesh.

From "Face masks: protecting the wearer but neglecting the aquatic environment? - A perspective from Bangladesh" by Hasan, N.A., Heal, R. D., Bashar, A. & Haque, M. M., 2021, *Environmental Challenges, 4* (100126), p. 4. (https://doi.org/10.1016/j.envc.2021.100126). Copyright 2021 by Elsevier.

Generally, people neglect, pay little attention to or are unaware about how such waste is being utilized. As explained by The Economist (2020), the general public, in contrast to experienced health-care professionals, is more likely expected to dispose of face masks incorrectly (Hasan

et al., 2021, p. 2). This can be supported by the frequently observed image of piles of face masks discarded on the streets nowadays. Such face masks discarded in public spaces or disposed in sanitary landfills usually enter rivers and lakes and then end up in the oceans (Shen et al., 2021, p. 2). The World Wildlife Fund indicated that incorrect disposal of only 1% of face masks can contribute to waste of 30,000-40,000 kg per day (Chowdhury et al., 2021, p. 1). The Fourier- Transform Infrared Spectroscopy (FT-IR) analysis of the degrading face masks provided evidence that microparticles from face masks could increase its accumulation in the environment within a short time (Fadare & Okoffo, 2020, p. 2). The Innovation Center at University of College London studied that 66,000 tons of contaminated plastic waste will be produced in a year from using one mask a day (Shen et al., 2021, p .9).

Many recent studies present extensive evidence of the negative impact of the Covid-19 surgical face masks on the environment. Fadare & Okoffo (2020) in their paper illustrated the data reported by the OceansAsia, an organization committed to advocacy and research on marine pollution, from February and May 2020, when the presence of many face masks in different colors and types was observed in an ocean in Hong Kong as well as along a highway and drainage in Ile- Ife in Nigeria (*Figure 3*) (Fadare & Okoffo, 2020, p. 2).

Figure 3. Collection of various Covid-19 face masks from an ocean and terrestrial environment in Hong Kong and Nigeria.

From " Covid-19 face masks: A potential source of microplastic fibers in the environment" by Fadare, O.O & Okoffo, E. D, 2020, *Science of The Total Environment, 737,* (140279), p. 3 (https://doi.org/10.1016/j.scitotenv.2020.140279). Copyright 2020 by Elsevier.

Moreover, Hasan et al. (2021) in their article decided to closely investigate the case of Bangladesh, where they noted that potential additional 11 million MT of plastic waste from face masks in Bangladesh goes to the waste stream contributing to pollution of the marine and freshwater environments (Hasan et al., 2021, p. 2)

Figure 4. Examples of plastic litter in aquaculture ponds in Muktagacha, Bangladesh

From "Face masks: protecting the wearer but neglecting the aquatic environment? A Perspective from Bangladesh" by Hasan, N.A., Heal, R. D., Bashar, A. & Haque, M. M., 2021, *Environmental Challenges, 4* (100126), p. 7. (https://doi.org/10.1016/j.envc.2021.100126). Copyright 2021 by Elsevier.

In addition, they presented findings from a survey carried out by Hiemstra et al. (2021) which was focused on the negative impact of Covid-19 waste on animal life. From the results of 28 investigated cases, 86% of these concerned face masks and gloves that negatively affected a wide range of animals such as swans, penguins, fish, dogs, bats etc. Besides, they mentioned the intensified presence of face masks in Dutch and English beaches between May and June

2020. They also highlighted that the Covid waste has even reached unabated islands such as the Soko Islands in Hong Kong (Hasan et al., 2021, p. 2).

Chowdhury et al. (2021) found that microplastic waste from face masks can have negative effects on human health causing cancer, infertility, or obesity. This is because microplastic particles are easily accessible to marine organisms living in freshwater and oceans that are a significant part of the global food chain (Chowdhury et al. 2021, p. 2). Moreover, Chowdhury et al. (2021) presented the results from their study of estimates of the potential marine plastic pollution from Covid-19 face masks usage, mismanaged usage, and plastic debris in 46 countries. They found that approximately 0.15 million tons to 0.39 million tons of plastic debris could enter the global oceans within a year from their analysis. What is more, they noted that Asian countries generate more plastic waste from face masks (1.51 million) than Europe (0.48 million tons) and that mismanaged plastic waste and marine pollution are higher in developing countries with lower income due to poorly developed waste management infrastructure (Chowdhury et al., 2021, p. 5).

The above studies certainly bring attention to the severity of the Covid-19 waste pollution problem and highlight that if this issue will not be handled as soon as possible we might be in danger of further aggravating a potential “plastic pollution pandemic”. However, as we currently start to see the pandemic possibly approaching its end it would be critical to consider how this affects waste trajectory going forward. How much plastic waste are face masks responsible for? Will the end of the pandemic make a difference?

3. Analytical approach and theoretical background

With respect to the topic of this thesis, we find it critical to define and explain our analytical approach as well as theories and key concepts most relevant for this study as we believe that it helps to frame our research and provides a justified basis for the analysis and discussion of the findings.

3.1 Analytical model

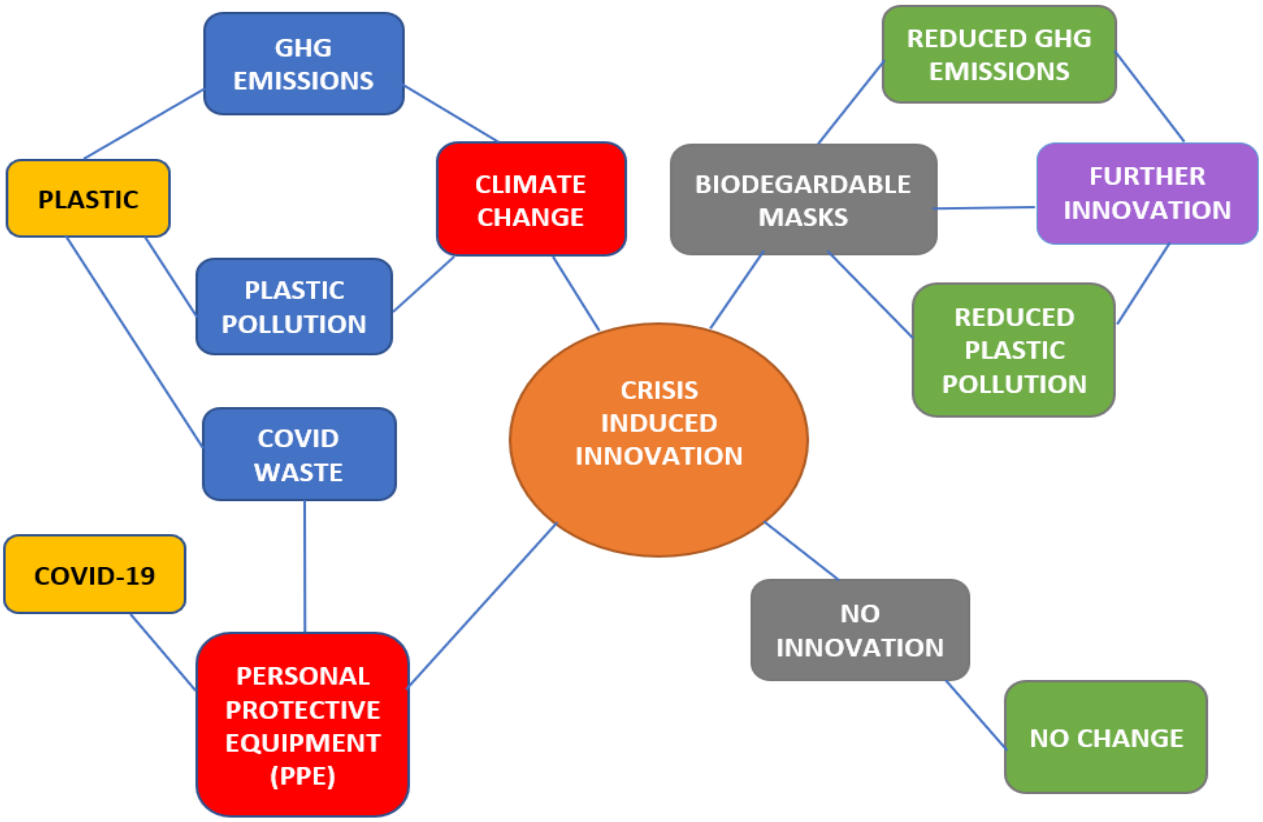

Figure 5. The analytical model (by authors Larsen & Koperek, 2022)

In this section we present the analytical model and approach to Crisis Induced Innovation, with the aim of explaining how the topics of study are related through perceived correlations and causality, and how we plan to apply our theoretical frameworks. We briefly clarify our analytical focus for the thesis, with a categorical description of what our approach accounts for. Following this section there is a detailed, in-depth description of the theoretical background and frameworks we believe to be relevant, accompanied with a depiction of how these frameworks are applied for the case study.

The model above is meant to function as a visual representation of the phenomenon "Crisis Induced Innovation." The model is color coded and accounts for seven categorical entries, moving from left to right in chronological fashion, detailing the perceived causal developments that create the necessary market conditions for Crisis Induced Innovation to occur, as well as the plausible outcomes it causes. The left side of the model accounts for identified crises marked yellow, directly associated problems marked with blue, and perceived drivers marked red. We have identified Covid-19 and Plastic as crises, with Greenhouse gas

emissions, plastic pollution, and Covid waste as associated problems, and the market demand for PPE and climate change as drivers for Crisis Induced Innovation. The right side of the model accounts for possible outcomes of the innovation process marked in gray, anticipated short term effects marked in green, and potential long-term effects marked in purple. To keep the model simple, we elected to look at potential outcomes as binary, meaning that the innovation project is going to be either be successful or unsuccessful. The anticipated short-term effects are a reduction in GHG emissions and plastic waste pollution if Artic Healthcare is successful in developing a biodegradable surgical mask, and no change if the project is unsuccessful. Finally, we have recognized further innovations as a potential long-term effect if the project is a success and if the developed technology is applicable to other products. At the center of our model, we find the phenomenon Crisis Induced Innovation, which is the focal point of our analytical efforts. We believe the model can explain the phenomenon in the following linear fashion:

CRISIS -> PROBLEM -> DRIVER -> CRISIS INDUCED INNOVATION -> OUTCOME -> SHORT-TERM EFFECT -> LONG-TERM EFFECT

The model at hand not only visualizes how Crisis Induced Innovation is an outcome of a complex series of causal conditions, but it also shows that the phenomenon itself is intricate and its own outcome uncertain. Working on this thesis, we have realized that the phenomenon as a whole is too complex to be studied by a single framework and have come to the conclusion that an equally complex approach is necessary. Therefore, we have elected to approach this subject with a layered analysis, in which we apply theoretical frameworks on individual parts of the recognized phenomenon in a step-by-step fashion. At the center of our analytical approach, we utilize the Multi-Level Perspective as a grand structure in which we can map out the elements of this complex phenomenon across its dimensions, and within this context apply each of the other theoretical frameworks individually. The theories and frameworks that are included in this grand structure is the application of emergency frames to identify and understand crisis and associated problems, the rhetorical situation and its lifecycle to better understand Artic Healthcare's standing in this phenomenon and associated challenges and opportunities, and innovation management theories to evaluate Artic Healthcare's performance and outlook. We have also gathered theoretical background information about the phenomenon of Crisis Induced Innovation, which provides a context in which we can properly conduct our analysis. Throughout this chapter we go through these

theories in detail, as well as practical descriptions for how they are applied for our analysis in the Discussion chapter.

3.2 Crisis Driven Innovation

Boin et al. (2009) refer to crises as "events or developments widely perceived by members of relevant communities to constitute urgent threats to core community values and structures" (Boin et al., 2009, p. 83). Crises are events defined by threat, urgency, and uncertainty with stages before, during and after and usually have long lasting impacts and "exhibit increasingly transboundary dynamics" on multiple sectors, systems, and social functions (Dahlke et al., 2021, p.1), (McHugh et al., 2021, p. 5). Therefore, they require quick response and joint actions from global actors to ensure safety (Dahlke et al., 2021, p. 1). Accordingly, such emergencies often create great freedom of actions and call for innovative solutions in an effort to help mitigate the negative effects. Many refer to such phenomena as a crisis driven or Crisis Induced Innovation.

Recent research on innovation connected to the current pandemic refer to Crisis Induced Innovation as to an open innovation, where there is an urge of joining forces by governmental institutions, non-governmental organizations, firms and individuals in order to mobilize the knowledge, shared resources and capabilities that are necessary to speed up the process of creating, testing and launching possible solutions (Dahlke et al., 2021, p. 2). Moreover, as stated by Bessant et al. (2012), innovation is an action for greater good, that usually is a combination of already existing elements rather than new ones. They highlight that social innovations often require cutting across organizational, sectoral or disciplinary boundaries in order to create new social collaborations between individuals and groups so they can contribute to the diffusion and embedding of the innovation as well as increase the potential for future innovations (Bessant et al., 2012, p.222). Similarly to Dahlke et al. (2021), they also refer to it as the notion of open innovation, where building on the inherent capacities of communities and individuals is especially significant. They describe crisis driven innovation as social innovation that often emerges out of urgency to meet the widespread needs and demands and limitations of resources, where new ideas and solutions for these innovations arise from creative rethinking and recombination processes (Bessant et al., 2012, p. 222).

Latest studies on effects of the pandemic bind formation of crisis- driven innovation to the changes in pronounced human needs that occurred during the Covid-19, for example increased need for health and protection. Research highlights that it is critical to identify and

monitor such human needs in order to help guide policies and relief efforts during the pandemic. Dahlke et al. (2021) presented the framework of Max- Neef et al. (1989), where he illustrated market demands as fundamental human needs and innovation as a provision for the satisfaction of these needs. This process involves and emerges from both consumers and producers (Dahlke et al., 2021, p. 2). Ebersberger and Kuckertz (2021) explain that crisis-driven innovations are the answer to crises that solve problems associated with it. They claim that such unforeseen problems that emerge during the crises lead to changes in needs and behaviors that trigger innovative solutions (Ebersberger & Kuckertz, 2021, p. 126).

Dahlke et al. (2021) pointed out that the pandemic has not only affected our physical health and needs but it has also caused enormous effects on the economic welfare, the entire socioeconomic system and it has put great pressure on socio-technical regimes (Dahlke et al., 2021, p. 2). As determined by Geels such regimes may include "technology, user practices and application domains (markets), symbolic meaning of technology, infrastructure, industry structure, policy and techno-scientific knowledge" (Geels, 2002, p. 1262). Moreover, they mentioned that Covid-19 had a strong effect on supply chains and caused shortage of resources followed by inability to provide certain goods and services which can also be associated with satisfaction of human needs and increase the demand and be a "pull" factor for innovation (Dahlke et al., 2021, p. 2).

Taking into consideration all the above-mentioned contributions, the involvement of actors such as firms and institutions in crisis innovations play a critical role here as they have required capabilities for identifying and addressing complex needs of consumers. They are capable of exploiting the opportunities and effectively utilize their resources in order to rapidly respond to the crises (Netz et al., 2022, p. 408). However, there are many factors determining whether the company decides to engage in innovation development.

Netz et al. (2022) indicated that whether the company decides to diversify into crisis driven innovation aiming to respond to new needs emerging from societal crises, strongly depends on their organizational cognition, influenced by social norms. They describe social norms as a guide towards the correct shared understanding regarding actions that are critical or forbidden, they drive collaborative action and entrepreneurial-driven radical innovation. Shared awareness of a crisis gives companies the purpose and entrepreneurial vision and energizes them to respond with new product innovation (Netz et al., 2022, p. 409). Moreover, Ebersberger and Kuckertz (2021) claim that innovation activities are a major driver of firm

success throughout a recession and that they can significantly contribute to firm recovery from the effects of crises which can also be considered as pull factor (Ebersberger and Kuckertz, 2021, p. 127).

Currently, many firms despite the possible lack of experience, limited knowledge about the market and uncertainty about potential future profits have decided to respond to Covid-19 by developing innovative solutions in order to mitigate the negative effects of the pandemic (Netz et al., 2022, p. 407). However, recent research shows that some of the companies are a better fit than the others to successfully develop innovative solutions.

According to Netz et al. (2022) for many already existing companies considering their involvement in innovation development it might be difficult to mobilize new product innovations as they first must ensure to secure the existing operations taking place in the firm. Moreover, development of a new product often involves increasing spending rather than cutting costs as well as it challenges path dependence, existing structures and difficult to overcome organizational inertia and commitments (Netz et al., 2022, p. 408). Additionally, another factor deciding about the firm's ability for introducing innovations is the response time. Time plays a significant role in all human activities and how quickly a firm can respond to the challenges is crucial because the quicker innovation time response the bigger potential for higher innovation speed. Ebersberger and Kuckertz (2021) in their study investigating organizational actors´ innovation response time, describe the response time as “the time from the first identification of needs to launching an innovation” (Ebersberger and Kuckertz, 2021, p.127). They explain that innovation response time depends mostly on how firms perceive time as a scarce resource. They present different dichotomies of time orientation that influence response time in the organization in regard to Covid-19 such as clock time orientation, linear versus cyclical time orientation and internal and external time orientation. They conclude that firms with clock time orientation are usually unequipped for innovating at a high innovation speed and firms with cyclical time orientation, where the past is a guide to the future activities might not benefit from it during a crisis as the past do not provide sufficiently valuable information about the future and the development. However, they highlight that innovation speed in an organization strongly depends on an organization's external entertainment. They refer to it as “the synchronization of an organization's activities to the dynamics of an external environment, and internal entertainment relates to understanding and orchestrating the pace of internal function” (Ebersberger and Kuckertz, 2021, p. 127).

Regarding the time response, Ebersberger and Kuckertz (2021) argue that start-ups are crucial to rapid innovation in crises and their innovation activities are considered as less affected by it. Current pandemic has not only changed the demand and supply but also influenced how we behave, think and consume and Covid-19 innovations entered many sectors such as health, urbanization, data and commerce. Therefore, the pandemic opened a great spectrum of opportunities for innovative start-ups. The study shows that, in contrast to already established firms and research institutions, start-ups are the quickest to react to the changing innovation landscape and speed up the innovation process (Ebersberger and Kuckertz, 2021, p. 132) as they do not follow the classic project management style but rather, they utilize discovering and iterative approaches to define their business model or effectual logic. They focus their goals on creating the future and achieving key milestones and events during the creation process rather than sticking to old habits and striving to predict the future (Ebersberger and Kuckertz, 2021, p. 127). They stand out with their entrepreneurial thinking and usually define themselves as a part of entrepreneurial ecosystems relying on other stakeholders such as investors, key customers, or economic development agencies (Ebersberger and Kuckertz, 2021, p. 127). They possess “assets of newness” such as organizational energy and flexibility which gives them a big advantage over the already established institutions (Ebersberger and Kuckertz, 2021, p. 132). These characteristics mostly result from start ups´ focus on linear time orientation and exhibited high external time orientation as well as maintained event time orientation (Ebersberger and Kuckertz, 2021, p. 128).

Considering the above-mentioned assets of startups, we aim to investigate whether the flexible structure of start-ups, which often correlates with innovation speed, give Artic Healthcare any advantages when undergoing their innovation project, or if being a young and inexperienced firm makes for a more challenging process. If the latter is more likely, how does Artic Healthcare fair in the face of these challenges?

In the Discussion chapter we revisit the topic of Crisis Induced Innovation, where we use the already established theoretical foundation in order to better identify and understand what a crisis is and how it drives innovation, as well as the importance of a fast response in crisis induced processes when time is of the essence.

3.3 The Multi-Level Perspective

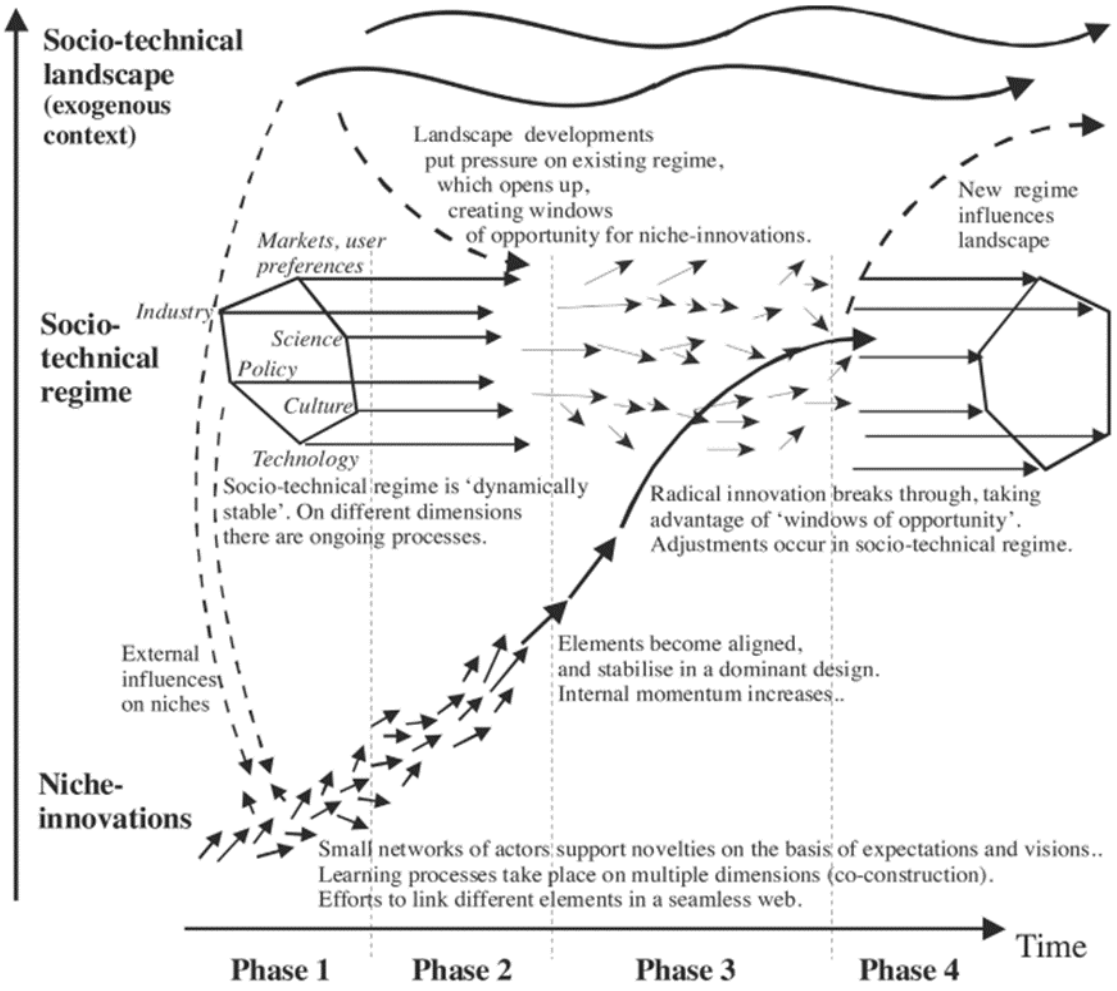

Figure 6. Multi-level perspective on sociotechnical transitions.

From "Disruption and low-carbon system transformation: Progress and new challenges in socio-technical transitions research and the Multi-Level Perspective" by Geels, F. W., 2018, *Energy Research & Social Science, 37*, p. 226. (https://doi.org/10.1016/j.erss.2017.10.010). Copyright 2018 by Elsevier.

The Multi-Level Perspective, commonly referred to as the MLP, is a theoretical framework with origins in the field of innovation studies and is designed to examine and understand socio-technical transitions. The framework is rather broad and allows the user to examine the phenomenon across three separate dimensions: socio-technical landscape, socio-technical regimes, and niche-innovations. At the core of this framework is the notion that transitions are not the result of linear developments or single-point sources of origins, but rather a complex result of interactions within and between these three levels (Geels, 2012, p. 472).

The MLP offers the user a framework that views social structures as a collection of socio-technical systems, placed in the regime dimension, that are made up of technologies, actors, structures, cultures, and more. These systems are stable and self-enforcing, though dynamic and ever-changing at slow, incremental speeds. The socio-technical regime, which is placed at the centre of the MLP framework at what is commonly referred to as the meso-level of analysis, is under constant pressure from landscape changes and niche developments (Geels, 2012, p. 472). The MLP, at its core, is a study of the outcome from an everlasting interaction between dynamic stability and radical change and is best used when wanting to understand how grand social transitions, with a focus on technological foundation and integration, take place and evolve over time. The MLP framework, as visualized in *Figure 6*, bear similarities to a dynamic map that showcases the three dimensions with extensive temporal dynamics that shows the content of each level, how the levels interact and impact each other, and with descriptive explanations of how transitions transpire. It is our intention to utilize the MLP as a grand theoretical framework that allows us to distribute the core elements that makes up Artic Healthcare's case of Crisis Induced Innovation across the three levels of study, so that we can break down the complex phenomenon into identifiable elements and gain a greater understanding of how these elements interact using the naturally dynamic structure of the MLP. Furthermore, we intend to apply additional theoretical frameworks into each of the three dimensions. We have identified a series of theories that we believe are suitable to study the individual elements of Crisis Induced Innovation, and that also have a natural fit within the MLP itself. Following we give a brief description of each level, how they interact, and which additional theories we integrate.

First, what exactly is a socio-technical system, and what does a transition entail? Socio-technical systems refer to a collection of elements that are interconnected and share a path-dependency on the basis on common culture, beliefs, technological foundations, market relations, and more. The regime is made up of groups of such systems, which represents public transport, energy sectors, consumer and financial markets, and more. These systems, in short, make up our social structures, and actors within specific systems and the regime as a whole have to abide by their rules. While the incumbent regime is subject to a high degree of stability, it is subject to change, and evolves due to a combination of internal incremental developments, landscape pressures, and the development of radical niches (Geels, 2018, p. 225).

The socio-technical landscape consists of the larger environment and context in which regimes and niches exist. The elements in this sphere influences both regimes and niches alike and offers a constant pressure on the other dimensions through slow-changing developments and exogenous shocks (Geels, 2018, p. 225). Slow changing influences includes geopolitical dynamics, changes that occurs over time in demographics, and, with special relevance to our case, global warming and climate change. Exogenous shocks on the other hand are rapid events with direct impacts, and can include financial crisis, armed conflicts, and pandemics. At the landscape level of our MLP analysis we use this dimension to evaluate how the "Crisis" in Crisis Induced Innovation has impacted the regime and created a window of opportunity that Artic Healthcare has identified. This effort is assisted by theoretical frameworks from the field of emergency frames.

Niche innovations encompasses radical developments at the micro-level of the MLP, and consists of scientific, technological, and social developments that differ from the standard of the socio-technical regime (Geels, 2018, p. 225). These novel developments are usually in the form of start-ups or research projects and are propelled up towards the regime level through three separate processes that can create momentum: learning processes, articulation and expression, and building social networks (Geels, 2012, p. 472). Learning processes refers to the process of self-improvement and developing the technologies, market understanding, efficient organizational structure, and more. The articulation and expression refer to internal and external communication, and focuses on how niches gather attraction and interest, and affects whether one collects external funding or partnerships. The building of social networks focuses on how a niche interacts and collaborates with other actors, attracting the right kind of collaborators that can help with development. Niches are known to accelerate their trajectory if they manage to align these three processes (Geels, 2012, p. 472). The MLPs dimension of niche innovation are applied to the case of Artic Healthcare with the purpose of examining their efforts in moving forward. This analysis is accompanied by selected theories related to innovation management.

While every socio-technical transition can be said to be unique, there is an established understanding of which elements are present and affect the process. In the process of a transition, all three levels of the MLP are involved: the existing regime is pressured by changes at the landscape level, resulting in a destabilisation of the regime creating a window of opportunity, and the niche development attains internal momentum advancing towards the window (Geels, 2012, p. 473). We believe that we can identify the key processes in the case

of Artic Healthcare and the phenomenon of Crisis Induced Innovation. The window of opportunity, resulting from these dynamics, is also analysed as a rhetorical situation.

3.4 Emergency frames

Nowadays, society must cope with a great deal of challenges that arise from certain events currently taking place in the world. As of today, people struggle with issues such as conflicts and wars or climate change and Covid-19 pandemic, which are the focus of this research. Such events, as mentioned before, are often viewed as crises, disasters, or emergencies. They are threatening and immediate in nature and happen unexpectedly, at least in relation to a specific location or timing. Moreover, they are usually on a global scale affecting most of the population (McHugh et al., 2021, p. 6).

However, before such unexpected and threatening events that occur in society become declared as an "emergency" or a "crisis", they are firstly perceived as a "risk", until more information is uncovered and a better understanding about it is gained. Up till recently, climate change was only viewed as a "future risk", where currently it is widely recognized as an "emergency" (McHugh et al., 2021, p. 3). Building on the example of climate change and sustainability, we aim to clarify how firstly an event is considered as "risk" and how it transforms into a "crisis" or an "emergency" over time and thereby explain how actors perceive such events and deal with uncertainty of actions and hazards that influence future outcomes.

There is a great deal of variety of research theorizing risk in different study areas, however the shared idea is that it is possible to manage future outcomes and decrease risk´s uncertainty by drawing lessons on present activities by determining the consequences of these activities. Hence, it depends on the intention of the action of actors whether risk brings new possibilities or undesirable outcomes. Yet, it is problematic to fully understand and account for risk before it occurs, as many "side effects" are not known before they unfold. Moreover, some of the risks, such as in this case climate change, are more complex and uncertain than others which makes it more challenging to address. When managing risk, it is critical to determine who accounts for the responsibility and blame as it is often unclear and confusing about who should be in power to do so. Therefore, the most critical matter in understanding the risk is accounting for its governance. Governance refers to the ways that many different actors and individuals from both private and public sectors cope with the risks surrounded by uncertainty, ambiguity, and complexity. Risk governance is viewed as a tool that brings

together different knowledge and values aiming to integrate the social, political and technical elements of risk (McHugh et al., 2021, p. 3). Nevertheless, over the years the perception of risk about climate change shifted dramatically from the state of "future risk" to the state of "current crisis/ emergency" due to the increased severity of the issue and time pressures related to it. Simultaneously, changing risk framing into emergency framing (McHugh et al., 2021, p. 3).

An emergency is about social interpretation of the events, and about what can be defined as an emergency depends on how social actors view, interpret, and frame the issue (McHugh et al., 2021, p. 5). Patterson et al. (2021) explain that emergency is not objective but rather it is viewed as shared perceptions and experiences of urgency and threat (Patterson et al., 2021, p. 842). Yet, determination of the beginning and the end of an emergency usually differs across social sciences. In organizational management approaches, the event is defined as an emergency by the managers involved in it, where in political science, an event can be recognized as an emergency only after it has undergone a process of politicization, by which social actors handle it differently to an everyday occurrence (McHugh et al., 2021, p. 6).

Patterson et al. (2021) describe emergency frames as "a sense-making lens that conveys the meaning that a given set of circumstances constitutes an emergency" (Patterson et al, 2021, p. 841). McHugh et al. (2021) refer to Entman´s (1993) definition of framing as to "selecting some aspects of a perceived reality and making them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described" (McHugh et al., 2021, p. 2). In other words, emergency frames are about a shared understanding over a matter that is extraordinary and urgent that calls for collaborative actions to avoid further catastrophe with worse outcomes. Emergency frames vary depending on the issue, place, time and who deploys the framing, and they have multiple drivers both socio-political and scientific. Framing is an interpretation and categorization for understanding an issue and providing responses. The aim of framing is to make sense of an uncertain situation or an issue where information is lacking and to influence and mobilize people and their behaviors, attitudes and action on such issues. Several actors can be involved in defining emergencies and in framing such as politicians, the general public, network of experts as well as the media. Emergency frames are a significant advocacy tool for actors that influences perception of the problem by policymakers and the general public as well as have an impact over political agendas (McHugh et al., 2021, p. 2).

The notion of "emergency" in a way assumes what is defined as a normal action depending on what kind of emergency frame is taken into consideration. Emergency-as-reaction´s purpose is to respond to immediate danger and to return to pre-existing conditions, where emergency-as-strategy is focused on making an exception to the norm by implementing a political innervation that brings attention to the issue in a new way. This applies especially to open-ended emergencies such as climate emergency where "quick fix" remedy does not solve the issue, but rather more complex solutions are required, which are usually time-consuming and very difficult to achieve (Patterson et al., 2021, p. 842). Moreover, for emergency-as-strategy, where there is no immediate danger, framing is "geared towards stimulating urgency (for example speed)" which increases the ambition of action (Patterson et al., 2021, p. 843). The key difference between both emergencies is that emergency-as- reaction responds to impacts that have already occurred, whereas emergency-as-strategy intends to avoid future impacts (Patterson et al., 2021, p. 843).

Patterson et at. (2021) shed a light on emergency frames in sustainability context and described how emergency frames are being formed in contemporary suitability. First, emergency frames are established to address the critical issues such as "day zero" in Cape town in 2018. Next, they become a strategic tool to attract attention, mobilize effort and obtain resources to be able respond to the issue with the action that was lagging. Examples of such are the United Nations Environment Programme actions labeling climate change and biodiversity as emergencies on their website since 2019 or issuing a report to "tackle the climate, biodiversity and pollution emergencies" from 2021 (Patterson et al., 2021, p. 842).

In the Discussion chapter we revisit the topic of emergency frames, where we use the revised theory to identify the markings of an emergency and how it differs from perceived risks. The theory is used together with the MLP in which we evaluate the pressure that the socio-technical regime puts on the regime. Furthermore, we use the established theoretical foundation to evaluate the difference between emergency-as-reaction and emergency-as-strategy in practical terms.

3.5 Innovation management

There is no one generally accepted definition of the term "innovation" as it varies across different fields of study. However, Eveleens (2010) suggested several explanations of this concept that can be found in innovation research (Eveleens, 2010, p. 2):

"Innovation is the specific tool of entrepreneurs, the means by which they exploit change as an opportunity for a different business or service" (Drucker 1985)

"Innovation is the successful development, implementation and use of new or structurally improved products, processes, services or organizational forms" (Hartley, 2006)

"Innovation is something new being realized with (hopefully) added value" (Jacobs and Snijders 2008)

Innovation is possible in multiple areas and can be applied to technology, product/service, organization, business, strategy, process or marketing. All these innovations vary from each other and have different purposes. However, this thesis focuses on and further explains product innovation. Product innovation is defined as a process that "results in a qualitatively superior product from a given number of resources" (Rosenberg, 1982, p. 4). Product innovation proposes a new way to solve consumer problems and goes beyond the traditional and standard practice and methods. It offers benefits to both consumers and producers through a development of novel ideas with improved performance, in comparison to the already existing ones. Moreover, it demonstrates improvements in "technical specifications, components and materials, the implemented software, facilitating the use of the product, or functional characteristics of the product" (Milić, 2013, p. 86). However, it must be mentioned that such innovation is associated with concepts of risk and uncertainty which are viewed as key attributes of it and that make the innovation management process more difficult than the traditional one (Murphy et al., 2015, p. 210).

Innovation management is considered as a business behavior that is recommended during the duration of the crisis, where innovation is recognized as a key to eternal recovery. Innovation management is about bringing an innovative culture into an organization by exploring, developing, implementing and promoting new ideas, discoveries and business opportunities. It is about targeting systematic processes to develop new products, services or processes based on creative ideas designed by the actors in an organization in a fast, efficient and qualitative way with a consistent flow targeting the market. This process is about utilizing new knowledge to enhance the products and services in different, innovative ways in order to satisfy end-users, secure businesses and stimulate the progress as well as address problems and increase efficiency (Milić, 2013, p. 83).

Based on Eveleens (2010) research investigating 12 different innovation management models from a variety of scientific research, we have constructed a figure that illustrates how innovations can differ across several dimensions (Eveleens, 2010, p .2-3):

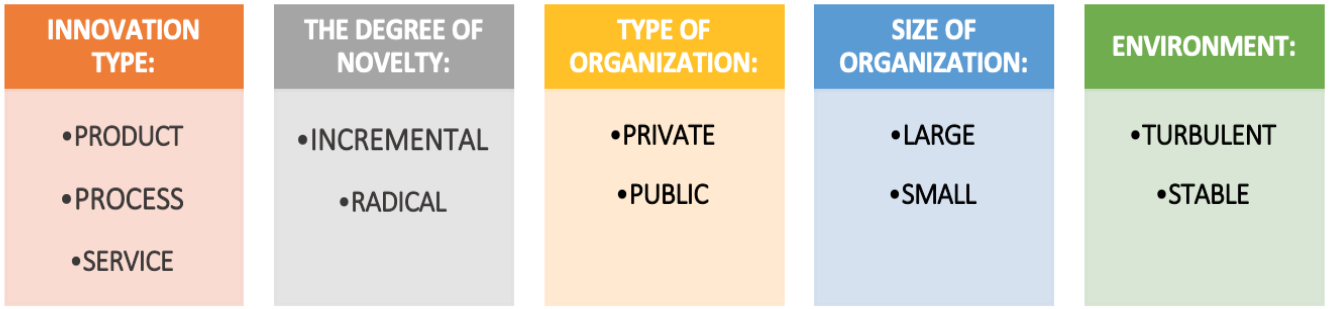

Figure 7. Five different dimensions of innovation (by authors Larsen & Koperek, 2022).

Based on "Innovation management; a literature review of innovation process models and their implications" by Eveleens, C., 2010, *Science, 800*(2010), p. 2-3. (https://www.researchgate.net/profile/Chris-Eveleens/publication/265422944_Innovation_management_a_literature_review_of_innovation_process_models_and_their_implications/links/5534fe9f0cf2df9ea6a41548/Innovation-management-a-literature-review-of-innovation-process-models-and-their-implications.pdf).

The above-mentioned figure is rather self-explanatory; however, we believe that it is worthy to describe the difference between radical and incremental innovation as this concept might not be familiar to everyone. Radical innovation explores new technology and focuses on products, processes or services with unprecedented performance features, where incremental innovation exploits already existing technology with the focus on costs or existing products, processes or services features' improvements. In radical innovation dramatic changes occur, which transform the existing markets and industries or create new ones. Incremental innovation aims at improving competitive edge in markets and industries that already exist (Milić., 2013, p. 84).

Eveleens (2010) points out that models of innovation management process differ depending on dimensions of innovation; however, he distinguishes certain phases that are characteristic for most of them. Figure below illustrates four different phases of an innovation management process and was created based on Eveleens´ (2010) evaluation (Eveleens, 2010, p. 8):

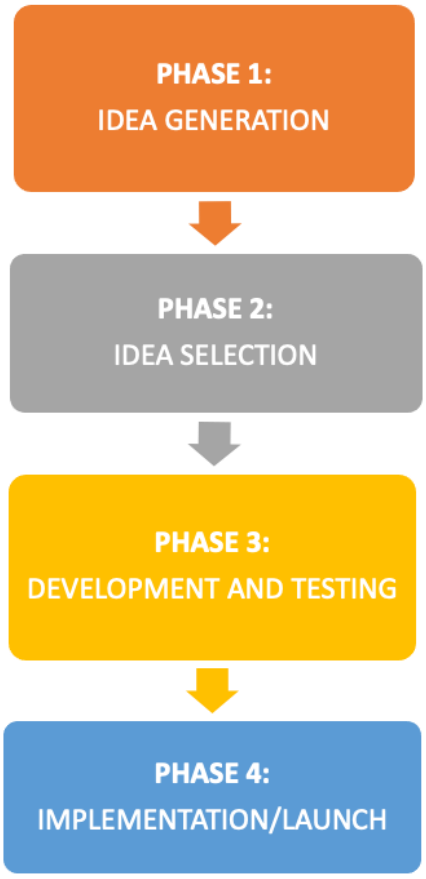

Figure 8. Phases in the innovation management process (by authors Larsen & Koperek, 2022).

Based on "Innovation management; a literature review of innovation process models and their implications" by Eveleens, C., 2010, *Science*, *800*(2010), p. 8. https://www.researchgate.net/profile/Chris-Eveleens/publication/265422944_Innovation_management_a_literature_review_of_innovation_process_models_and_their_implications/links/5534fe9f0cf2df9ea6a41548/Innovation-management-a-literature-review-of-innovation-process-models-and-their-implications.pdf.

The process starts with phase 1, where idea generation occurs. Here, actors in the organization search and brainstorm different ideas for innovation and consider opening new possibilities. In phase 2, actors sort the options and narrow them down. The decision-making process takes place, and the final idea is being selected. This decision should be based on organizational strategy and existing portfolio of projects to roll out the risk. In this stage, it should be accounted for whether the innovation will be profitable and if it will raise public value. In phase 3, a selected idea develops into an innovative product, process or service. Here, testing

of the innovation takes place and more resources are designated to the project. In the last phase, the developed innovation is introduced and implemented to the market. It consists of customer preparation and marketing related activities.

These four stages are critical for the innovation development process however, there are other phases that occur after the implementation of the innovation which can also be considered as a part of the process. The *post launch phase* and *explicit learning* phase are the phases that include sustaining and supporting the innovation as well as learning about the innovation and its process with the aim to draw valuable conclusions for the future (Eveleens, 2010, p. 8).

Based on the theoretical foundation that we now have established concerning innovation management, in the Discussion chapter evaluation of Artic Healthcare's progress in their innovation project is performed. This is with the aim of getting a temporal perspective on innovation speed and the path still ahead. The theory is utilized in tandem with the niche development framework utilized with the MLP.

3.6 Rhetorical situation

There are many kinds of situations wherein a problem or a challenge arises, or a situation that simply requires some form of action to be handled. If these situations can be treated, partially or fully, through means of communication, they are rhetorical. However, the situation is not as broad and inclusive as one would think at first glance, as it demands that you communicate in a particular way, and there are three core elements that needs to be present in any situation for it to be a rhetorical one: Exigence, a rhetorical audience, and rhetorical constraints (Kjeldsen, 2016, p. 80).

An exigence refers to an appearing situation that requires urgent care to be treated, but it does not necessarily mean that the arising situation must be a negative one. The exigence is usually considered as a problem or a challenge and requires the use of rhetoric or other forms of communication to be solved (Kjeldsen, 2016, p. 81). Furthermore, the rhetorical situation requires the presence of a rhetorical audience. Rhetoric is per definition directed, strategic communication, uttered with the purpose of receiving a specific response from its recipient. It affects change by influencing peoples' thoughts, decisions and actions, and its intended audience are the people who have interest and capability to solve your problem, the exigence (Kjeldsen, 2016, p. 83).

The exigence in questions needs to be made up of conditions with applied interest, meaning an issue and a framing that makes your audience attached to it with a will to provide a solution. Therefore, it is essential that the rhetorical message is designed to resonate with both the actual problem as well as the interest to solve it. What this means in practical terms is that the rhetorical audience must agree that the identified exigence is a problem, and that it is a problem worth fixing (Kjeldsen, 2016, p. 84-85). Attached to each unique rhetorical situation is a perceived degree of urgency. It is not only shared perspective and interest that affects whether the audience will join you, but there is also a degree of responsiveness, where the more urgent the matter the more likely it is that you will be successful in your rhetorical response (Kjeldsen, 2016, p. 86).

This leads to the requirement of a fitting response. As each rhetorical situation is unique, so is the requirement for successful action. This can be exemplified with the case of Artic Healthcare and the phenomenon of Crisis Induced Innovation, where we believe to have identified a rhetorical situation connected to their ongoing innovation project. As presented in the Findings chapter, Artic Healthcare has identified a unique opportunity in which they can bring a sustainable surgical mask to the market, given that they are able to solve some key issues. Firstly, there is an exigence in the form of lacking funds, where the solution is to attract funding through convincing Innovation Norway that their project will be a success. The second, given that the first issue is resolved, is to convince a rhetorical audience to purchase their biobased, biodegradable products instead on non-sustainable alternatives. This is quite a unique situation, and quite challenging as well, as we now unveil the next variable into the situation: The life cycle.

Rhetorical situations appear, grow, and mature up to the point where a rhetorical response is most appropriate. The time frame for when the situation is mature does not have a standard limit, but is rather unique to each individual situation, and can last anywhere between seconds, days, and years. If you do not make a fitting rhetorical response within the correct timeframe, the situation will eventually start to decay and deteriorate to the point that it is no longer possible to solve it with rhetorical means (Kjeldsen, 2016, p. 89). The rhetorical situation has a life cycle that consists of four stages: 1 Origins, 2 Maturity, 3 Deterioration, and 4 Dissipates.

At the stage of origins, we discover the appearance of the exigence, although at this stage it is not accompanied by an audience or rhetorical conditions and can therefore not be responded

to at this stage. Next, at the stage of maturity, rhetorical conditions are identified and there is an audience that is willing and capable to solve the problem. It is at this stage that the problem can be solved with a rhetorical response. If left unaccounted for, the situation will start to deteriorate and becomes far more difficult to solve, the audience is less willing, and conditions may have changed. Finally, the situation dissipates, and at this stage the conditions for success are no longer available (Kjeldsen, 2016, p. 90-91).

Throughout this entire chapter we have presented an analytical approach, a descriptive contextualisation of the phenomenon Crisis Induced Innovation, as well as the theoretical frameworks of the MLP, emergency frames, and innovation management. Due to the level of complexity associated with the phenomenon in focus, we believe it to be necessary to break down the concept down to individual, more easily digestible pieces that can study individually with the purpose to better understand the whole. The Multi-Level Perspective allows us to map out the various mechanics of the phenomenon across three dimensions of analysis, wherein we can identify the temporal dynamics of landscape pressures, regime responses, and niche development pathways. The application of theories associated with emergency frames allows us to identify the perceived threat associated with the phenomenon with special focus on the Covid-19 pandemic and the environmental impact of plastic waste pollution, further identifying how these dynamic developments open a window of opportunity in the socio-technical regime. Now, with the descriptive and detailed introduction to rhetorical situations, we have the opportunity to evaluate the window of opportunity that the phenomenon Crisis Induced Innovation has opened, allowing us to analyse the situation as a whole as a rhetorical situation with specified conditions to its life cycle limiting the window of opportunity. These steps are further detailed in the Discussion chapter.

4. Research design

In this chapter, we highlight the research design chosen for this study as well as describe the strategies, methods, and techniques utilized to obtain and analyze the data. Moreover, we address the quality and limitations of our work.

4.1 Research approach

Abductive strategy

In abductive strategy social scientific findings are derived from everyday accounts (Blaikie, 2010, p.10). The strategy is associated with observing, interpreting, explaining, and describing an already known phenomenon within a new context, thus producing new meaning (Danermark et al., 2002, p. 91).

Accordingly, our thesis conforms to an abductive design through our efforts at performing interviews that address important gaps in the literature with the aim of adjusting existing knowledge in the analysis process. Data and information relevant to the contextual aspects of this case study were produced by interacting with the people involved. We have conducted expert interviews with the people involved in Artic Healthcare and their ongoing innovation project. This allowed us to get a better understanding of their motives and behavior, which is interpreted and later discussed in contexts related to Covid-19, sustainability and innovation.

Ontological and epistemological assumptions

Research strategies are based on the ontological and epistemological assumptions. Both assumptions´ aim is to define what we know and how we know it. In abductive strategy, the epistemology of *constructionism* as well as *subtle realist* and *idealist* ontology are used. Blaikie (2010) describes *subtle realist* and *idealist* assumptions as assumptions, where the reality exists independently of social scientists and where social actors perceive the social reality based on the shared interpretations that they construct and reproduce throughout everyday life experiences as well as that reality is represented by the creation of the human mind. *Constructionism* refers to everyday knowledge being an outcome of our interpretation of the physical world and of human interaction, where scientific knowledge is reinterpretation of this everyday knowledge made by scientists, which is then transferred into technical language. Social research depends on the researchers' standpoint and all observations are supported by the theory, therefore there is no specific criteria for checking the validity of the knowledge (Blaikie, 2010, p. 92-95). Thus, such assumptions are essential to consider for our analysis where we interpret and discuss gathered findings about real life experiences of actors involved in this study.

Research paradigms

Research paradigms are considered as a source of traditions of theoretical and methodological ideas that are used as a background when developing social research. There are four different types of research paradigms that can be distinguished such as *Positivism, Critical Rationalism, Classical Hermeneutics* and *Interpretivism.* Blaikie (2010) refers to them as possible sources of assumptions and ideas that can be used where it is suitable. For this thesis, *Interpretivism* research paradigm was chosen as it closely fits to previously selected abductive strategy and shares the same perception of social reality based on social actors´ interpretation (Blaikie, 2010, p. 98-99).

4.2 Qualitative methods

After performance of a thorough investigation of various research methods, it was decided that a qualitative research design is the most suitable for this study. A qualitative research method utilizes "soft" sources of data such as words, sentences, photos and symbols, where dominates the "language of context" based on relying on principles from critical or interpretive social science (Neuman, 2014, p. 167). In qualitative research a detailed examination of cases that emerge in social life is being performed, where we interpret experiences of individuals and identify their meanings with the aim to get better understanding or new insights and to generate new hypotheses (Sovacool et al., 2018, p.28).

The case study design

Case study allows the researcher to perform an in-depth examination of a specific subject or a particular phenomena and the contextual conditions related to it. Case study is an investigation focused on a specific case or several cases of for example firms, cities, communities or individuals with the use of multiple sources of evidence such as interviews, documents or direct observations (Sovacool et al., 2018, p. 30). Highly cited work of Yin (2003) on case studies, proposes utilizing case studies for "how and why" questions about a contemporary set of events or over which the investigator has little or no control in order to obtain a real-life context of a phenomenon. In case study, data collection and analysis are guided by and benefits from the previous development of theoretical propositions (Yin, 2013, p. 13-18). Flyvbjerg (2006) refers to case studies as to a valuable research method or a

method of learning that focuses on context-dependent knowledge and experience that are essential for expert activity (Flyvbjerg, 2006, p. 222).

For this thesis we decided to focus on a single case study." Single case studies tend to be evidence-rich, allowing a range of relevant factors to be measured and assessed and allowing a consistent and coherent narrative and argument" (Sovacool et al., 2018, p. 30). They are exploratory and descriptive in nature with the goal for generating hypotheses and assumptions as well as to make deep or thick descriptions. (Sovacool et al., 2018, p. 31). In particular, in this thesis we investigate the case of Aric Healthcare and their innovative projects that emerged during the Covid-19 crisis. This start-up company was established during the pandemic to help in responding to needs and demands that emerged on the market during that period of time. We decided to focus specifically on a single case study as we do not aim at making any comparisons or generalizations about how other companies with similar purposes deal with Crisis Induced Innovation. Rather, the objective is to better understand the phenomenon of Crisis Induced Innovation through the case of Artic Healthcare, to examine how they have exploited the drivers of innovation in a time of crisis, and how they plan to make their efforts have a lasting impact that goes beyond the scope of the crisis itself.

4.3 Methods of data collection and analysis

For the data collection for this research the triangulation method was utilized. Triangulation is a strategy in qualitative research that focuses on making observations from different viewpoints rather than investigating a phenomenon only from one perspective. In particular, this study focuses on a "triangulation of measure", where multiple measures and methods are taken to study the same phenomena (Neuman, 2014, p. 166). The choice of this method was made in order to enhance the reliability and validity of the study as well as to gain more comprehensive insights and provide more sophisticated answers to our research questions (Sovacool et al., 2018, p. 20). For this thesis data was obtained through semi-structured interviews and document analysis. They all allow to collect and analyze the data about perceptions, opinions, and attitudes of the individuals and groups in different contexts and are explanatory and inductive in nature (Sovacool et al., 2018, p. 18).

Interviews

Interviews provide better insights and deeper understanding into people's stories, motivations, experiences, meanings and beliefs than other techniques such as for example surveys. Interviews may be structured, semi-structured or unstructured in nature and it is the researcher´s choice to implement the interview with individuals or small groups as well as decide whether to target the general population or particular stakeholders (Sovacool et al., 2018, p. 29). For this paper, it was decided to perform semi-structured interviews due to their effectiveness, flexibility, and accessibility as well as the capability of obtaining important often hidden information about organizational behavior (Sandy & Dumay, 2011, p. 246).

Prior to the interviews each of the participants received and signed an Information and Consent letter, in accordance with the Norwegian Centre for Research Data (NSD), which included description and purpose of the study and the standard description of participant rights. The interview process, along with the guide used, was approved by NSD before the data collection process started. In addition to the required documentation, the interviewees also received a detailed list of topics that we were interested in talking about, with the purpose of them being as well prepared as possible. Of the interviews that we conducted, one was conducted in person, while the other two occurred over the digital platform Microsoft Teams. In accordance with our approved application with NSD, none of the interviews were recorded. This was by design, as we wanted the experts to feel as natural as possible. Another reason for not recording is the sensitive nature of innovation projects, where we wanted to afford subject control over what goes on record and what should be removed. Parts of the conversations were not included in the final transcripts as they covered sensitive information. To substitute the research quality afforded by recording, we elected to both take notes during the conversations, to ensure that our transcripts would be as detailed as possible. Furthermore, after completion of the transcripts, we provided them access with the purpose of them accepting the transcript as is or making changes if necessary. In addition to the formal requirements, we also signed NDA contracts with Artic Healthcare covering details of the innovation project and daily operations, which was in accordance with their wishes.

The expert interviews were carried out with actors working for Artic Healthcare and Borregaard, the latter of which is a collaborating organization that is involved in their innovation project. Through our data collection process, we have conducted interviews with

three people that are directly and indirectly connected to the project, all with expert insights that can prove valuable for this thesis. Prior to the data collection process, we designed a semi-structured interview guide that allows for a naturally progressing conversation, with the core idea being that if the respondent answers beyond the scope of the original question or answers in a way that the conversation transitions from one topic to another, it is easy to follow up as well as move back and forth in the guide without disrupting the flow. The interview guide that we used was made up of six main questions, each representing a topic of interest, and each with a series of sub-questions that could be used as follow-up questions if the original answer did not cover all the information that we desired. The questions were not always asked verbatim as written in the guide but were rather voiced in a way to stimulate a naturally flowing conversation. Through these conversations we asked questions connected to the organization of Artic Healthcare, the role of the interviewee in their respective organization, challenges brought on by the Covid-19 pandemic, challenges brought on by global warming and climate change, environmental impacts of plastic, and the ongoing innovation project to develop biodegradable surgical masks.

Of the people that we talked to, two were associated with Artic Healthcare, and one with Borregaard. Our first interview was with Sjur Paulsen, co-owner of Artic Healthcare. The interview was in person and lasted roughly one hour. The second interview was with an employee at Borregaard, who is an expert in biomaterials, and is involved as a scientific advisor for the project. This conversation was held on Teams and lasted roughly 40 minutes. The third and final interview was with Reidar Goffeng, Chairman of the board at Artic Healthcare. This conversation was also held on teams and lasted roughly one hour. These people were all chosen as interview subjects due to their connection to the innovation project, all of which with the necessary knowledge to provide expert information that is useful for this thesis. Our goal with this process was to acquire information that otherwise would not be available through other sources. The results of these interviews are presented in detail in chapter 5.

Document analysis

In document analysis, the researcher analyzes different sources of documents such as reports, letters, articles, books, websites and news media. This method was utilized with the aim to get insights into different information provided by various actors and look for possible connections among them (Sovacool et al., 2018, p. 29).

The data for this research was selected from several sources. Most of the information for the literature and theoretical background as well as the methods was based on the scientific peer-reviewed articles and books accessed online via scholar search services databases such as "Google Scholar" or University of Stavanger's digital library "Oria". Moreover, practical and statistical data was mostly gathered online from open sources that are publicly available such as official websites of organizations, articles from web-based newspapers as well as research news provided by different digital platforms.

Data analysis and reduction

Data reduction techniques are used in research designs with the purpose of adjusting the produced data into a suitable form of analysis. Therefore, it is significant for gathered data to be established in a set of coding categories. In qualitative research, the collected data that comes in the form of text from interview transcripts, documents and observational notes must be also analyzed. According to Neuman (2014), to analyze the data is to organize, integrate and examine as well as to search for relationships and patterns among the specific details. This process allows the researcher to expand theory and knowledge as well as improve understanding through connecting the data to concepts, advancing generalizations and identifying themes and trends (Neuman, 2014, p. 477). According to Blaikie (2010), softwares such as NVivo, Ethograph, ATLAS.ti and MAXQDA are some of the available tools to help analyze such descriptive data (Blaikie, 2010, p. 210). The two key activities in analyzing qualitative data are *conceptualization* and *coding. Conceptualization* refers to organizing the data into categories based on similarities, concepts and themes and making sense of it (Neuman, 20, p. 480). The purpose of *coding* is to simplify the descriptions and to generate the analysis and theory (Blaikie, 2010, p. 211).

Accordingly, gathered information from documents and interview transcripts for this research were consciously evaluated, sorted and organized in a codebook that was created with the use of qualitative data analysis software NVivo. This process allowed us to categorize, analyze and store the evidence from different sources efficiently and helped to identify patterns and relationships between them. As a result, we have achieved richer and more comprehensive insights which enabled us to produce more plausible, valuable and intelligible findings.

4.4 Research validity and quality

Research development is a complex process that requires ensuring that constructed content is well grounded and trustworthy. Accordingly, in an effort to enhance the reliability and validity of our study we have followed the core principles and features for achieving validity presented by Neuman (2014):

First, we have ensured that the process of collecting the data and making observations was consistent and that the produced research is authentic. We provided an honest and balanced description of the real-life experiences of the social actors that were examined in this study. Second, we also made sure to be open about the weaknesses to determine the realness of the evidence (Neuman, 2014, p. 218). Third, we made an effort to ensure that all of the claims produced in our research are convincing and powerful by supporting them with a variety of different sources of empirical data. Lastly, we looked for connections and relationships in the separate details of collected data as we have learned that empirical data is not made up of a fixed collection of scientific concepts, but it comes in diverse separate elements that need to be put together (Neuman, 2014, p. 219).

Qualitative research´s quality- "Big tent criteria"

Additionally, scientific research also requires establishing standardized criteria for evaluating its quality. In qualitative research such criteria are not as well-established as in quantitative research, however there are certain widely accepted rules, norms and guidelines that create standards for scholars to follow and help them evaluate the research with common understanding and acknowledgment (Tracy & Hinrichs, 2017, p. 1).

Accordingly, for this study we decided to perform such an evaluation based on the criteria from the "Big-tent" model developed by Tracy (2010) originally published in "*Qualitative Inquiry*". This model was chosen for the evaluation as it provides the basis for proving credibility of the research and it is a widely recognized framework that has been highly cited in a variety of qualitative research studies.

The "Big-tent" model incorporates eight different dimensions that determine high-quality research, such as (1) worthy topic, (2) rich rigor, (3) sincerity, (4) credibility, (5) resonance, (6) significant contribution, (7) ethics and (8) meaningful coherence, that can be approached by variety of means. Table below presents our own evaluation based on such criteria (Tracy & Hinrichs, 2017, p. 3-4):

Table 1. Eight "Big-tent" criteria for excellent qualitative research (Based on Tracy & Hinchrins, 2017).

Criteria for quality	*How was it achieved for this study?*
Worthy topic	Crisis induced innovation within Covid-19 and sustainability context has not been widely investigated so far due to its novelty. We believe this topic is relevant and significant for the present times as well as that it will be important for the future due to ongoing climate change.
Rich rigor	Rich rigor was achieved by sufficient and abundant descriptions of concepts and theoretical constructs, with the use of appropriate approach, methodology and strategy as well as suitable data selection relevant to the area of the study in order to produce meaningful and significant claims.
Sincerity	We were transparent about our roles and motives for this research and about the challenges, mistakes and limitations that we have faced during the process. We have reflected on ethical aspects and pointed out possible biases of actors involved and explained how it might have influenced our study.
Credibility	Credibility was proven by using different methods, measures and tools (triangulation and multivocality), investigating the phenomena from different perspectives and by utilizing multiple types of data sources and different theoretical frameworks.

Resonance	Resonance in this study was achieved by providing thick descriptions and insights to real-life stories and experiences in order to understand and interpret meanings of social actors. This helps the reader to better understand the studied phenomenon and relate it to her/ his own experiences to then look for connections and make naturalistic generalizations about it.
Significant contribution	Due to the novelty of the investigated topic and uncertainty around it, we believe that this study makes significant contributions in all four domains: theoretical, heuristic, practical and methodological. Even though the pandemic is slowly coming to an end, the impacts of it as well as the climate change issues will continue. Therefore, it is critical to provide improved understanding of this topic for the future measures and actions.
Ethics	Regarding ethics, we have ensured to treat with respect and protect the identities and privacy of all actors involved in this study. The actors were informed in detail about the performance of the whole process as well as about the outcome and data presentation after which a mutual consent was achieved. All gathered data was analyzed and reflected upon, with consideration of sensibility of some information. After a vigilant selection of data only worthy information was exposed.

Meaningful coherence	The purpose of the thesis was achieved using suitable literature, methods and procedures in a way that interconnects each section of the study together and provides answers to the research questions and illuminates the problem statements. The end report is clear, meaningful and coherent for the reader.

4.5 Limitations and ethical implications

When developing a research study there are possible limitations and challenges that one should account for throughout the process. This chapter highlights challenges and limitations that we have faced while developing this thesis. Moreover, it presents weaknesses and mistakes we have made along the way and discusses the ethical implications of the study.

To begin with, we shed a light at limitations connected to chosen methods in this research. We decided to focus on a single case study, where we examine only one subject, which notably limits the results as we are not able to generalize or compare and present any of the findings in a broader perspective. Our results are only valid for this particular case, which means that if we have focused on a different case, the results might have been different as well. Yet, generalization of results was not the aim of this study. Moreover, regarding the interviews one of the limitations was the number of interviewed participants. Originally, we were aiming to perform interviews with four different subjects, however for reasons beyond our control we were only able to perform three of them. This being a relatively small number may challenge the validity and reliability of this study. Yet, we believe that gathered information from these conversations was enough to provide valuable insights and answer our research questions sufficiently enough. Additionally, regarding our mistakes, we did not account for possible delays connected to the interview performance and we were not fully aware of the consequences that it might generate. Time and availability were one of the major obstacles for us during this process. Due to limited availability of investigated subjects this process was quite time intensive and uncertain, with the risk that something unpredictable happening could significantly impact our research. Regarding ethical implications, a close connection of associated actors to the case of this study may be viewed as possible bias suggesting that they had something to gain from this study and that they could adjust their answers in a way that is favorable for them instead of providing truthful answers. Another ethical challenge was the information sensitivity and confidentiality aspect of the interviews.

We had to account for many different factors to ensure that the whole process was transparent and well explained to the examined subjects and all the disclosed information were carefully selected and published only after a mutual consent was achieved.

5. Findings

To analyze the data from the interviews performed with the three individual participants, we have gone through each of the transcripts attentively and have investigated them in depth. This allowed us to look for and distinguish key themes and topics that provide a common ground to the analysis of all the dialogues. This chapter is an objective and brief presentation of the findings relevant to our research questions that are described in a logical order.

5.1 How can a crisis drive innovation? - from a challenge to an opportunity.

To begin with, all the participants were asked how the concept of their innovation projects emerged as well as what were their origins and purpose. The reason for this was to find out how and why one decides to be involved in the innovation process and what are the conditions that propel such actions.

Firstly, we focused on the interviews with the representatives at Artic Healthcare. We have interviewed Sjur Paulsen, the co-owner and board member and Reidar Goffeng, the chairman of Artic Healthcare, who have established the company and the innovation projects of high-quality single-use surgical face masks and biodegradable surgical face masks together and are directly engaged in them. They indicated that both Artic Healthcare and their projects connected to premium medical equipment emerged mainly as a response to the crisis Covid-19 pandemic and the changes in social needs and market demand. Yet, they revealed that one of the other drivers, particularly for their current project development of biodegradable PPE, was the climate change crisis. They highlighted that due to the main focus on the pandemic, the climate change issue faded into the background and began to be forgotten. Therefore, they acknowledged that it was significant for the sustainability aspect to be accounted for as well. Reidar expressed that these crises allowed them to turn the challenge into an opportunity. He pointed out that in his perception Covid-19 pandemic and climate crisis together gave them a chance to possibly make a groundbreaking impact. Moreover, the idea was also driven by their perception of the urgency of the problem as well as by their shared values and social norms. Both Sjur and Reidar indicated that the main goal behind all of this was to positively

contribute to the society and the environment as well as to help people to better prepare for the crisis.

Sjur elaborated on this matter as follows:

> *"Early on there was a consensus that we did not want to financially exploit an already dire situation. The idea of making a lot of money on a social necessity, which also was unsustainable with several negative environmental impacts, resembled, at least to us, the concept of war profiteering, and it was imperative for all members that all recognizable social and environmental concerns were accounted for to the best of our ability".*

Regarding the origins of the company and their project of high-quality single-use surgical face masks, they pointed out that Artic Healthcare was born to many requests from several Norwegian actors approaching them for help and that this concept was completely novel, in the sense that they entered the market without any previous knowledge about medical equipment. However, they noted that they were formerly involved with several other industries, where they established networks with the Chinese market. This allowed them to start this journey and arrange for production of face masks in China and import them to Norway.

5.2 Hope for a sustainable future? - birth of the idea

With respect to the innovation project of biodegradable face masks and its purpose, both Sjur and Reidar indicated that the idea is a continuation of the previous project of high-quality surgical single-use face masks but with high focus on sustainability of the product. The motive behind was their desire to make a positive impact. Sjur noted that his main personal goal was to change the current actions from working against nature to working with nature and look for sustainable alternatives that could replace or reduce the plastic and its pollution, which is a major factor that contributes to ongoing climate crisis.

Moreover, he mentioned aspirations for the company and their products:

> *"Aspirations for our products and our company, both in this time of crisis as well as when looking forward, is to be a reliable provider of dependable products, to be the owners of our own brand, and through our actions be agents of positive change. It is our goal to continuously develop and innovate products that perform better, both in terms of functionality*

and comfort, as well as making the products themselves more sustainable and environmentally friendly"

Besides, he added:

"Innovating in this space, replacing unsustainable plastic, can alleviate many problems. The ongoing climate crisis, which includes global warming and a changing climate, are symptoms of systemic practices. Reducing our dependence on plastic and developing sustainable value chains will reduce pollution of both carbon dioxide in the atmosphere as well as plastic pollution in our natural environment and is in my opinion a good place to start when addressing the underlying causes driving these changes."

Accordingly, the idea of a more sustainable future opened up an opportunity for Artic Healthcare to join forces with the Norwegian biorefinery "Borregaard" which specializes in biomaterials, mainly in production of lignin-based biopolymers and which core business practice is innovation and specialization. The collaboration between Artic Healthcare and Borregaard on the innovation project of biodegradable face masks started during the pandemic, when Borregaard was approached by Artic Healthcare with the idea of utilizing their biodegradable innovative material "Exilva" in Artic Healthcare's surgical face masks.

The employee of Borregaard, the third participant of the interviews, when asked about the purpose of their partnership in this project and about utilizing Exilva, explained:

"Exilva is a natural cellulose extract with enormous surface area, can be used to improve and control flow and stability, and has natural film-forming properties, all of which makes it a good fit for the filter part of masks. […] regarding our role in this project, we provide scientific advice concerning technical design and supply them with free materials for testing".

In addition, he indicated that Borregaard and Artic Healthcare share similar goals, at least regarding sustainability and the desire to fight for a better future. Therefore, they have immediately recognized the importance and potential of this project as since the start of the pandemic there has been a significant increase in Covid-19 waste, especially in face masks that have been incorrectly disposed of.

He expressed it as:

"As we are building our brand on values such as sustainability, this project with Artic Healthcare becomes a natural fit."

With respect to our first research question of *"How did Artic Healthcare come up with their concept following the outbreak of C*ovid-*19?"*, the above-mentioned results revealed that Artic Healthcare and their concepts were born to respond to the ongoing crises: the Covid-19 pandemic and climate change. In particular, the findings showed that Covid-19 caused major shifts in social needs and the market demands which required an urgent response to tackle the problem as soon as possible. At the same time, the ongoing climate crisis and its threats were also putting pressure on sustainability. Hence, the members of Artic Healthcare, being aware of the importance of both these crises, decided to get involved and develop innovative concepts that could help the society. Moreover, the results indicated that this decision was driven by their personal perception of the problems, their social norms and values and the desire to make a change and positively contribute to the society and to the environment.

5.3 The struggles of a "better tomorrow"

Afterwards, participants were asked about the challenges and risks that they have faced during the process of development of the innovation projects with the aim to get insights into how such a process came about and what factors had to be accounted for during its development.

Findings presented, that for a start-up company such as Artic Healthcare, the process of developing novel products was quite challenging to perform, where they had to face and overcome distinct risks and uncertainties at different stages of it.

The high-quality single-use surgical face masks

We begin by looking at the project of high-quality single-use surgical face masks. When asked about the development of high-quality surgical face masks, Sjur pointed out four different areas where challenges occurred, these being design, production, transportation, and distribution.

Firstly, he referred to the product itself, explaining that the aspiration of developing an entirely novel product entailed the necessity of having certain knowledge about it and about the materials that it is made of to be able to achieve the desired outcome.

He pointed out:

"Challenges to be overcome were related to materials used and their composition in the product, ventilation quality, aesthetic design, and comfort. It was important that users could wear our product over longer periods of time without the mask providing too much of a strain."

Secondly, he elaborated on the production and its costs and the standards. He explained that in the beginning of the process it was important to account for the costs of the production as it was significant to recognize the degree of profitable margin in order to avoid possible losses. Moreover, considering standards of the production it had been acknowledged that once implemented, it needed to be ensured that they are followed along the process.

"[…] whereas it is easy to implement such standards it is more difficult to guarantee that they are followed, given that the actual production took place on the other side of the planet with limited insights into the day-to-day operations because of societal lockdown".

Thirdly, he emphasized the importance of the choice of transportation method. As transportation was a critical component in the entire process, he pointed out that it was challenging to make a right decision with consideration of aspects such as practicality, costs and sustainability. He noted that often the most practical, time- and cost-effective methods are not very sustainable, therefore it is important to reach a compromise and choose the method that accounts for all of these aspects, including sustainability.

"Transport of the goods was important to us, as it was practically important to make sure that products could move frequently and relatively uninterrupted, but just as important that we identified and chose a practical method of transportation with a lower carbon footprint than traditional shipping".

Lastly, he described problems related to the distribution and sales due to high production costs, difficulties with marketing of the product as well as unpredicted demand level. He explained that this ambitious project turned out to be more expensive than predicted, which led to defeat in public bids against cheaper alternatives and having to rely on commercial markets. In addition, this forced them to lower the selling price, which resulted in lower profit margin. Regarding the marketing, he underlined that establishing the marketing strategy was a key component necessary to increase the sales of the product, which in their case was reliance

on market availability and visibility. Finally, he brought attention to the market demand in relation to production scale. He explained that the challenge was uncertainty, with the difficulty to predict whether the demand for the product will increase or decrease in the near future or even disappear due to the end of mandates for face masks usage or the end of the virus itself.

"The uncertainty of the market left us with the impression that we were playing a high-stake game of hot potato, potentially risking having to sit with large quantities of unsold merchandise in the case of reduced demand."

Furthermore, he explained how such demand has evolved through the pandemic, emphasizing that the effect of the pandemic on the market was radical. Basically, going from zero employees and revenue to making sales totaling millions of kroners, being able to produce without having to take up any loans. However, he pointed out that currently this heightened demand has been significantly reduced.

Sjur referred to this issue as follows:

"The heightened demand, which allowed us to sell nearly 35 million masks in the span of 18 months and generated 50-70 million kroners in revenue in 2020 alone, has been reduced to an estimated 1-2 million masks annually going forward, projected based on an equal market share. We have not seen any changes in our margins either, so these numbers are not enough to keep the business going long-term."

Reidar also elaborated on how the demand for face masks looked throughout the pandemic and highlighted the current issues related to the demand. Similarly to Sjur, he pointed out that their first developed product of high-quality surgical face masks became a bestseller at the height of the pandemic with extremely high demand but recently it started plummeting. This resulted in steadily falling sales and thus much lower turnover.

"The demand for PPE practically exploded overnight, especially the demand for high quality masks as they have been used to prevent risks of infections, as well as preventing further transmission if the user is infected. […] But the greatest challenge is probably the one we are facing right now. The core business of Artic Healthcare has pretty much been wiped away clean as the pandemic slows down. Our bestselling product has always been our Type 2R surgical masks, which we started providing the market with at the height of the pandemic.

Sales have been high during the crisis, but started plummeting earlier this year, steadily falling throughout the months of January, February, and March"

However, he emphasized that this situation was in a way expected and referred to it as follows:

"We have been prepared for this, however. We always knew that we were responding to an acute shortage of Personal Protective Equipment, and that this window of an opportunity would start to close as demand reduces when the pandemic comes to an end."

In addition, he referred to the drop in sales:

"Third year however, which we are in right now, the sales have been far lower following a severe reduction in demand. In March of this year our sales dipped below a hundred thousand NOK."

The biodegradable face masks

Moving forward, we looked at challenges associated with sustainability and the innovation project development of biodegradable masks.

The employee of Borregaard, when asked about his thoughts on single- use face mask and sustainability highlighted the necessity for this innovation project by following:

"Single-use masks have obviously proposed a challenge during this pandemic, as they have been necessary to combat the spreading virus, while at the same time have a negative effect on the environment. Making these masks recyclable would be a positive development [...]the problem is that when they are disposed of incorrectly, they can find their way into the natural environment, but even if disposed of correctly they either find their way to garbage dumps or are incinerated, neither of which is ideal. Going forward in a sustainable transition, composition of the masks will be critical."

Besides, Reidar also shared such concerns about sustainability issues by referring to the scope of the problem:

"In this pandemic we have seen an enormous consumption of single-use masks, and it has brought with it a nearly incomprehensible level of waste pollution. We see the face masks that end up on beaches, streets and trails, but what is less visible is masks that end up in the

ocean. From what we can gather, billions of single-use masks ended up in the ocean in 2021 alone. This poses a great challenge, because those that do not make it to shore end up floating around until they break down into smaller and smaller pieces of plastic, until it is no longer visible, but still very much a problem."

He also shed a light on his personal example:

"This topic has given me many sleepless nights, thinking about our work. Seeing that, by producing plastic face masks, we became a part of the problem. Therefore, with this project we see an opportunity to change it and be a part of the solution instead. When I was picking up trash in my neighborhood, I saw that in the area there has been a lot of face masks thrown away in nature. I believe that maybe this image will change people's perception and will make them more aware of the problem of plastic pollution. We have to realize that this issue is much bigger than we think."

Additionally, he explained that due to the enormous scale of the above-mentioned issue it is very difficult to match it with an equally scaled solution. He emphasized that despite possible positive outcomes of implementation of their innovative project, it does not solve the entire problem and there is still a long way ahead in doing so.

He referred to it as:

"However, this does not solve the entire equation, as there is still the matter of the waste already created that must be cleaned up before it is no longer feasible to do so. It is obvious that our solution is not equal to the problem as a whole, as it does not account for existing waste from face masks, nor waste resulting from other types of plastic products, but for the specific problem that we have identified, I think we have also identified a very much possible solution."

The development of the innovation project of biodegradable masks, like the results in above-mentioned findings about single-use face masks, also brought along many, if not more challenges. Sjur indicated that this innovation project is particularly difficult due to the novelty of the biodegradable materials. Therefore, the materials require complex examination before they can even be considered as suitable for utilization in face masks. He emphasized that the process and its individual stages include a lot of risks and uncertainties, and that it is

costly and time-consuming, hence financial support from the appropriate authorities is needed.

He elaborated on this issue as follows:

"The innovation project will go through several stages, exploring individual sequences before advancing to the next. The phases that we will need to get through are analysis of the material and determining its viability for our product, designing, and producing a prototype, testing, and finally determining whether it is suitable for mass production and commercially viable. Each of these steps include elements of uncertainty that must be addressed and accounted for, and it is a costly and time-consuming process."

However, he also indicated that obtaining such funding is not an easy case:

"We are currently in active communication with Innovation Norway, and have been for some time, discussing the necessary elements that need to be addressed before we can formally apply for financial support. Due to the lack of research and experience in this specific field, there is currently an ongoing debate whether this is an innovation project or industrial research project, which affects the degree to which Innovation Norway can provide resources to the project"

Reidar also shared such thoughts, explaining:

"Our primary obstacle at this time is to secure enough funding for the project, so that we do not end up with empty pockets halfway through with nothing to show for it."

Moreover, regarding the materials, the employee of Borregaard noted that for this project to kick off, it requires to prove the concept. In other words, a feasibility study must be conducted to examine the materials, which also heavily depends on the granted funding.

Another challenge that all respondents referred to was the time factor. They indicated that the process of development of such a product is very time consuming and for it to fully develop will certainly take some time. What is interesting, findings about the time of development of the product varied between respondents. Sjur indicated that he believes that it will take at least another year before the product is fully developed unless any delays occur. Reidar also noted that it will take at least a year to complete the innovation process or maybe possibly longer. Yet, from the point of view of an employee of Borregaard, this process might even take many years due to its complexity. He explained that there are so many uncertainties to account for

that it is difficult to predict and give a precise answer. However, he pointed out that despite the time challenge, he is positive that Artic Healthcare will succeed with moving forward with this innovation.

He referred to it as:

"However, Artic Healthcare has one great advantage moving forward, and that is that they are already present and have great insights in the respective market for facial masks. Radical innovations take place in, and must account for, three dimensions: product, process, and market. In other words what you make, how you make it, and to who and how you distribute it. Market development will always be the greatest challenge in the process of radical innovations, as it is the one dimension that you cannot control and carries with it the most uncertainty and risk. That is why Artic Healthcare will have a great advantage going forward."

5.4 Impacts of Covid-19 and the climate change

In addition, participants were asked about their individual perception of the challenges associated with Covid-19 and climate change as well as about how these crises have influenced their innovative actions. The objective here was to investigate the connections between crises and innovation and understand how they impact each other.

Covid-19 pandemic

When asked about their professional point of view on the greatest challenges brought by the Covid-19 pandemic, both Sjur and Reidar referred to adaptation to the virus as the most challenging. In their eyes, having to learn how to live with limitations and lockdown was the hardest for the society and forced everyone to rethink their approach to how to deal with the challenges under such conditions. Sjur emphasized the issues regarding the pandemic which they have faced at Artic Healthcare:

"In the face of a global crisis, we had to approach the challenge, and provide a solution, through digital platforms, rethink our commercial behavior, face supply chain stoppages and delays, and lift each other up, all at a distance. These are all issues that we have dealt with before, in some form or another, but doing so in an impersonal manner has been a learning curve for many, at least it has for me."

The employee of Borregaard, when asked about the same, mentioned establishing trust as the main issue. In particular, he indicated that it is difficult to establish, develop and maintain trust with external partners over digital platforms, when face-to-face meetings are not an option.

"If it becomes difficult to establish a positive relationship with your counterpart, it becomes even more so to get these kinds of projects off the ground."

In addition, he referred to the direct consequences of the pandemic which affected many of the businesses that Borregaard works with. Many have faced challenges associated with logistics, access to materials, and limited productivity at their plants as a consequence of the pandemic. This will of course have tremendous impact on any organizations efforts to get through the pandemic, but it also carries with an effect in the sense that it affects the future as well, as the resources needed to sustain their position have to be relocated from other efforts. He referred to it as follows:

"Challenges that many of them have faced are mainly related to logistics and limited access to raw materials, but some have even had to shut down their plants. [...] A trend that we have seen through the pandemic is that many of our affected customers and prospects have been put in situations that demand changing priorities, and as they have focused on securing their daily operations, they have not had the time or resources necessary to participate in innovation projects with us."

Man-made climate change

Regarding the challenges associated with man-made climate change, Sjur and Reidar highlighted that as the name "man-made" points out, the greatest issues associated with climate change are people and their practices. They believe that only changing our actions could help to avoid the direst of consequences.

Sjur explained:

"Our modern societies run on oil and gas and are built using petrochemicals like plastic. It is not enough to innovate or adapt in the face of our future consequences, but to succeed in avoiding the direst of consequences, we will have to entirely change how we build, how we create."

Later, he elaborated on how climate change issue has influenced their work at Artic Healthcare and highlighted the urgency of change in action:

"In the case of Artic Healthcare, this grand challenge is forcing us to re-evaluate every aspect, every stage of our products and the process of creating and distributing them […] My point is, every step of the process, from production to consumption, leaves an undesired impact that can be, and should be avoided going forward. And it is not enough that we adopt this mindset, but we must influence every single one of our collaborators, suppliers, and customers into developing the same frame of thinking. Unsustainable options cannot be viewed as viable, no matter how small the impact, when it is the system that perpetuates them that is at fault. We can reduce the amount of carbon dioxide we emit or reduce the amount of plastic waste that enters our environment, but even better, we can replace the source of the waste all together. Not reduce but remove."

Reidar also shared similar view on the necessity for change:

"The challenges we will face tomorrow truly take the form of a perfect storm. Luckily, there are some that have risen to the occasion, trying to develop alternative green solutions, to reduce their environmental footprints, and to inspire others to follow suit. I count myself as one of the inspired ones, which is driving me and my colleagues to always consider the environmental cost in all our endeavors, trying to make positive changes where we can"

Similarly, the employee of Borregaard also indicated that global warming and climate change were major drivers for regulatory and innovative change across many sectors. However, the challenge here is that this change is often radical and not everyone might want to accept it.

He explained it as follows:

"At Borregaard we envision a change in which the future becomes more biobased and that we utilize more sustainable materials and practices. In the short term, this trajectory might prove a bit challenging, as consumers have grown accustomed to the product quality associated with traditional plastics"

Accordingly, he pointed out that making changes in materials to put new products together can also be a deciding factor as this process might lead to changes in price, quality and functional properties which could impact the overall product experience.

He highlighted that currently the shift from fossil-based to bio-based solutions is treated more seriously than before as can be observed with, for instance, the recent EU ban on single-use plastics. However, this shift requires more radical changes in business practices and market regulations, which are still not in place. For instance, there are still no consequences for current actions of producers of fossil-based products and their contribution to the pollution of the environment.

He referred to this matter as:

> *"Currently, producers of fossil-based products do not pay the cost for associated pollution and environmental impact, but it is instead passed on to the developers of sustainable and environmentally friendly alternatives, as they themselves must take on the risk and cover the monetary cost of research, product development, and market development and acceptance. This is a situation that is far from fair.*"

With respect to our second research question of "*What short and long demand does Artic Healthcare set out to fill and what are the associated risks of these efforts?",* the above-mentioned results indicated that in the start of the Covid-19 pandemic Artic Healthcare was established to respond to the increased demand for PPE, in particular for surgical face masks, that occurred on the market due to the Covid-19. Hence, since this vast and rapid increase in demand needed to be filled out as soon as possible, in the beginning, the project of single surgical face masks was supposed to serve as a short-term solution to help tackle the problem. This high demand that was growing more and more everyday resulted in remarkable revenues for Artic Healthcare, going from zero to millions. However, the findings presented that with slowing down of the pandemic, the demand decreased dramatically and so did the income, bringing the future demand into question. Despite the uncertain future demand, the members of Artic Healthcare decided to turn this temporary concept into a long-term project focused on sustainability. The gathered findings indicated many risks associated with achieving these efforts, where the most challenging turned out to be the uncertainty about the future demand, the project costs and completion time as well as the complexity of the process and the current lack of funding necessary to develop the project.

5.5 What does the future hold?

Subsequently, all participants were asked about the upcoming steps and plans regarding the project of biodegradable single-face masks. The aim of such was to find out what actions have to be undertaken considering current changes in the market conditions caused by the slowing down of the pandemic in order to secure the future and carry on with the project. Moreover, the goal was to understand what kind of impact this project will have for the future if its development is successful.

To begin with, the findings revealed how the process of developing the innovation project of biodegradable masks began and will continue to evolve in the time ahead. Each of the participants elaborated on several stages of the project, which analyzed and put together presented us the insights into how this idea came about step by step.

Firstly, they emphasized that as the project has not been able to start yet due to lack of funding, most of the stages in the process have not been carried out yet. However, they have managed to create a detailed project plan, establish the market and contacts with partners necessary for collaboration and identify materials for testing. Secondly, they aim at performing a feasibility study and evaluation of samples of the material introduced to them by Borregaard, which will be conducted by experts in the field of non-woven materials at the research institution in Leeds. Thirdly, if such a study proves that this material is a match that can replace polypropylene, steps such as designing, building a prototype, establishing production requirements and methods as well as evaluation of costs will be carried out. Furthermore, when the funding is finally in place, they estimate at least a year to complete the innovation process. They believe that more than one type of biomaterial will be required to develop their biodegradable product. Therefore, there will certainly be a need for further study and evaluation as well as for marketing efforts, establishing customer segments and distribution channels until all requirements are met and the product can be introduced to the market.

In addition, Reidar elaborated on the future plans at Artic Healthcare if the project is successful:

"If we are successful, and we manage to develop a fully biobased and biodegradable surgical mask, that is not the end of our road, but as we view it rather the beginning. This is not a project focused on a single innovation, but rather a project that will require a long series of

innovative breakthroughs to bring to fruition. It is our goal that this will serve as a pilot project, and as we make advances here, they might be applicable for other products and processes. There are many products out there that are non-woven, that are blown into molds, and that has filter properties, just to name a few of the distinct areas that we will have to touch upon in our project"

Moreover, Sjur indicated that seeing as demand for masks is currently decreasing, they aim to continue their work of being a provider in this market for the foreseeable future with focus on Norway, where their contacts with different actors are already established. Besides, he pointed out that the usage of PPE during the pandemic contributed positively to lowering the hospitalization of flu cases. He emphasized that this proves that Artic Healthcare products could survive in the consumer market in the future and be a seasonal product, even when the pandemic ends.

Additionally, both Sjur and Reidar mentioned that regarding future expansions in their strategies they aim to penetrate the professional markets for surgical masks under normal conditions. Reidar elaborated on that matter referring to the response in the market to their proposed product. He indicated that representatives from public sectors, such as the university-hospital in Oslo, responded positively to their idea and are open for future cooperation as they recognize the importance of such opportunity and are actively seeking and encouraging the development of sustainable and affordable alternatives to many of the utilized PPE products.

However, the response from private sectors was not so enthusiastic regarding their interest in the product. However, Reidar highlighted that this obstacle is most likely to vanish once the fully developed product hits the market:

"Unfortunately, we have not been met with the same enthusiasm from the private sector, but as we know private consumers are growing ever more environmentally conscious, so it will only be a matter of time before the flute plays another tune. We are quite optimistic that once we reach the finish line, there will be interested actors in the public and private sector alike."

Moving forward, both Reidar and Sjur explained that as being aware of the current situation in the market associated with decrease in demand, they are investing time and resources in widening their product offering, which if successful, hopefully would open more possibilities in the market and secure them a permanent supplier role.

Reidar pointed out:

"There has yet to be developed a fully biobased and biodegradable surgical mask, and if we are successful, we will be adding these traits to an already high-quality product. This will be a major selling point that might get us into the professional markets in Norway and possibly the rest of the world. It of course depends on many other factors, such as final cost of the product once offered, but we are quite optimistic."

Sjur also indicated:

"We estimate that the market for facial masks going forward will be significantly larger than it was pre-pandemic, but it is doubtful that it will ever reach the heights that we have now experienced. That is why our ongoing strategy is to penetrate the larger markets by competing on product quality, environmentally friendly attributes, and brand value. Our aspirations going forward, as mentioned earlier, is to scale up to be a global provider of high-quality personal protective equipment, providing individuals and institutions with gloves, masks, and antibacterial solutions."

All participants expressed their optimistic thoughts regarding the future project of biodegradable masks. As already indicated above by Reidar, they all explained that if they succeed with identifying a biomaterial that could replace plastic in their products, it will open up a possibility for development of other sustainable and innovative products.

The employee of Borregaard explained it as:

"*[..] there would be a positive transition in which the market for single-use masks gains access to a biodegradable and recyclable alternative to today's plastic-based standard. Additionally, this could prove invaluable as a pilot project, in the sense that there are many other filter applications in which Exilva could be applied, as well as non-woven materials in general which could replace their base materials with biomaterials proved effective by this project."*

Later, he continued:

"Years from now, I believe that Exilva will be widely used, but in heavily segmented markets. It will probably be limited to specific niches, but therein make its presence in many different formats and applications".

Moreover, Sjur indicated that if they were to succeed in developing such products and penetrate the global markets, regional production would have a significant impact on reducing the carbon footprint associated with long-distance transport as well as the general plastic waste pollution.

He referred to this as:

"We have identified a biomaterial that has similar properties as Polypropylene, a popular plastic used in single-use products, and are in the early phases of reviewing its compatibility for use as a base material in our surgical masks. If successful, it could be the start of a great, green adventure, as it would foster further innovations and product developments, steadily phasing out polypropylene and other similar plastic types wherever possible"

In addition, Reidar also elaborated on the possible future impacts of their products:

"The potential role of biomaterials will be huge, but it will also require a fair amount of research and innovation before it can be utilized at an equally grand scale as what it might replace. Let us take plastic for instance. It is all around us, practically everything that we buy, whether it is a car or a new phone, has plastic in it. Just as we have created all of these magnificent things with synthetic polymers, we can also do so with natural ones. The development of biomaterials to the same level as that of plastics, would allow us to continue our way of life, but with a greatly reduced level of environmental impact."

Furthermore, the employee of Borregaard added to this matter:

"[...]Making these products compostable and biodegradable would lessen the environmental impact of incorrect disposals, and those masks that are disposed of correctly could be recycled so that the biomaterial finds new purpose".

Finally, with respect to the remaining research questions of *"What steps have Artic Healthcare taken to ensure long term viability and what challenges are associated with the*

transitions from acute response to operational longevity?" and of *"How does Artic Healthcare plan for future market demand for their Crisis Induced Innovation product in times of relative normalcy?",* the results revealed that Artic Healthcare has undertaken many actions to ensure the long term viability of the innovation project of biodegradable masks. Amongst others, they have created a solid project plan with several stages to be completed to develop the product and they have set a clear goal about how to go forward. Their way to achieve it is to firstly become a provider in this market, especially in Norway. Regarding the future expansion, they aim at penetrating the professional markets for surgical masks under normal conditions. Moreover, the findings indicated that they are constantly working on improving the quality, sustainability and the brand value as well as they are investing time and resources with the goal to expand their product offering and secure a permanent supplier role on the market. However, for such a transition to be successful many obstacles need to be overcome. As already mentioned before, the results pointed out that one of the biggest risks of this project development process is uncertainty about several factors such as funding, project completion time, final product cost and the future demand. Yet, despite the challenges Artic Healthcare expressed their positive thoughts about succeeding with the innovation and suggested that this pilot project will make a significant impact and will open the door for many future innovative solutions.

At last, we find it significant to point out the findings, which we have not been able to find and which we believe would be valuable for this research. In particular, due to the inability to perform the interviews with all associated organizations, there are still many interesting areas, about which information has not been gathered. Moreover, due to the above-mentioned lack of funding for the project of biodegradable face masks that have caused major delays, we have not been able to access all the information about the actual project. This, in result, has somewhat impacted our research and has limited certain areas of the Discussion. This matter is further elaborated on in the Discussion chapter.

6. Discussion

The purpose of this thesis has been to explore the journey of Artic Healthcare, a Norwegian company that was established during the early stages of the Covid-19 pandemic, and that has made strategic decisions to leverage their standing in the market as a supplier of high-quality

Personal Protective Equipment to develop a state-of-the-art sustainable alternative through the opportunities that arose from the crisis itself.

Artic Healthcare has over the past years been involved in a project to develop a biodegradable Type 2R surgical mask that is meant to be 100% biobased and fully biodegradable. The project, which is conducted in league with several other actors, is quite interesting as a case study. On the journey of this research project, we have used Artic Healthcare as natural laboratory in which we have set out to study the phenomenon Crisis Induced Innovation. Our overall objective is to better understand how a firm may capitalize on radical changes in market conditions and make the adaptive move last beyond the crisis. Given that Artic Healthcare was founded with the purpose of providing essential medical supplies in a time of acute shortages, what will happen when the acute shortage dissipates, and demand returns to normal?

Through this project we have delved into existing literature and theoretical foundations with the purpose of developing a solid stage from which we can better observe, and hopefully understand this phenomenon. Through our journey we have established firm knowledge bases within relevant contextual fields such plastic production, the environmental impact of our dominant plastic culture, and potential solutions from nature. Beyond the scope of materials and their capabilities, we have also explored the detrimental Covid-19 pandemic, which swept the world two years ago, as well as the accompanying cultures of mask usage and waste disposal.

The theoretical fabric that we have woven are from a wide set of aspects, with frameworks encompassing the multi-level perspective, emergency frames, innovation management, and rhetorical analysis. Through our journey, we have experimented with how to approach the phenomenon with the frameworks in question, and the resulting conclusions have been that the complex nature of what we seek to understand demands that we analyse the topic across multiple dimensions.

In this discussion it is our intention to go through the most prominent theoretical evaluations that we believe to best explain the dynamics that has driven Artic Healthcare through this process. Following the presentation of the most interesting theoretical applications and findings, we review the data basis that they are based on, with a primary focus on planned methodology and the actual data results that we managed to produce using the interviews.

Theoretical evaluation

Boin et al. (2009) define a crisis as a fundamental threat to the core values and structures of our communities (Boin et al., 2009, p. 83). When the WHO designated Covid-19 as a global pandemic in March of 2020, that is exactly what many experienced: a fundamental threat (WHO Europe, 2022).

As the world was swept by a global pandemic that affected our societies on a multitude of scales, there was a common response following the impact. As we have presented in our chapter regarding context and literature review, the cases of infections reached millions in a matter of a few months, and the style of comfort and the type of outlook that many had on life changed drastically. Quite interesting though, is the fact that the response, as great as it was, was synchronized in its challenge and success alike. One major challenge that is commonly associated with the early stages of the pandemic is the lack of preparedness in terms of accessibility of quality Personal Protective Equipment. While the world experienced the harsh consequences of not having enough resources to effectively fight the virus at the early stages, that quickly changed, as companies that already existed as well as newly established actors stepped up to face the challenge head on.

Among the companies that was established in this timeframe was Artic Healthcare. This is a Norwegian company that still exists today and consists of board members that were uniquely qualified to aid in the efforts to combat the pandemic. Funnily enough this was not due to existing competencies within the fields of pandemic preparedness or the development of protection equipment, but rather due to their extensive networks overseas.

As the world united in these combined efforts, the global production of PPE skyrocketed, especially in the face mask category. While there had been a severe underproduction just a year before, global production of face masks reached billions per day during the height of the pandemic in 2021. While this had an initial positive effect, especially when examined in the light of its intended purpose, there were also what some would categorize as unintended, and unacceptable consequences. McHugh et al. (2021) refer to emergencies as social constructs that are experienced uniquely depending on who is looking (McHugh et al., 2021, p. 5). As Artic Healthcare looked upon the effects of their efforts, it was not necessarily pride that was the initial reactions to the results of their efforts, but rather fear. Through our conversations with Sjur Paulsen and Reidar Goffeng, we managed to gain some valuable information regarding how they started their journey on the road towards sustainability. While it is

commendable that they managed to build a company from scratch and supply the Norwegian market with high quality type 2R surgical masks within months, their recollection of what transpired in this period is focused more on the costs of these results, rather than the results themselves. During this period, as billions of masks were produced on a global scale, the associated waste soared.

Patterson et al. (2021), stated that there are two types of emergency frames that companies can adopt: emergency-as-reaction, which entails that you react to an emergency as it unfolds, and emergency-as-strategy, which is a strategy employed to avoid future dire consequences by being prepared (Patterson et al., 2021, p. 843). As Sjur and Reidar witnessed the consequences of widespread implementations of PPE in our daily lives, they both understood that an emergency could come. The equipment that we have been using through this difficult period, that has kept us, as well as the people that we care for, safe, are typically single-use products and made using unsustainable materials such as plastic. As we have explored in this thesis, the role of plastic as a core building block has had wonderous impacts in terms of technological and scientific developments, as well as hugely positive effects on our quality of life, but its true cost has just recently started to present itself. As we learned in our conversations with the founders of Artic Healthcare, as well as with the representative from Borregaard, plastic is a wonderful material, but there are available options that we can rather focus on.

Bessant et al. (2012) refer to crisis driven innovation as a natural occurrence that unveils itself when the needs and wants of people are not met, while others refer to it as an occurring answer to emergencies that solves the problems associated with the crisis (Bessant et al., 2012, p. 222). Artic Healthcare understood that the need for protective equipment is absolute when it comes to protecting the people around us, but they also understood that it could be made in a different way. A sustainable way. As we talk to the representative from Borregaard, he tells us that he first was introduced to the people at Artic Healthcare when they approached him with the purpose of explore the potential of Exilva, a cellulose-based material that Borregaard manufactures. As we have explored the available literature that we believed to be particularly relevant to this thesis and the planned research, we have poised the questions of whether a fully biobased and biodegradable surgical mask can realistically be developed, and what impact it would have. Questions that we raised in the literature were “Can the biodegradable Type 2R surgical mask that Artic Healthcare aims to develop in their innovation project be made exclusively with biomaterials, and if so, how would that affect the

associated emissions?" and "Can single use face masks such as the Type 2R surgical masks be made with bioplastics and the function of biodegradability, and if so, what kind of materials can they use?". As we talk to the representative at Borregaard, these questions are not asked directly, but we do talk on the subject. Regarding the question of whether it is technically feasible, we are told that there is no doubt, it is 100% possible, but quite difficult and challenging. Regarding the type of material, we talked about Exilva, one of the materials that Artic Healthcare are evaluating, to which we get the response that it is possible that the material can play a key role in such a product, although he believes that it would require other materials as well. Regarding the effect on GHG emissions if such a product were to be developed, we have already come across that answer in the literature review, where discovered that roughly 4% of all gas and oil emissions are associated with feed for plastic production, and we can therefore state that this would equal the hypothetical positive effect in such a transition.

Following the initial meeting between the founders of Artic Healthcare and the representative from Borregaard, there have been several developments that all play a vital role in how this thesis has developed, and of course its outlook. Two especially significant events however are the sudden drop in sales of face masks as of 2022, wherein the revenue of Artic Healthcare went from millions to nearly zero seemingly overnight, and the second is the unfortunate pause in the niche development of their sustainable biobased surgical masks.

Eveleens (2010) offers a four-stage description of the development of innovations, in which a project will course through the phases of idea generation, idea selection, development and testing, and market launch (Eveleens, 2010, p. 8). Artic Healthcare has been working actively with their innovation project since the second half of 2021, and the project evolved to encompass a series of qualified partners and collaborators, a detailed project description that entailed progress through a series of feasibility studies, as well market relationships with potential buyers within the professional healthcare sector. Despite these positive developments, the project has been paused until it can secure enough funding to secure the services of external experts that will execute the technical stages of the product. That means that even though they have been working at this project for nearly a year, the project is at a standstill between stages two and three in this proposed progress model. That means that the niche development is not moving forward towards the window of opportunity that they discovered during this crisis, which can be a great challenge, as time is about to become a determining factor for success.

Geels (2012) states that the MLP specifies three elements that must be aligned for a niche innovation to gain momentum in its trajectory: learning processes, articulation and expression, and the development of social networks. Learning processes refers to the improvement of internal structures and competencies, and can include for instance market experience, technological insight, and organizational efficiency (Geels, 2012, p. 472). These elements are all accounted for in the case of Artic Healthcare, as they have a specialized team consisting of experienced managers leading the company, they already have a strong foothold in the market across a multitude of companies, and the necessary technological knowledge is secured through their collaboration with Borregaard who acts as advisors on the project. The development of social networks is also not a point of worry, as it is their extensive network that secured them their position during the pandemic to begin with. This leaves articulation and expression as the point to be desired, in which they have slowed down their progress to a halt following an unsuccessful attempt at securing funds for the project. This opens to new dimension of analysis for this case, in which we can evaluate the phenomenon as a rhetorical situation (Kjeldsen, 2016). This framework establishes rhetorical situations as a situation with a problem that can be solved through communication, establishes a rhetorical audience that can solve your issue, and establishes timelines for success (Kjeldsen, 2016, p. 83). In the case of restarting their previous momentum, there will be a need to improve communication to convince Innovation Norway to grant funds, which would align the three elements of Geels (2012) trajectory.

When we started our work with this thesis, we were under the impression that Artic Healthcare would be further along on their project projection, which can be reflected in our proposed analytical framework which assumes potential outcomes from the process. Another element that has had a negative effect on our final trajectory is the unintended limitation of our scope. Early in the process of developing this case study, we had intended to interview representatives from outside of Artic Healthcare and collaborating organizations, to get insight into user experiences among individuals and professional healthcare workers. We also intended to speak with distributors, with the intention of gaining a stronger insight into the market dynamics that surrounds the phenomenon of Crisis Induced Innovation in the case of Artic Healthcare's innovation project. These ambitions were let go, as we were not able to secure the necessary interviews, which in turn affects our ability to properly evaluate our analytical approach and provide sufficient answers to the many intriguing questions that has arose during our work.

7. Conclusion

The purpose of this thesis has been to illuminate the dynamics of Crisis Induced Innovation, using a case study based upon an innovation project established by the company Artic Healthcare. Through our efforts we have delved into a broad spectre of available literature concerning relevant context and theoretical frameworks that we believe to fit the field of study. Early on we made the conscious choice that the focus of the thesis should be the phenomenon in question, and not necessarily the company. This meant developing an analytical approach in which we used the available literature on innovation management, emergency frames, rhetorical situations, multi-level perspectives on socio-technical transitions, and of course literature concerning Crisis Driven Innovation. These readings, alongside readings on the contextual information that covers the topics of study, such as plastic industries and Covid-19 pandemic, have affected our outlook on the phenomenon and our approach to it.

The objective of our study has been to better understand how a company like Artic Healthcare can capitalize on radical changes in market conditions. This objective entails understanding how a company can utilize the radical effects of a crisis to act as a driving force for innovative developments. As we approached this subject it has been with some degree of caution, as there has been many challenges along the way that affected the nature of what we studied and to what degree we could study it precisely, but we believe to have achieved a substantial understanding of the phenomenon and the effects of it across multiple levels of study.

We have based our research on the study of Artic Healthcare and their innovation project with the purpose of viewing it as a living laboratory, in which the dynamics that has affected their development since the company's conception during the pandemic and driving forces behind their innovative efforts. To this purpose, we devised the research questions to provide answers regarding how they perceived risks and potential rewards, what steps that has been taken with the purpose of attaining long-term success, and how they plan for the future without the crisis induced demand for single use face masks. In addition to providing the answers to these questions, we have also worked with an analytical approach that is based on perceived causal dynamics.

Through our conversations with three people associated with the project we have learned that the planning for how Artic Healthcare wanted to move forward was opportunity based, in the

sense that they viewed the possibility to develop a biobased and biodegradable alternative to the standard plastic-based solution as a potential pilot project that would allow for further expansion. In addition, we have learned that the end of line goal which this project entails is that having a superior product with sustainable values at its core will make it attractive in the public sector, despite not being able to compete on traditional pricing grounds. Finally, in terms of the long-term planning where Artic Healthcare envisions a future beyond the crisis induced demand, we learned about strategies that involve internationalisation and the development of an integrated production line across all major continents. This speaks volume in terms of what kind of opportunity they envisioned that the innovation project will have if successful.

As stated in the discussion, the envisioned development of this thesis did not necessarily match with the reality, as there were a series of short fallings through the process at several levels. First off, we planned to interview more people, especially candidates that would be able to give valuable insights into other aspects of this case of Crisis Induced Innovation phenomenon. As we stand, we have only explored the dynamics from the point of view from the producers and product owners. As there are several more dimensions to account for if we are to illustrate the full scale of this phenomenon, there are dimensions such as the consumer side of the spectrum, distributors that operates with stores that has specific knowledge about market conditions, the professional dimension that represents hospitals and other professional services, technical dimensions such as engineering and composition of the product and not only the materials considered. The point to be made is that there is an amazing well of potential new research projects that could be aimed at this type of study.

Another point of interest that can be of great value is the how the phenomenon stretches beyond the scale to which we studied. As the innovation project has been paused and the development has not reached its technical stage, there is a whole other level of study that we did not get the chance to explore. In the analytical approach that we designed and used to design our case and method of progress, we made predictions regarding how the project would evolve beyond the point of Crisis Induced Innovation and potential outcomes. At this level there are late scale dynamics that can be interesting to study through the same frameworks that we employed, such as the MLP and rhetorical situation.

While we could not produce all the result that we set out to explore, we are under the impression that the product that is this thesis is still of great value. As we have studied the

dynamics of innovation and how they interlink with crisis dynamics at relatively short spans of time, understanding that a crisis is a crisis in name only. As we have shown with the employment of emergency frames, the conclusion is that an emergency is dependent on who experiences it. Our overall objective, to understand how a firm may capitalize on the dynamics of Crisis Induced Innovation, and to study the effects as the crisis died down, showed us that the original product was not able to survive. And that despite the innovation project reaching an early stop, it showed great promise, and shows that this field is worthy of further study.

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Appendix: Interview transcripts

Transcript 1. – Interview with Sjur Paulsen – 20.05.2022

Q = Question (Interviewer)

A = Answer (Interviewee)

Q = Roger Larsen and Kinga Koperek
A = Sjur Paulsen

Q: In your own words, can you tell us "What is Artic Healthcare?". We would like to learn about its origin and purpose.

A: Artic Healthcare is a company that designs and produces premium medical equipment, primarily for the consumer market. Our primary objective is to positively contribute to society, mainly by providing products that improve the defense against both external and internal threats to the immune system. We do this through two categorical product lines, firstly by improving the immune system itself using vitamins and omega-3 supplements, and secondly through our "Presana" product line, which offers high quality personal protective gear, these being single-use type 2R surgical masks, antibacterial gloves, hand-disinfectants, and surface disinfectants. We do not design or produce any type of medicine, we are quite a young company and pharmaceutical products are quite complex and require funds, knowledge, and time to develop, but it might be part of our repertoire in the future.

As to our origins, Artic Healthcare was founded in May of 2020 as a response to the emerging Covid- 19 pandemic. Me and my partners were approached by several different actors in Norway, who wanted us to utilize our extensive, international commercial network to import personal protective equipment, with an emphasis on facial masks, so that individuals and institutions in Norway would be better prepared in this time of crisis. Originally, we were involved in several different industries, but the main predecessor to Artic Healthcare was an organization that specializes in the food markets with business dealings in China. Due to our knowledge of the Chinese markets and our network therein, we were asked to arrange for additional production of facial masks in China with the purpose of importing them to Norway. We hastily agreed, but we were also under the impression that developing high quality

products and strategies that allowed for long-time viability were just as important, if not more so, than to mass-produce masks without regard for quality or integrity. Imbedding our personal values and convictions into this process, we founded the company Aeris Medical, which later changed its name to Artic Healthcare. Alongside our collaborators, we developed high quality products with low margins, which allowed us to provide our masks to the Norwegian markets at a relatively low price and to stay competitive. Every step of the process, from production to transport, has continuously been re-evaluated for the purpose of optimization and to develop a conscious and more sustainable brand. By the end of 2021 we estimate to have sold between 30 and 35 million masks in Norway, with a positive response from both individuals as well as professional consumers and are now one of three preferred and recommended brands by Apotek 1 and Vitus.

Q: What challenges have you faced, and what are your aspirations going forward?

A: There have been, and still are, many challenges along our journey, from the stage of conception to our aspirations going forward. Originally, when first embarking on this journey, our concerns regarding challenges were related to business ethics. Early on there was a consensus that we did not want to financially exploit an already dire situation. The idea of making a lot of money on a social necessity, which also was unsustainable with several negative environmental impacts, resembled, at least to us, the concept of war profiteering, and it was imperative for all members that all recognizable social and environmental concerns were accounted for to the best of our ability. The revelations associated with our responsibility did not of course appear all at once, but was rather a stream like process, wherein we constantly identified problems, or challenges, that we not necessarily had to account for, but wanted to.

When discussing challenges of a more practical nature, there were four areas that presented distinct challenges that we felt we had to overcome, these being design, production, transport, and distribution. In terms of the product itself, our own priority for comfort and functional quality demanded that we design the masks ourselves, which presented many challenges as this was a new product that we had little knowledge of beforehand. Challenges to be overcome were related to materials used and their composition in the product, ventilation quality, aesthetic design, and comfort. It was important that users could wear our product over longer periods of time without the mask providing too much of a strain. Other aspects of the

product that we had to account for were related to cost of production, as it was important that we at the very least had some degree of profitable margin so we would not produce and distribute at a loss. Standards related to the production process was a topic of discussion, but whereas it is easy to implement such standards it is more difficult to guarantee that they are followed, given that the actual production took place on the other side of the planet with limited insights into the day-to-day operations because of societal lockdowns. Transport of the goods was important to us, as it was practically important to make sure that products could move frequently and relatively uninterrupted, but just as important that we identified and chose a practical method of transportation with a lower carbon footprint than traditional shipping. Our solution was to identify train lines that stretched from China to Norway, which is more environmentally friendly than using ships or air travel. This was a time consuming, but in our opinion worthwhile endeavor. We are also in the process of evaluating potential sites for production here in Europe, which would solve many of the challenges associated with transport, as well as the cost of transport. Currently we are reviewing possibilities of producing in Poland and in Norway. Challenges related to distribution and sales of our products were many, and we have had to use creativity to overcome them. Our ambition to develop high-quality type 2R surgical masks for the consumer and professional market alike makes our product more expensive than many other face masks, which has led to two primary consequences. Firstly, we have not been able to win public bids to institutions due to competitors providing cheaper alternatives, which has made us rely on the commercial markets, where we sell our products through retailers such as groceries and pharmacies, in addition to our own website. The second challenge related to our relatively high cost of production is that the retailers sell our products at the same price as competing products, which leaves us with a lower profit margin. This has not been a major cause for concern, given that our primary focus is not related to earnings, but could prove challenging if the cost of production were to rise, for example if the cost of individual materials were to become temporarily scarce because of a high global demand that surpasses production quantities, or the speed or availability of transport routes following potential lockdowns at border crossings. The next challenge associated with distribution and sales followed a ban enacted by Google on the marketing of face masks on their platforms, which was also adopted by other actors such as Facebook, which made it difficult to communicate to potential customers. This ban was of course understandable, and to a certain degree applauded, as it prevented malevolent actors from exploiting the market demand and selling products at a mark up to desperate consumers. Consequently, we relied on market availability and visibility as our main

marketing efforts. This meant ensuring that the product was visible for consumers shopping at pharmacies or groceries, and that it stood out from the rest. One of the tactics that we employed was experimenting with color schemes, as we introduced our product lines in different shades beyond the “sterile” design of traditional face masks, and sold products in white, blue, pink, and black. Lastly, we had concerns related to market demand in relation to production scale. Throughout 2020 and 2021 it was difficult to predict if demand would increase or decrease in the near future, or whether the demand would disappear altogether following the downscale of public mandates or recommendation regarding face mask usage, or the disappearance of the virus itself. The uncertainty of the market left us with the impression that we were playing a high-stake game of hot potato, potentially risking having to sit with large quantities of unsold merchandise in the case of reduced demand. Luckily, that has not happened as we have been able to scale production according to demand.

Aspirations for our products and our company, both in this time of crisis as well as when looking forward, is to be a reliable provider of dependable products, to be the owners of our own brand, and through our actions be agents of positive change. It is our goal to continuously develop and innovate products that perform better, both in terms of functionality and comfort, as well as making the products themselves more sustainable and environmentally friendly. While we now see that demand for our products, especially the surgical masks, are going down, we aim to be a provider in this market for the foreseeable future, at least in Norway where we have already had an established presence in supermarkets and pharmacies. We have also seen a positive effect on another phenomenon than Covid. In 2020 and 2021 we saw a record low hospitalization of flu cases, which we credit to the usage of personal protective equipment and higher sanitary standards. This is an indication that our product lines can survive in the consumer market also after the end of the pandemic, and be a seasonal product used for external protection against the flu or endemic cycles of future Covid strains. Regarding future expansions our strategies are currently limited to the Norwegian market, where our priorities lie in penetrating the professional markets for surgical masks, doing so through innovation that allows us to provide superior products compared to available alternatives. Beyond improvements related to comfort and function, which already meet the requirements for sterile usage which states that our masks bacterial filtration capabilities are greater than 98%, we also plan to develop a biodegradable mask. Our strategy revolves on environmental factors to penetrate the professional markets, as well as to compete outside of Norway, although many hurdles need to be overcome before reaching this stage. Current

estimations concerning sales without the Covid-19 pandemic as a driver puts projections at 1-2 million masks annually, which is quite a lot smaller than our output during the height of the crisis, at which our sales were estimated to have totaled 30-35 million masks from the summer of 2020 to the end of 2021. As we cannot assume increased frequency in usage among individuals, market growth depends on reaching more users in total, which is why we focus on product innovation as a key part of our vision going forward.

My personal goal related to my involvement in Artic Healthcare is to make a positive impact, be it big or small. The word “sustainability” is overused at this point and is flourishing all around us as a go-to buzzword, so I try to avoid it. Simply stated, my goal is to help humans work with nature, rather than against it. Innovating in this space, replacing unsustainable plastic, can alleviate many problems. The ongoing climate crisis, which includes global warming and a changing climate, are symptoms of systemic practices. Reducing our dependence on plastic and developing sustainable value chains will reduce pollution of both carbon dioxide in the atmosphere as well as plastic pollution in our natural environment and is in my opinion a good place to start when addressing the underlying causes driving these changes.

Q: What is your role in Artic Healthcare?

A: I am a co-founder and co-owner of Artic Healthcare. I have a seat on the board of directors and relating to day-to-day operations of the company I function as a by-need consultant, meaning that no two days are alike and that my responsibilities frequently change based on the needs of the company as it evolves. Typically, I am involved in negotiations, participate in meetings internally as well as with external collaborators to strategize and oversee progress, I write and approve product descriptions to ensure clear and understandable communication with our audience, and more. I like to describe my position as an equivalent to a potato on the dinner plate, I go along just fine with pretty much everything, and I pride myself in not having a typical 9-5 day-job but have developed a position that is flexible and allows me to be creative in my endeavors.

Q: From your professional point of view, what have been the greatest challenges brought on by the Covid-19 pandemic?

A: From my point of view, the greatest challenge associated with the pandemic is not necessarily the virus itself, but rather how we have had to adapt to combat it. Here in Norway, we pride ourselves on our freedom, a privilege that is not prevalent globally, at least not to the scale that we enjoy it. Having been used to live a life without boundaries, we now find ourselves limited, both physically and mentally. We rely on movement and social activities in our everyday lives, the limitations following social lockdowns and social distancing in general, not only serves as an object to be overcome to function, but also a challenge in and of itself given that we have been forced to rethink our approach to how we deal with challenges under social restrictions. In the face of a global crisis, we had to approach the challenge, and provide a solution, through digital platforms, rethink our commercial behavior, face supply chain stoppages and delays, and lift each other up, all at a distance. These are all issues that we have dealt with before, in some form or another, but doing so in an impersonal manner has been a learning curve for many, at least it has for me.

Q: How has the pandemic affected the market for medical protective gear?

A: The effect, at least as we experienced it, was radical. Due to the demand and order sizes, we went from zero employees and a non-existent revenue stream to making sales totaling millions of kroners, with the first orders and payments coming in before we even had our product lines in production. Artic Healthcare and its operational activities, ranging from design, production, and transport, were established without having to take up any loans, and virtually without any fiscal risks, which is unprecedented regardless of what industry you would compare it to. Also, all future growth, relating to investments in the company and securing funding for our ongoing product developments, has been done only using this revenue stream. But, as drastically as the market first changed, it has done so again. The heightened demand, which allowed us to sell nearly 35 million masks in the span of 18 months and generated 50-70 million kroners in revenue in 2020 alone, has been reduced to an estimated 1-2 million masks annually going forward, projected based on an equal market share. We have not seen any changes in our margins either, so these numbers are not enough to keep the business going long-term. That is why we are now focused on widening our product offering, with a larger focus on other products than just facial masks, and we are

investing time and resources into developing a sustainable surgical mask, which would, if successful, secure us a permanent supplier role as it would open larger portions of the market. We estimate that the market for facial masks going forward will be significantly larger than it was pre-pandemic, but it is doubtful that it will ever reach the heights that we have now experienced. That is why our ongoing strategy is to penetrate the larger markets by competing on product quality, environmentally friendly attributes, and brand value. Our aspirations going forward, as mentioned earlier, is to scale up to be a global provider of high-quality personal protective equipment, providing individuals and institutions with gloves, masks, and antibacterial solutions. But before we can reach this stage, we need the right product first. That is why our focus now is on successfully identifying a biomaterial that can replace plastic in our product, and the successful development of this product at a viable price point. There are some uncertainties ahead, but we are confident that we are on the right track. The Covid-pandemic has exposed single-use, plastic based protection equipment to be a challenge worth facing, and who knows, if we are successful in implementing our solution in this product, it might be possible to do so with other products as well.

Q: From your professional point of view, what have been the greatest challenges brought on by global warming and the impending climate change?

A: The way I see it, and I believe I can speak on behalf of my business partners as well, is that the greatest challenge associated with our ongoing, man-made climate crisis is not necessarily the crisis itself, but rather how ingrained the causing practices are in our society. Our modern societies run on oil and gas and are built using petrochemicals like plastic. It is not enough to innovate or adapt in the face of our future consequences, but to succeed in avoiding the direst of consequences, we will have to entirely change how we build, how we create. In the case of Artic Healthcare, this grand challenge is forcing us to re-evaluate every aspect, every stage of our products and the process of creating and distributing them. Through our ongoing innovation project, we are attempting to replace the plastic component of our type 2R surgical masks with biodegradable alternatives, and to do so we are studying biomaterials. Beyond the scope of the actual product, we are examining the possibilities of decentralized production strategies. If we succeed in developing biodegradable masks and penetrate the global markets, regional production will reduce the carbon footprint associated with long-distance transport, utilizing production facilities in Europe, America, and Asia, for their corresponding geographic markets. Beyond means of transport, packaging is also a source of waste, and we

are looking at more sustainable alternatives to plastic packaging. Currently we are working on cardboard packaging, which has a smaller environmental footprint than traditional plastic. My point is, every step of the process, from production to consumption, leaves an undesired impact that can be, and should be avoided going forward. And it is not enough that we adopt this mindset, but we must influence every single one of our collaborators, suppliers, and customers into developing the same frame of thinking. Unsustainable options cannot be viewed as viable, no matter how small the impact, when it is the system that perpetuates them that is at fault. We can reduce the amount of carbon dioxide we emit or reduce the amount of plastic waste that enters our environment, but even better, we can replace the source of the waste all together. Not reduce but remove. Of course, this may seem like a far-fetched fever dream, but if we are going to try, this seems like a great place to start. We have identified a biomaterial that has similar properties as Polypropylene, a popular plastic used in single-use products, and are in the early phases of reviewing its compatibility for use as a base material in our surgical masks. If successful, it could be the start of a great, green adventure, as it would foster further innovations and product developments, steadily phasing out polypropylene and other similar plastic types wherever possible.

Q: You have mentioned Artic Healthcare's ongoing innovation project quite a few times. What challenges are you facing in this project, and how long will it take to develop a biodegradable mask?

A: There are many challenges to overcome in a project such as this, many that we are already prepared to face, but we are also aware that just as many, if not more, will present themselves along the way. The major challenges that we have identified so far is to determine whether the identified biomaterial, which is a cellulose-based product, has the required characteristics and can replicate the function that polypropylene has in type 2 surgical masks, with emphasis on filtration. Furthermore, we need to determine whether the selected material can be processed into a format that can be used in the production of face masks, both in terms of physical characteristics as well as being financially viable, meaning that it does not become too expensive. We also need to determine if the selected material is compatible with current production methods, or whether this replacement requires the development of entirely new processes. The innovation project will go through several stages, exploring individual sequences before advancing to the next. The phases that we will need to get through are analysis of the material and determining its viability for our product, designing, and producing

a prototype, testing, and finally determining whether it is suitable for mass production and commercially viable. Each of these steps include elements of uncertainty that must be addressed and accounted for, and it is a costly and time-consuming process. We believe that it will take at least another year before we have a finished product, given that there are not more delays in the project. We are currently in active communication with Innovation Norway, and have been for some time, discussing the necessary elements that need to be addressed before we can formally apply for financial support. Due to the lack of research and experience in this specific field, there is currently an ongoing debate whether this is an innovation project or industrial research project, which affects the degree to which Innovation Norway can provide resources to the project. That being said, we are optimistic to a fault, and not only do we believe that this research project will be a success, but also that the development of a biodegradable type 2R surgical mask is not the end of our path, but rather the start of an extensive green pathway with untold opportunities ahead.

Transcript 2. – Interview with Borregaard – 07.06.22

Q = Question (Interviewer)

A = Answer (Interviewee)

Q = Roger Larsen and Kinga Koperek

A = Borregaard

Q: In your own words, can you tell us "What is Borregaard?"

A: Well, Borregaard is a biorefinery that specializes in biomaterials, and was founded in 1889. While originally known as a producer of paper, a lot has changed in the last hundred years. Over the course of the past decades, innovation has been established as a core business practice, bringing many changes over the years, both in terms of what we offer as well as how we make it. One thing that is relatively unchanged however, is the company's association with forests. Today, utilizing the same wood as raw material as we did a hundred years ago, Borregaard has been established as a cutting-edge provider of bio-based solutions. Our business is primarily export oriented, with 95% of our products being sold in more than a hundred countries.

We have a presence in a wide range of sectors, from agricultural to oil and gas, and are industry leading producers of lignin-based biopolymers, a viable alternative to many fossil fuel-based solutions. Our market position is a result of integrating specialization and innovation as core concepts of our business model, and we aim to generate 15-20% of our revenue from products that are less than five years old. As a result of this strategy, we invest a large portion of our profits in research and development, and nearly 10% of our 1100 employees work with innovation. We pride ourselves on our radical innovations, one such is Exilva, a novel development that shows great promise in many different applications as an additive.

Q: In what capacity does your organization work with Artic Healthcare?

A: We were contacted by Artic Healthcare in 2020. At this point in time, they were in the early stages of planning an innovation project and were inquiring about the possibility of utilizing Exilva for a key component of a biodegradable surgical mask. We quickly recognized a real possibility of collaboration. Exilva is a natural cellulose extract with enormous surface area, that can be used to improve and control flow and stability, and has natural film-forming properties, all of which makes it a good fit for the filter part of a mask. Now, regarding our role in this project, we provide scientific advice concerning technical design and supply them with free materials for testing. However, our role is a rather passive one, at least until they manage to prove the concept.

Q: How do you prove the concept?

A: They will need to conduct a feasibility study. This responsibility has been contracted to a research institute in Leeds, NIRI, which specializes in non-woven materials and is an ideal match for this kind of product. NIRI will conduct this study as soon as Artic Healthcare secures the necessary funding, and if they are successful in proving the concept then Borregaard will likely accept a more active role in the project.

Q: What value do you see in Artic Healthcare's operational activities and proposed products?

A: Borregaard holds sustainability as a core value in all our activities, so we recognize the importance of making PPE, and especially single-use facial masks, more sustainable and environmentally friendly. We recognize the importance of a circular economy moving

forward, a concept that can, and should, be introduced into this sector. As we have seen throughout the pandemic there is a negative trend of single use masks being either incorrectly disposed of or burned, neither of which is truly ideal. Making these products compostable and biodegradable would lessen the environmental impact of incorrect disposals, and those masks that are disposed of correctly could be recycled so that the biomaterial finds new purpose. As we are building our brand on values such as sustainability, this partnership with Artic Healthcare becomes a natural fit.

Q: From your professional point of view, what have been the greatest challenges brought on by the Covid-19 pandemic?

A: Trust. Throughout the pandemic there have been periods in which the world has partially, or seemingly fully shut down, limiting travel and face-to-face meetings. Thus, we have had to resort to establishing, maintaining, and developing relationships over platforms such as Teams. As experience has shown, it is quite difficult to establish trust, which is highly personal, in an impersonal setting. This has proven to be rather challenging for us, as a core part of our business is based on innovation projects conducted in league with external partners. If it becomes difficult to establish a positive relationship with your counterpart, it becomes even more so to get these kinds of projects off the ground. If I am to account for more direct consequences of the pandemic and the physical restrictions it has brought, it would be how it has affected many of our customers and prospects. Challenges that many of them have faced are mainly related to logistics and limited access to raw materials, but some have even had to shut down their plants. As you can imagine, this has had an enormous impact as it affects time, one of the most vital resources that any organization has. Borregaard however has been able to come through the pandemic relatively unscathed, but that is not to say that we have not been affected. As stated earlier, a large portion of our revenue comes from products less than five years old, which in turn is used to fund new products. A part of our business model can be described as market driven innovation. A trend that we have seen through the pandemic is that many of our affected customers and prospects have been put in situations that demand changing priorities, and as they have focused on securing their daily operations, they have not had the time or resources necessary to participate in innovation projects with us. This makes it even more important, both for us as well as others, to keep up and increase the innovation speed as the pandemic slows down, to reinitiate and refocus our efforts.

Q: From your professional point of view, what have been the greatest challenges brought on by global warming and the impending climate change?

A: Global warming and climate change are of course inherently negative, but its focus as of late are beginning to show some negative and positive effects alike, at least when accounted for by social response. Focus on climate change has been a major driver for regulatory and innovative changes across a multitude of sectors, which is a positive development. A challenge however is whether consumers will accept these often radical, but necessary, developments. There is a strong opportunity ahead, as we observe a growing understanding of the causes and consequences of global warming, more and more people come to the realization that we need to make changes and adapt to the situation. At Borregaard we envision a change in which the future becomes more biobased and that we utilize more sustainable materials and practices. In the short term, this trajectory might prove a bit challenging, as consumers have grown accustomed to the product quality associated with traditional plastics. As we make changes to materials and how we put them together to make products going forward, there might be changes in quality, price, and functional properties, all of which affects the product experience. But we are already starting to see these changes on the horizon, following the recent EU ban on single-use plastics and a growing public understanding that we need to make a shift from fossil-based to bio-based solutions. In my opinion, there is an obvious need to implement circular economic practices across all dimensions of both consumer and industry-oriented endeavors going forward. These dimensions need to include business practices and market regulations, both of which have a long way to go. Currently, producers of fossil-based products do not pay the cost for associated pollution and environmental impact, but it is instead passed on to the developers of sustainable and environmentally friendly alternatives, as they themselves must take on the risk and cover the monetary cost of research, product development, and market development and acceptance. This is a situation that is far from fair.

Q: In this light, what are your thoughts on single-use masks?

A: Single-use masks have obviously proposed a challenge during this pandemic, as they have been necessary to combat the spreading virus, while at the same time have a negative effect on the environment. Making these masks recyclable would be a positive development. Throughout this pandemic we have seen these masks be used and disposed of, either correctly or incorrectly. The problem is that when they are disposed of incorrectly, they can find their

way into the natural environment, but even if disposed of correctly they either find their way to garbage dumps or are incinerated, neither of which is ideal. Going forward in a sustainable transition, composition of the masks will be critical. You need the correct materials put together in the right way, both of which proves it challenging to make a compostable model. But if such a mask was produced, they could have collection stations at hospitals and other institutions where masks are frequently used, which could then be sorted and recycled. And if they were to be disposed of incorrectly, biodegradable features would lessen the environmental impact considerably.

Q: Could Exilva be the solution to this challenge?

A: It could certainly be part of the solution. In the case of Artic Healthcare and their development of a biodegradable Type 2R surgical mask, it would technically be regarded as a bio-based non-woven mask, in which Exilva could potentially make up the filter solution. The rest of the materials would likely have to be replaced by other biomaterials. Exilva would not be able to replace the function of let us say Polypropylene, which is commonly found as a base material in single-use masks. While Exilva is a completely natural material, derived from cellulose found in trees, it is mainly applied as an additive that improves or adds new features to the base material. This makes Exilva suitable for filter application, while the non-woven material in the mask, which is made up of plastic fibers, should be replaced by other biomaterials.

Q: In your professional opinion, is it possible for Artic Healthcare to develop a 100% biobased and/or biodegradable surgical mask, and if so, how long do you think it will take?

A: Absolutely, the majority if not all single-use face masks could be made 100% biobased and biodegradable. But how long it would take to get there is more difficult to answer than whether it is feasible. It will probably take Artic Healthcare many years to develop a biodegradable surgical mask, due to the many steps such an innovation project would have to progress through. First, you would have to prove the concept, something that Artic Healthcare has not done yet. Then you would have to account for the technical aspects of producing such a mask: identify, research, and develop the right materials, product composition and production methods, something that might take years to accomplish. Then there is the question of developing the market, in which there is a lot of research and analysis to be

conducted, marketing efforts, establishing customer segments and distribution channels. However, Artic Healthcare has one great advantage moving forward, and that is that they are already present and have great insights in the respective market for facial masks. Radical innovations take place in, and must account for, three dimensions: product, process, and market. In other words what you make, how you make it, and to who and how you distribute it. Market development will always be the greatest challenge in the process of radical innovations, as it is the one dimension that you cannot control and carries with it the most uncertainty and risk. That is why Artic Healthcare will have a great advantage going forward. But even so, I still believe that it will take at least a few years to fully develop the product, because just as they have an advantage of already being present in the market, they also have a relatively great disadvantage, in the sense that they lack insight and knowledge concerning the technology that they are using. But that is why they are conducting a feasibility study, and why we are involved in providing scientific advice, and they have also made great choices in partnering with organizations that have the relevant knowledge and experience that they themselves are lacking.

Q: If Artic Healthcare can prove the concept and develop a biodegradable surgical mask, what impact will this have?

A: Firstly, it would be a good business opportunity for Borregaard, as the producer of Exilva. Secondly, there would be a positive transition in which the market for single-use masks gains access to a biodegradable and recyclable alternative to today's plastic-based standard. Additionally, this could prove invaluable as a pilot project, in the sense that there are many other filter applications in which Exilva could be applied, as well as non-woven materials in general which could replace their base materials with biomaterials proved effective by this project.

Q: Throughout this conversation, we have heard many mentions of Exilva. Could you reiterate what this is and its applications?

A: Exilva is a natural part of our environment. In its original form, it is found as the fiber structures of wood fibers and can best be described as a nest of thin fibers surrounded by water. The product that we offer is still in its natural form, cellulose, but merely extracted from its natural environment. Exilva is primarily used as an additive, roughly at a 0.5% formulation when mixed with a base material and is used to enhance or add new properties to

the product. Currently it is mainly applied in coatings and adhesives. Despite being discovered already in the 1980s, Exilva is still a novel product to the market, but available on a commercial scale.

Q: What role do you believe, if any, that Exilva will play in the sustainable transition?

A: Well, Exilva has already proven to possess the necessary properties to replace many synthetic, unsustainable additives. Years from now, I believe that Exilva will be widely used, but in heavily segmented markets. It will probably be limited to specific niches, but therein make its presence in many different formats and applications.

Transcript 3. – Interview with Reidar Goffeng – 13.06.2022

Q = Question (Interviewer) A = Answer (Interviewee)

Q = Roger Larsen and Kinga Koperek

A = Reidar Goffeng

Q: In your own words, what is Artic Healthcare and what is its purpose?

A: The short answer? Artic Healthcare is a provider of high quality medical protective gear and is the resulting culmination of when opportunity meets demand. It was founded at the start of the Covid-19 pandemic, where it sprung to life at request by representatives of the public health sector who wanted us, the founding members, to use our business connections in China to import face masks to Norway. Beyond this description, it represents our interests in doing something good for others in times of great distress. It was decided early on that if we were going to embark on this venture, we were going to do it right. So, the mission statement of Artic Healthcare has never merely been to import any given mask from China, but to purposely design and produce the best possible masks to bring to the Norwegian market. So, what is Artic Healthcare? It is our attempt at using our knowledge, resources, and network to do something good, to be a part of the solution.

Q: Have you faced any challenges on this journey?

A: Definitely! But the greatest challenge is probably the one we are facing right now. The core business of Artic Healthcare has pretty much been wiped away clean as the pandemic slows down. Our bestselling product has always been our Type 2R surgical masks, which we

started providing the market with at the height of the pandemic. Sales have been high during the crisis, but started plummeting earlier this year, steadily falling throughout the months of January, February, and March. We have been prepared for this, however. We always knew that we were responding to an acute shortage of Personal Protective Equipment, and that this window would start to close as demand reduces when the pandemic comes to an end. But as I said, we have always planned ahead with this in mind, and have established the foundational ideas for a series of product developments, three of which are currently in their starting phase.

Q: What are these three projects?

A: Among the three projects there is one that is our primary focus, which also happens to be the most challenging and resource demanding, in which we aim to develop a biobased and biodegradable alternative to single-use surgical masks. First of the other two, we are developing a new dispenser solution for single-use plastic gloves. We are currently in the early stages of discussing a collaboration with a series of gas stations across Norway and Europe, where they keep glove dispensers outdoors. When you use these dispensers, it is difficult to just take one at a time, you usually grab one and another two or three follows with. There is also a problem related to strong winds, when they occur, the gloves are known to blow out of the dispenser. Plastic gloves are quite light, so even a weak wind can bring them across great distances, allowing for plastic pollution in the surrounding environments. In addition to the dispenser, we are also planning changes to the gloves themselves. Single-use gloves are usually made up of 100% virgin plastic, but we are working on a design that utilizes a 70/30% mix, introducing recycled plastic into the production to make them slightly more sustainable. This project is partly tied up with the innovation project mentioned previously, in which we will be researching biomaterials. If successful, it is our ambition to use the findings from the project concerning surgical masks to also develop biodegradable gloves, thus solving two separate issues: Firstly, the issue regarding material waste, and the second related to the material itself. The third project is at the behest of some business contacts in China. We are developing healthy, nutritional supplements, based on omega 3, that will be exported to the Chinese market. These products will first be launched in Finland. To do so is not necessarily a strategic choice, but more a coincidence. We continuously expand our professional network and list of partners based on needs and accessible talent and researchers. When we received the request from China, we were already in contact with someone based in Finland who had the necessary expertise and resources.

Q: You mentioned that the sales have plummeted. How has the sales progressed throughout the pandemic?

A: In our first year, 2020, we had a turnover of 10 million NOK, and in our second year, 2021, we had a turnover of 12 million NOK. Third year however, which we are in right now, the sales have been far lower following a severe reduction in demand. In March of this year our sales dipped below a hundred thousand NOK. Through this period, Artic Healthcare has sold north of 30 million masks in total.

Q: What are the aspirations of Artic Healthcare going forward?

A: Artic Healthcare will likely be a sleeping company for the time going forward, following the reduced demand. As said earlier we have a few ongoing projects, but these will mainly be administered through other dedicated organizations. The idea is that Artic Healthcare will wake up again if there is a resurgence in demand or if any of the projects reach the market, in the latter scenario Artic Healthcare will act as a distributor of these new products. But I want to reiterate myself regarding the previous statement. When I say sleeping, I do not mean totally dormant. The company will still be active, making our current product assortment available for customers. We have also made some interesting developments in the dental industry, where we have access to products lined up to potential customers across Europe. These will also be distributed by and carry the Artic Healthcare brand.

Q: Now that we have gotten a glimpse into the organization, we would like to know more about the man. What is your role in Artic Healthcare?

A: I am chairman of the board, meaning that I hold an oversight responsibility across all aspects of the organization. In addition to this general role, I also have more specific responsibilities. I primarily work with imports and sales and have to maintain and develop relationships with our extensive network of partners and customers. The import side is primarily related to our Chinese relations, while the sales is done through Bonaventura, who are our distributors towards pharmacies. Beyond the role of Chairman and my responsibilities in import and sales, I consider myself to be somewhat of an in-house handyman, working towards solving any kinds of problems as they appear.

Q: What values do you see in Artic Healthcare's operational activities and proposed products?

A: Firstly, I view Artic Healthcare as a platform upon which I have been able to do some good in times of difficulties. It is a positive feeling to know that I can contribute something of value at a time that it is needed the most. Secondly, the people that are working in or with Artic Healthcare, at least its core members, are good friends of mine. In a time characterized by social distance I have had the privilege of working alongside these friends solving an acute demand together, which has been quite rewarding. Lastly, but probably most important, we have established partnerships with both UNICEF and Redd Barna, both of which receive a portion of our profits as donations. This is something that I am truly proud of, and it motivates me through difficult days.

Q: From your professional point of view, what have been the greatest challenges brought on by the Covid-19 pandemic?

A: For Artic Healthcare the pandemic has been viewed more as an opportunity rather than a challenge, given that our organization was created in order to respond to the crisis. For society however, the equation is quite different. For many people around the world the last two years have presented an onset of tragedies, in which the virus has had both direct and indirect impacts across a multitude of dimensions. The pandemic has made people sick, some facing even chronic, possibly life lasting symptoms, and for others even death. An indirect impact that I think we have all experienced is tightly associated with how we responded to the pandemic. Societies across the world shut down overnight, leaving many businesses and individuals without stable income, which in turn has resulted in grave economic impacts. Many people in the world do not have social structures to fall back on, which means that once you lose your income you might lose a vital pillar to sustain your way of life. As a result, many around the world have been faced with the gruesome reality of poverty in a time where neighborly behavior is limited, meaning that many have truly faced these consequences alone. But it has not all been strictly bad. In Norway for instance, I believe that the pandemic has given many the opportunity to use this global pause to stop and refocus, rethink, and put our situation into perspective. This is probably mainly due to two main factors, the first being relatively low population density which means that we have not been hit by the virus as hard as many other countries. The second, that our strong social institutions do not leave people stranded, meaning that we have not had to focus on how to survive, at least not as individuals.

One example of how we have had the opportunity to evaluate our standing, is how we relate to traditional plastic as a central material of our world. This is at least what we in Artic Healthcare did with PPE, which has been a driving force behind our planned innovation project. The pandemic has also shown many how brittle the world is, not merely as a whole, but also the many small bits and pieces it is made up of. I hope that as many as possible use this insight to spur further new innovations and developments to improve our world, make it stronger and more resilient to the new challenges to come.

Q: How has the pandemic affected the market for medical protective gear?

A: The demand for PPE practically exploded overnight, especially the demand for high quality masks as they have been used to prevent risks of infections, as well as preventing further transmission if the user is infected. It is almost funny. For years, people living in the west have practically made fun of many Asian societies, such as China, Japan, and South Korea, where masks have been commonplace in the civilian population for years as a means of protection from viruses and bad air quality. Suddenly, people living in western cultures transitioned from this mocking stance, to accepting the use of face masks seemingly without a second thought.

Q: How do you think the demand for medical protective gear will look going forward?

A: That is a hard question to answer. We saw a substantial use of single-use masks during the pandemic, even in-between the heights. But it seems now that the demand has slowed down dramatically, practically to a non-existing point, at least in the private consumer market. We have consciously made an effort to evaluate market conditions throughout this period, so to better anticipate future demand, and it is our understanding that there is a growing trend in the western world that people are tired of mandates recommendations, and that while people understood that products such as face masks had a timely function for our society to properly function under a dire situation, many are under the impression that the needs of these measures are past. Our product offering, while being of a high quality, has merely had relevance in times of acute market demand, and as demand diminishes so does the relevancy of our product. This is one of the driving forces behind our innovation project, where we plan to penetrate the market as it is under normal conditions. There has yet to be developed a fully biobased and biodegradable surgical mask, and if we are successful, we will be adding these traits to an already high-quality product. This will be a major selling point that might get us

into the professional markets in Norway and possibly the rest of the world. It of course depends on many other factors, such as the final cost of the product once offered, but we are quite optimistic.

Q: From your professional point of view, what have been the greatest challenges brought on by global warming and an impending climate change?

A: The greatest challenges that we can attribute to global warming and climate change are still very much in front of us. I do not think most people are truly aware of the crisis to come. We talk about it everyday with friends and neighbors, it is a constant topic of discussion on TV and in the newspapers, and with regular intervals we get the newest science from certified experts from related fields in industry and academic circles. But even with all this information, I do not think most people realize how great of a threat these challenges, if left unchecked, will bring. The greatest challenge will be facing, adapting to, and fighting, if possible, the direct consequences of a changing climate. Wildfires far beyond the scope of both frequencies and size compared to what we see today. Reduced food production will result in hunger catastrophes and extreme famine in exposed regions. The warming of the ocean will impact the life it sustains, the value we extract from it as a food source, it will cause far more frequent extreme weather conditions, and we might even see alterations in subsea water currents which in turn results in a domino effect across the globe. These are just some of the consequences of our industrial efforts, our winnings from gambling with nature. The challenges associated with global warming and climate change will affect every aspect of nature and man alike and will likely trigger causal effects across dimensions that we would never be able to anticipate. It is difficult to envision a world without ice caps or glaciers, no coral reefs, nor tropical forests or peatlands. And just as seemingly impossible it is to imagine a world so different from the one we currently live in, an almost alien world, it is just as impossible to imagine the true consequences of losing these elements. The challenges we will face tomorrow truly take the form of a perfect storm. Luckily, there are some that have risen to the occasion, trying to develop alternative green solutions, to reduce their environmental footprints, and to inspire others to follow suit. I count myself as one of the inspired ones, which is driving me and my colleagues to always consider the environmental cost in all our endeavors, trying to make positive changes where we can.

Q: How has the environmental focus affected the market for medical protective gear?

A: Not at all. Obviously, there are some that are aware of the plastic and carbon pollution associated with PPE, that are aware of the harmful impacts. But PPE has a critical function in modern healthcare across the world, and as most of these articles are single-use and therefore needed in high quantities, even in times of normalcy in hospitals and other health related services, there has been a much greater focus on improving functional quality and reducing costs, making them useful, accessible and affordable across the world, especially in developing countries where they usually are needed the most. There have been some developments in recent years, such as ensuring correct disposal and utilizing recycled plastics as production material instead of virgin plastics. That being said, there are currently several research and innovation projects across the globe, in which the purpose is to develop sustainable alternatives, but as far as I am aware non have yet to bear fruit. If we are successful in our innovation project, we will be among the earliest, if not the first, to bring a commercially viable biobased and biodegradable Type 2R surgical mask to the market.

Q: How does Artic Healthcare relate to the Sustainable Development Goals?

A: Well, truth be told, we in Artic Healthcare have not developed our concept in any conscious effort to align with any of the SDG's. That being said, we have rather had a general idea of making positive changes in terms of environmental impact and sustainability. We are aware that our organization and market activities, at least our market aspirations, are aligned with several of the sustainability goals, but that is merely coincidental. The activities of Artic Healthcare that can be labeled as green, are primarily opportunity driven. As mentioned previously, the organization itself and the demand it sets to fulfill was a response to an external request to provide the Norwegian market with medical protective equipment, it was first when we evaluated this possibility that we noticed the potential for green alternatives.

Q: Do you perceive the usage of single-use protective gear to have a negative effect on the natural environment?

A: This topic has given me many sleepless nights, thinking about our work. Seeing that, by producing plastic face masks, we became part of the problem. Therefore, with this project we see an opportunity to change it and be part of the solution instead. When I was picking up trash in the neighborhood, I saw that in the area there has been a lot of face masks thrown away in nature. I believe that maybe this image will change people's perception and will

make them more aware of the problem of plastic pollution. We have to realize that this issue is much bigger than we think.

Q: As you have experienced firsthand, single-use plastic-based items, such as face masks, can have a grave impact on natural environments due to unsustainable value-chains and improper disposal. How is this being combated?

A: We had this exact discussion quite early on when we started the company. While not having seen the issue of masks firsthand at that point, we were all aware that the material composition of high-quality single-use masks, such as the Type 2R surgical masks that we sought out to produce, would have some degree of environmental impact at every stage of the process. Sustainability was a topic of interest when deciding on types of materials and where to get them, the production process, packaging, and transport from China to Norway. Most of these phases only offer minor degrees of improvement when considering alternatives, and we realized quickly that the one with the largest potential for positive change also happened to be the one we knew the least about. Polypropylene was the material that we identified as best suited for the type of mask we wanted to create, but it is also this very material that poses the greatest threat in terms of the environmental impact of this product. Therefore, we started a creative process quite early on, trying to figure out if there was a material out there that would be able to fulfill the same function and be within a reasonable price range when considering the cost of the final product. I do not want to jinx it, but we hope to have found this replacement in a biomaterial based on cellulose. With the help of Borregaard, a biorefinery based in Norway, we have identified a material that, at least on paper as well as in other applications, seems to share many of the same properties as Polypropylene. We will have to conduct some extensive testing before moving forward, but we are optimistic. We have already contacted a research institution in England that are world leaders in the field of non-woven materials, and they have agreed to conduct these tests on our behalf as soon as we receive funding.

Q: Can you give any insights to the scope and impact of the problem you are aiming to solve?

A: The true scope of the issue is too great to delve into in a short interview, but what I can tell you is that any possible solution must be equal to the problem at hand. In this pandemic we have seen an enormous consumption of single-use masks, and it has brought with it a nearly

incomprehensible level of waste pollution. We see the face masks that end up on beaches, streets and trails, but what is less visible is masks that end up in the ocean. From what we can gather, billions of single-use masks ended up in the ocean in 2021 alone. This poses a great challenge, because those that do not make it to shore end up floating around until they break down into smaller and smaller pieces of plastic, until it is no longer visible, but still very much a problem. For a solution to match this problem, we must replace the essential building blocks of these masks, we must replace the plastic polymers. If we are successful in our project, if our cellulose-based replacement proves to be a match for our purpose, mismanaged waste that ends up in the ocean, or in other places, would still linger for a few years, but within a relatively short amount of time degrade into its natural biological building blocks, thus disarming a huge portion of the potential impact. However, this does not solve the entire equation, as there is still the matter of the waste already created that must be cleaned up before it is no longer feasible to do so. It is obvious that our solution is not equal to the problem as a whole, as it does not account for existing waste from face masks, nor waste resulting from other types of plastic products, but for the specific problem that we have identified, I think we have also identified a very much possible solution.

Q: You and your colleagues are as you say currently in the process of developing a biodegradable alternative to single-use surgical masks. Can you tell us a bit more about its current status and where it is headed?

A: Certainly. So, the core concept of this innovation project is to develop a sustainable alternative to today's single-use surgical masks. These are traditionally based on polypropylene, a synthetic polymer, and our goal is to replace this synthetic structure with one derived from biomaterials. The project has not started yet, as there are some kinks that we still have to straighten out before we can hit the ground running. Our primary obstacle at this time is to secure enough funding for the project, so that we do not end up with empty pockets halfway through with nothing to show for it. But we have already created a detailed project plan, as well as established contact with partners who have agreed to participate, so as soon as we secure funding we can start straight away. First of all, we will start with a feasibility study, in which Borregaard has presented us with test samples of Exilva. This material will be studied and evaluated by a research institution in Leeds, NIRI, who are experts in the field of non-woven materials. The purpose of this evaluation is to learn whether the biobased alternative can replace the polypropylene structure, and if so, will the mask still function as

intended? Next follows a step-by-step process in which we design and build a prototype, figure out production requirements and methods, and evaluate if this is something that can be mass produced at an acceptable cost per unit. Regarding where it is headed. When we secure funding, we estimate that it will take at least a year to complete the innovation process, possibly longer. It is likely that a product as the one that we envision will require more than just one type of biomaterial, as different materials have different properties, and there are a lot of different functional requirements for a type 2R surgical mask. However, it is our goal to make this mask 100% biobased and biodegradable, and as long as we have funding, we will keep evaluating materials until we manage to meet these requirements and bring the product to market. If we are successful, and we manage to develop a fully biobased and biodegradable surgical mask, that is not the end of our road, but as we view it rather the beginning. This is not a project focused on a single innovation, but rather a project that will require a long series of innovative breakthroughs to bring to fruition. It is our goal that this will serve as a pilot project, and as we make advances here, they might be applicable for other products and processes. There are many products out there that are non-woven, that are blown into molds, and that have filter properties, just to name a few of the distinct areas that we will have to touch upon in our project.

Q: In your opinion, what role will biomaterials play in the sustainable transition?

A: That question would probably be easier to answer if you turned it on its head, what role will it not play? The potential role of biomaterials will be huge, but it will also require a fair amount of research and innovation before it can be utilized at an equally grand scale as what it might replace. Let us take plastic for instance. It is all around us, practically everything that we buy, whether it is a car or a new phone, has plastic in it. Just as we have created all these magnificent things with synthetic polymers, we can also do so with natural ones. The development of biomaterials to the same level as that of plastics, would allow us to continue our way of life, but with a greatly reduced level of environmental impact.

Q: How has the market responded to your proposed product, is there a demand?

A: We have actively maintained a dialogue with representatives in the public sector, such as the innovation department at the university-hospital in Oslo. It is our impression that they are actively seeking and encouraging the development of sustainable alternatives to most, if not all the products that they use. But it is important to note that price evaluation plays a very

important role, so being sustainable is not necessarily enough, you also have to be relatively affordable compared to the alternative. That being said, as soon as a biodegradable surgical mask is made available, they will have no choice but to thoroughly evaluate it as an option. If the Covid-19 pandemic has shown us one thing, it is how great the potential environmental impact of single-use medical protective gear can be. Unfortunately, we have not been met with the same enthusiasm from the private sector, but as we know private consumers are growing ever more environmentally conscious, so it will only be a matter of time before the flute plays another tune. We are quite optimistic that once we reach the finish line, there will be interested actors in the public and private sector alike.