Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Economics and Management
Dept. of Industrial Economics and Technology Management

Tobias Linkjendal

Entrepreneurial uncertainty during the COVID-19 crisis.

Master's thesis in Entrepreneurship
Supervisor: Roger Sørheim
June 2021

NTNU
Kunnskap for en bedre verden

Tobias Linkjendal

Entrepreneurial uncertainty during the COVID-19 crisis.

Master's thesis in Entrepreneurship
Supervisor: Roger Sørheim
June 2021

Norwegian University of Science and Technology
Faculty of Economics and Management
Dept. of Industrial Economics and Technology Management

NTNU
Norwegian University of
Science and Technology

Assignment text

To study how tech startups have handled the uncertainty induced by the COVID-19 crisis, as well as which measures that have been essential for tech startups to overcome this uncertainty, by investigating and interviewing four startups that have experienced the crisis to date.

The following main topics will be included: Theory on uncertainty and COVID-19, methodology, case study, analysis of empirical data, discussion of findings, conclusion, and implications for further research.

Preface

This master thesis was written during the spring of 2021, as a part of the master's program at the NTNU School of Entrepreneurship at the Norwegian University of Science and Technology (NTNU). The thesis is an assignment as part of the course TIØ4945. The aim of this master thesis is to investigate how tech startups have handled the uncertainty induced by the COVID-19 crisis, as well as which measures that have been essential for Norwegian startups to overcome this uncertainty.

The author wants to thank his supervisor Roger Sørheim for his assistance and guidance throughout the project. His feedback has been essential and much appreciated. The author would also like to thank the interviewees and corresponding startups for the time donated to the project. Their participation and information have brought crucial value to this thesis.

Finally, the author wants to thank his family and friends for their backing throughout this thesis, in particular his wife, Marianne; and son, Samuel. Her continuous support and encouragement, and his need for alertness, have been necessities to motivate and activate the author to finish this thesis.

The author,
Tobias Linkjendal

June 11th, 2021

Abstract

The uncertainty induced by the COVID-19 crisis has been broad and fluctuating. To date, the COVID-19 crisis has surpassed the Global Financial Crisis in 2008 in terms of uncertainty, and is compared to that of the Great Depression in 1929–1933. Current research suggests that during shocks and crisis events, the uncertainty escalates to such speeds that their impacts become crippling for startups, and that the COVID-19 crisis in particular has led to specific challenges for startups in adapting to the new environment. Due to the newness of the COVID-19 crisis, and the fact that it is still ongoing, the author has seen a need for more empirical data on how startups handle and overcome the uncertainty caused by the COVID-19 crisis. The author has formulated the following research questions:

1) How have tech startups handled the uncertainty induced by the COVID-19 crisis?
2) Which measures have been essential for tech startups to implement in order to overcome the uncertainty during the COVID-19 crisis?

To answer the questions, a qualitative approach with multiple case studies has been conducted. The author has interviewed four case firms consisting of early-stage tech startups, with focus on specific domains where uncertainty could be experienced: *Financial, customer, product, business partners, team*. An analysis of the interviews was then conducted and tied to existing literature.

The findings both confirmed and challenged existing literature, where among the most important measures for the startups were to create a longer runway in terms of financials to avoid immediate failure. The startups were to a large degree depended on grants, loans and smaller investors. Other essential measures were to stay resilient and adaptable as a team, which startups are largely credited for in the literature. There were also discovered several measures the startups took within the other domains for uncertainty presented in this thesis. The author did not find evidence that the extreme crisis of the COVID-19 pandemic crippled the startups, but rather the opposite. It is suggested to pursue further studies with more startups and specialized criteria.

Sammendrag

Usikkerheten som er forårsaket av COVID-19-krisen har vært omfattende og varierende. Per dags dato har COVID-19-krisen passert usikkerheten under finanskrisen i 2008, og er sammenlignet med usikkerheten man opplevde under den store depresjonen/verdenskrisen i 1929-1933. Nåværende forskning antyder at usikkerhet under sjokk og kriser eskalerer i hastigheter som handlingslammer oppstartsbedrifter, og at COVID-19-krisen spesielt har munnet i nye utfordringer hvor oppstartsbedrifter må tilpasse seg. Siden COVID-19-krisen er en ny hendelse og fortsatt pågående, har forfatteren sett et behov for mer empirisk data på hvordan oppstartsbedrifter har håndtert og bekjempet usikkerheten fra COVID-19-krisen. Forfatteren har formulert følgende forskningsspørsmål:

1) Hvordan har teknologiske oppstartsbedrifter håndtert usikkerheten som er forårsaket av COVID-19-krisen?
2) Hvilke tiltak har vært essensielt for teknologiske oppstartsbedrifter å implementere for å bekjempe usikkerheten under COVID-19-krisen?

Det er gjennomført flere casestudier med en kvalitativ tilnærming for å besvare disse spørsmålene. Forfatteren har intervjuet fire case-bedrifter bestående av tidlig-fase teknologiske oppstartsbedrifter, med fokus på spesifikke områder hvor usikkerhet kan bli opplevd: *Finansielt, kunder, produkt, forretningspartnere, team.* En analyse av intervjuene ble så gjennomført og knyttet til eksisterende litteratur.

Funnene kunne både bekrefte og utfordre eksisterende litteratur, hvor blant de viktigste tiltakene var å sikre seg finansielt for å unngå umiddelbar konkurs. Oppstartsbedriftene var i stor grad avhengig av tilskudd, lån og mindre investorer. Andre essensielle tiltak var å være motstand- og tilpasningsdyktig som team, noe oppstartsbedrifter i stor grad er tilegnet i litteraturen. Det er også funnet flere tiltak innenfor de forskjellige områdene hvor usikkerhet kan oppleves. Forfatteren fant ikke empirisk bevis på at den ekstreme krisen rundt COVID-19 pandemien handlingslammet oppstartsbedriftene, heller tvert imot. Det anbefales å studere videre med flere oppstartsbedrifter og mer spesialiserte kriterier for sakene.

Table of contents

List of tables and figures

1.0 Introduction

The uncertainty that the world population has experienced due to the COVID-19 crisis is nothing short of extreme. It has not only been detrimental to public health, but also taken its toll on the worldwide economy. To date, the COVID-19 crisis has surpassed the Global Financial Crisis in 2008 in terms of uncertainty, and is compared to that of the Great Depression in 1929–1933 (Baker et al., 2020). It is unlike any situation we've experienced in many decades, and therefore an interesting and important event to research and gain valuable information from. Previous research into crisis events with focus on startups have shown that startups during recessions not only start smaller, they also tend to stay smaller in future years even when the macroeconomic conditions recover (Sedláček & Sterk, 2017). As startups are disproportionately important to economy-wide innovation, long-term job creation, and value formation (Howell et al., 2020), the author of this thesis wishes to explore the relationship between the extreme uncertainties that the COVID-19 crisis has introduced and how startups handle this new environment.

1.1 Necessity of new literature.

Due to the lack of large crisis events, there is an equal lack of empirical data in regard to crisis management, especially for startups. The current research into uncertainty and entrepreneurial uncertainty is tightly connected to the establishment of new ventures (Milliken, 1987; McMullen & Shepherd, 2006; Packard et al., 2017). The newness and ongoing development of the COVID-19 crisis is also an important reason for the 'gaps' in literature, as it is impossible to have sufficient data to date due to the simple fact that the crisis is not over. The effects of the COVID-19 crisis will be thoroughly researched in the following years, and there is a lack of empirical data on startup crisis management.

1.2 Purpose

This thesis seeks to examine and gain empirical data on how startups have handled the uncertainties that the COVID-19 crisis has induced, and to gain insight in which measures that have been essential for startups in order to overcome the COVID-19 crisis. We know that uncertainties make it harder to succeed and might cripple the

actors in the environment that experience the uncertainty. Increased research and knowledge within this field will allow startups and entrepreneurs to be better prepared in face of a future crisis situation. As a means to focus the master thesis within the scope of the author's network, the research questions concern startups operating in the technology sector.

1.3 Research Questions

To address the purpose of this thesis, the author has formulated the following research questions:
RQ1: How have tech startups handled the uncertainty induced by the COVID-19 crisis?
RQ2: Which measures have been essential for tech startups to implement in order to overcome the uncertainty during the COVID-19 crisis?

1.4 Contribution

Most of the existing research to date concerns how entrepreneurs handle uncertainty during venture creation, which is important, but in face of extreme uncertainty due to sudden crisis events have yet to be researched extensively. The author believes he can make important contributions in terms of empirical and qualitative research on how startups have handled the COVID-19 crisis that is not extensively covered in existing literature, and highlight important measures that can benefit startups in the future and facilitate further research into the topics of crisis management for early tech startups.

1.5 Structure

This chapter has touched upon the importance of crisis management and why this topic is critical to deal with for startups experiencing extreme uncertainties. During the next chapter, a literature review on the topics of entrepreneurial action, uncertainty, and the relevant connections between the COVID-19 crisis and startups will be presented. Chapter 3 covers the methodology used by the author when gathering data for qualitative case studies, followed by presentation of the four case studies with relevant findings in Chapter 4. Then Chapter 5 will analyze and discuss the findings, before a conclusion is drawn in Chapter 6. Lastly, Chapter 7 will cover implications for further research.

2.0 Literature Review

A semi-structural systematic mapping process has been completed for this master thesis, followed by a snowballing technique on selected articles to gain further insight of the available literature and research.

2.1 Entrepreneurial action

Before the author can delve into the topic of uncertainty in relation to startups, it is wise to have reviewed some of the literature on what an entrepreneur is and entrepreneurial action. Entrepreneurship requires action, and to be an entrepreneur (...) is to act on the possibility that one has identified an opportunity worth pursuing (McMullen & Shepherd, 2006). There has been several attempts to define what an entrepreneur is, from the earliest 1755 definition by Richard Cantillon *"someone who engages in exchanges for profit; specifically, he or she is someone who exercises business judgment in the face of uncertainty"* (quoted in Hebert & Link, 1988: 21), to the more modern definitions by Mark Casson *"someone who specializes in taking judgmental decisions about the coordination of scarce resources"* (1982: 23), and the broader Hebert & Link *"someone who specializes in taking judgmental decisions that affect the location, the form, and the use of goods, resources or institutions"* (1988: 155). These definitions suggest that an entrepreneur is someone who exercises judgment, which McMullen & Shepherd (2006) through Hastie (2001) extracts to be what must be exercised to make a decision between alternative courses of *action* that take place in an *uncertain* future. McMullen & Shepherd (2006) further stresses the importance of not only deciding, but deciding to act. This is what is required to be an entrepreneur, where one is responding and creating change with entrepreneurial action throughout time and an uncertain future (Hebert & Link, 1988). Entrepreneurial action here refers to the behavior in response to a judgmental decision under uncertainty about a possible opportunity for profit (McMullen & Shepherd, 2006). Because action takes place over time, and because the future is unknowable, action is inherently uncertain (Mises, 1949).

Packard et al. (2017) describes *dynamic* judgment as a continuous process by which judgments are made, evaluated, and remade over intervals of time, displayed in Figure 1. The environment (outcomes) are continuously affected by exogenous factors and the

actions made by the entrepreneur. This gives feedback to make new judgment calls and actions.

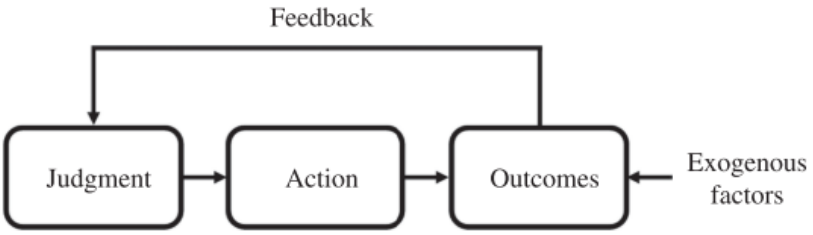

Figure 1: The continuous judgment process (Packard et al., 2017).

2.2 Uncertainty

Knight (1921) was among the first to distinguish risk and uncertainty in his work "Risk, Uncertainty, and Profit". To Knight, a decision was deemed risky when a decision maker didn't know what an optimal decision was, but knew both the possible outcomes of that decision and their probabilities. A decision was uncertain when the decision maker didn't know either the number of outcomes or their probabilities. This coined the term Knightian uncertainty, which has sparked further research and theory for the subject of uncertainty. Packard et al. (2017) describes these in the following topological table:

Scholar	Types of uncertainty				
Knight (1921)	Risk	Uncertainty			
Savage (1954)	Risk	Uncertainty			
Shubik (1954)	Risk	Ignorance	Indeterminacy		
Ellsberg (1961)	Risk	Ambiguity			
Thompson (1967)		Incompleteness	Contingency		
Milliken (1987)			State uncertainty Effect uncertainty Response uncertainty		
Spender (1989)		Incompleteness	Indeterminacy Incommensurability (Irrelevance)		
Dosi and Egidi (1991)		Substantive uncertainty Procedural uncertainty			
Dequech (2011)	Weak uncertainty		Strong uncertainty		
		Procedural/Substantive uncertainty			
	Risk	Ambiguity	Fundamental uncertainty		
	Risk	Ambiguity	Creative uncertainty	Environmental uncertainty	Absolute uncertainty

Table 1: Comparison of uncertainty typologies (Packard et al., 2017).

In recent years, the types of uncertainty have been distinguished to five types with increasing levels of uncertainty: Risk, ambiguity, creative, environmental, absolute. Packard et al. (2017) further describes these conventional terminologies within four

domains, distinguishing the types on whether the set of options and outcomes are open or closed, illustrated in Figure 2:

		Set of outcomes[1]	
		Closed	Open
Set of options[2]	Closed	*Risk/Ambiguity* *e.g., insurance, gambling*	*Environmental uncertainty* *e.g., make or buy decision*
	Open	*Creative uncertainty* *e.g., find a solution to a problem*	*Absolute uncertainty* *e.g., commercialization of radically new technologies*

[1]Includes all foreseen outcomes, imagined or given, that are considered possible as a result of some considered course of action.
[2]Includes all possible courses of action, imagined or given, that are considered potentially viable in generating some preferred outcome.

Figure 2: Uncertainty topology (Packard et al., 2017).

Risk follows the theory of Knight (1921), where both options and outcomes are known, as well as their probabilities. This is similar to throwing a dice.
Ambiguity follows Ellsberg's (1961) conception, where both options and outcomes are known, but their probabilities are not. This is similar to throwing a custom loaded dice with unknown and different side weights.
Creative uncertainty is where the set of outcomes are closed, and the options are open. This is similar to working towards a goal without a specified method.
Environmental uncertainty is the opposite of creative uncertainty, where the set of outcomes are open, but the options are closed. This is similar to performing tasks but not knowing the outcome. Strategy and entrepreneurship have been interested in this uncertainty type due to its relevance to business decision making (Packard et al., 2017).
Absolute uncertainty is the epitome of the uncertainty types, where neither the set of options nor set of outcomes are known. To have any chance of getting out, one can follow a path of *causation* or *effectuation* (Sarasvathy, 2001) by firstly populating the outcome or option set respectively.

Packard et al. (2017) conceptualizes this in Figure 3, where the entrepreneurial process can be seen as a series of smaller judgments by which entrepreneurs resolve uncertainty. The model shows transitions from one state of uncertainty to another, until the uncertainty is sufficiently resolved to make an (entrepreneurial) action.

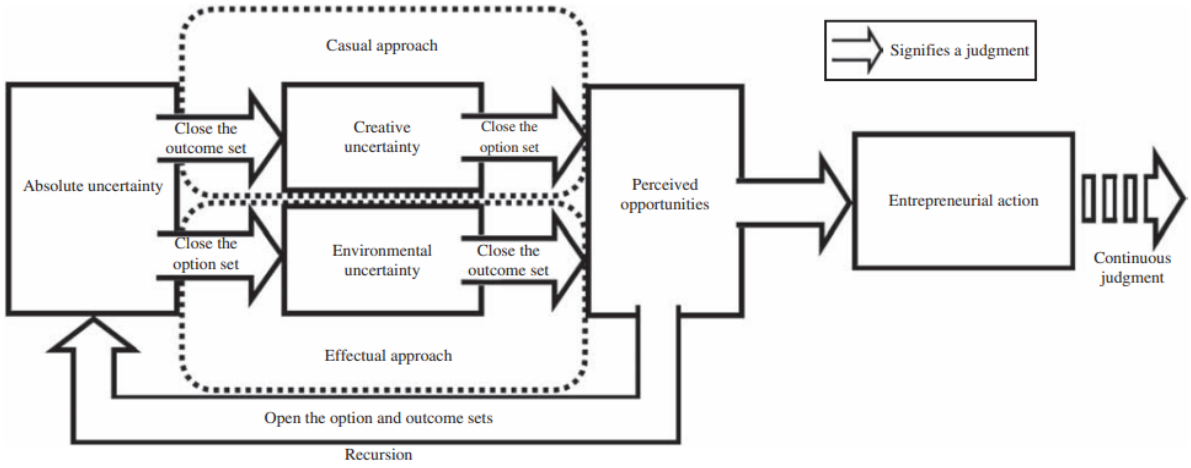

Figure 3: Model of the entrepreneurial judgment process originating in absolute uncertainty (Packard et al., 2017).

Milliken's (1987) framework consists of three distinct types of uncertainty. *State uncertainty* - when environments are perceived as unpredictable. *Effect uncertainty* - when one is unable to predict what the nature of the impact of a future state or change will be. *Response uncertainty* - lack of knowledge of response options and/or inability to predict the consequence of a response choice. He further points out that *"response uncertainty is likely to be salient when there is a perceived need to act [...] because a pending event or change is perceived to pose a threat or to provide some unique opportunity"* (1987: 137). McMullen & Shepherd (2006) suggest that Milliken's (1987) framework, in the context of action, can be simplified into three questions asked by a prospective actor about their relationship to the environment:

1) What's happening out there? (State uncertainty)
2) How will it impact me? (Effect uncertainty)
3) What am I going to do about it? (Response uncertainty)

McMullen's and Shepherd's (2006) research has outlined a debate on the role that uncertainty plays in preventing entrepreneurial action. Due to alternative conceptualizations of uncertainty, their article describes the emergence of two research streams. One stream focuses on the difference in knowledge as the driving factor for whether a decision maker will act entrepreneurially. The second stream focuses on the willingness to bear uncertainty as the driving factor, in essence motivation. Because an

individual must act to become an entrepreneur, and because action involves knowledge *and* motivation, McMullen and Shepherd propose a conceptual model relating to perceived uncertainty and motivation to entrepreneurial action, shown in Figure 4. The model consists of two stages: *The attention stage* where one is to acknowledge a third-person opportunity. This can come from either new/prior knowledge, personal strategy, or a combination of both. Once a third-person opportunity is believed to exist, one can move to stage two. *The evaluation stage* is where a prospective entrepreneur evaluates whether the third-person opportunity constitutes a first-person opportunity, something for him/her to pursue. Simply believing that one has recognized a third-person opportunity does not necessarily mean that one believes one possesses the knowledge and motivation necessary to exploit it (McMullen & Shepherd, 2006). It is however through obtaining new knowledge and motivation one can overcome the feeling of perceived uncertainty, and act entrepreneurially. This shows that one does not necessarily have to have a high tolerance for uncertainty if one believes that they know what they are doing (McMullen & Shepherd, 2006).

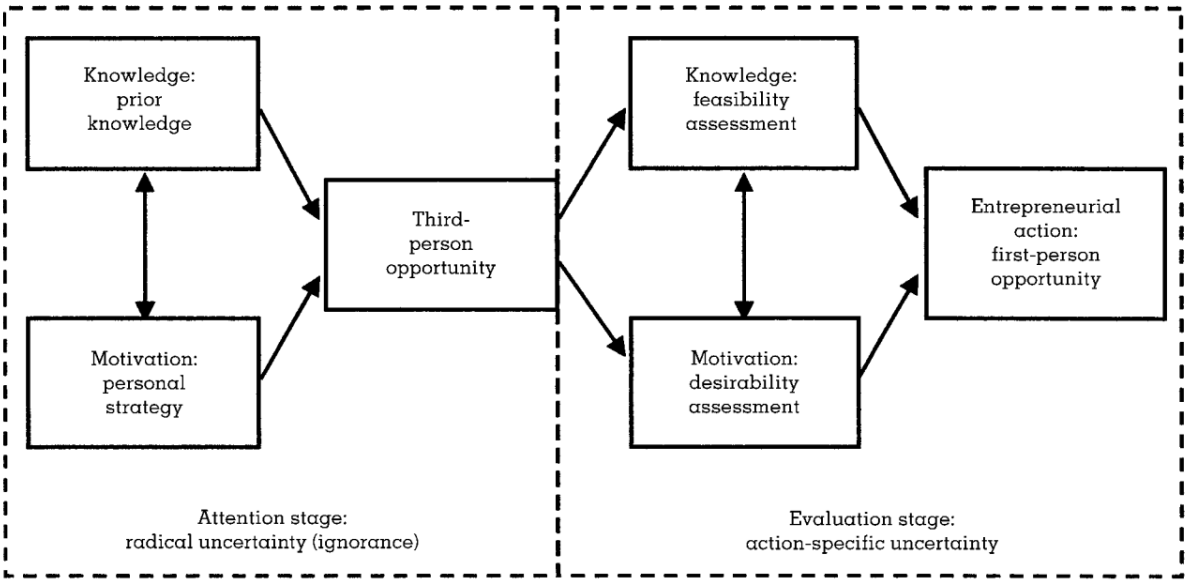

Figure 4: Conceptual model relating to perceived uncertainty and motivation to entrepreneurial action (McMullen and Shepherd, 2006).

Schmitt et al. (2018) found in their research that increased levels of perceived environment uncertainty within entrepreneurs were dependent on the entrepreneurs' *self-efficacy*. Entrepreneurial self-efficacy is the domain-specific belief of an entrepreneur in their abilities to successfully execute entrepreneurial tasks (Zhao et al.,

2005). Those with high self-efficacy identified opportunities through exploration, whereas those with low self-efficacy did not. To have self-efficacy is therefore a valuable resource when acting in uncertain environments. They developed a moderated mediation model displayed in Figure 5.

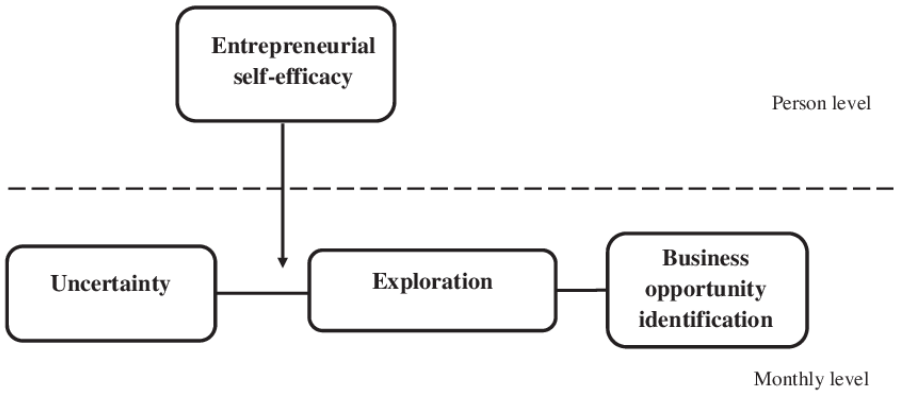

Figure 5: Moderated mediation model (Schmitt et al., 2018).

2.3 The uncertainty of the COVID-19 crisis

Ansell and Boin (2019) define a crisis as:

"When a group of people, an organisation, a community, or society perceives a threat to shared values or life-sustaining systems that demands an urgent response under conditions of deep uncertainty."

The literature is, unsurprisingly, unanimous to define the COVID-19 pandemic as a *crisis*, and that it has had extreme effects on society as we know it (Baker et al., 2020; Brown et al., 2020; Kuckertz et al., 2020; Howell et al., 2020). The perpetrator of the crisis, known as the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was discovered in China late 2019 (Zhu et al., 2020). During the first months of 2020 the virus quickly spread and became an official pandemic on the 11th of March 2020 (Ducharme, 2020). Due to the high infection rates of the virus, governments around the world have placed a multitude of restrictions on the population (Ratten, 2020) in an attempt to slow the spread down. The levels of uncertainty have been compared to that of the Great Depression in 1929–1933, surpassing the levels of uncertainty during the financial crisis in 2008-2009 (Baker et al., 2020).

2.4 COVID-19 and startups

While entrepreneurs by nature are resilient, the COVID-19 crisis in terms of its magnitude and length has led to specific challenges faced by entrepreneurs in adapting to the new environment (Ratten, 2020). There has however been conducted conflicting research on Indonesian entrepreneurs, which outlined that they were reluctant to innovate, be proactive, and take risks when an uncertain environment exists (Herani & Andersen, 2012).

During shocks and crisis events, Brown and Rocha (2020) express that levels of uncertainty escalate to such speeds, their impacts become crippling for both entrepreneurs and entrepreneurial actors such as banks and investors (McMullen & Shepherd, 2006; Packard et al., 2017).

Howell et al. (2020) has found that venture capital (VC) activity in the U.S. fell drastically during the initial phases of the COVID-19 crisis, despite government efforts to prop up startups. They found that the number of weekly early-stage VC deals declined by nearly 38% in the two months starting March 4th, 2020, relative to the previous four months (Howell et al., 2020). The decline in early-stage investment is also reported by Brown et al. (2020) for the United Kingdom. To add to this, there is research which shows that startups born during recessions not only start smaller, they also tend to stay smaller in future years even when the macroeconomic conditions recover (Sedláček & Sterk, 2017). This has major implications as VC-backed startups are disproportionately important to economy-wide innovation, long-term job creation, and value formation (Howell et al., 2020).

It is expected that the government responds to a crisis by making subsidies available for businesses, but Kuckertz et al. (2020) report that several of the crisis measures put in place by the government simply are not available for startups, especially those in the early phases. Their research further looks at two potential research streams for crisis management related to COVID-19: How businesses respond to a crisis (entrepreneurial

crisis management), and policies that can nurture a firm's survival during a crisis. It is pointed out that resilience is an essential concept in entrepreneurial crisis management (Doern et al., 2019), which not only describes one's ability to continue functioning through a disruptive event, but also considers which resources accumulated prior to the crisis to be used throughout and after the event (Williams et al., 2017). Small businesses also tend to be more flexible and adaptable (Smallbone et al., 2012), which allows them to use effectual logic (Sarasvathy, 2001) to better maneuver the crisis. That is where one is able to use reasoning to explore economic opportunity given a set of means. Kuckertz et al. (2020) also builds up a table of actionable measures that entrepreneurs and governments can do, displayed in Table 2, however they also have found in their qualitative research that resilient entrepreneurial ecosystems are essential to faster regain pre-crisis level of activity. Given the importance of venture capital to innovation in general (Howell et al., 2020), it would be an important measure for the government to not only make funds available for startups, but also incentivise VC investors to provide growth capital despite the crisis. This would provide short-term means to survive the crisis while laying the foundations for further recovery (Kuckertz et al., 2020).

Challenges	Startup options	Policy options
Avoid immediate startup failure Drop in sales and mounting operating costs drive illiquidity. Entrepreneurs perceive existential fear.	• Use resources at hand to create solutions to new problems (e.g., creatively combine existing technology and human capital) • Activate network resources (e.g., flexible payment options, joint sales initiatives, flexible staff rotation)	• Offer payment delays, wage subsidies, direct payments • Communicate community feeling to stimulate mutual assistance ("We can do this")
Adapt due to disruptions in core startup infrastructure Interruption in value generation processes, disruptions in the supply chain and increasing hurdles to personnel recruitment and management.	• Restructure internally with a focus of channeling resources only on recently viable and value generating activities • Downsize other activities (retain the possibility to upsize again at a later point)	• Offer employee development programs (e.g., for digitalization) • Support temporal downsizing (e.g., through wage subsidies)
Continue startup growth against all odds Reservations about innovation experienced through a hostile climate for innovative products and services (except solutions to crisis-response) along with additional hurdles in startup funding.	• Discover opportunities creating value in solving consequences of the crisis (e.g., developing hygiene or digital work solutions) • Proactively engage in broader opportunities that may arise in the aftermath of the crisis (e.g., shifting trends and behavior after crisis – boost in digitization)	• Secure future innovativeness through mid-, or long-term policy measures linked to larger policy objectives (e.g., sustainability and/or digital transformation) • Lay foundations for post-crisis recovery (e.g., incentivize investors to provide additional growth capital) • Nurture knowledge diversity and entrepreneurial culture in the ecosystem • Boost positive business climate for consumption and innovation
Respond to mismatch of initial policy measures First policy support services experienced as not being meant for startups ("we are stuck in the middle"). Additional barriers in the application for and implementation of policy support services specifically for startups.	• Gather information and best-practice through entrepreneurial networks (e.g., exchange information in online crisis groups, learn about the application and implementation of support services from similar startups) • Support lobbying initiatives of (trade) associations to be included in policy decisions and programs	• Provide information and support services addressing the specific challenges of startups (e.g., hotlines) • Communicate intention for startup specific support early • Decrease specific barriers for startups in the application of startup specific support (e.g., consider future growth trajectories instead of past revenues) and reduce red tape

Table 2: Actionable measures for startups and policy makers (Kuckertz et al., 2020).

2.5 Theoretical summary

In this chapter the author wants to focus on the theory that will in particular assist in answering the research questions presented in this thesis. The author takes note of the relevancy of the continuous judgment process presented by Packard et al. (2017) in Figure 1, as it shows elements that is believed to be important in relation to the COVID-19 crisis, being an exogenous factor that affects the outcome that also the entrepreneurs do through their actions. It is a fluid and continuous process, and opens up to look more into entrepreneurial action as presented by McMullen and Shepherd (2006). As the uncertainty framework presented by Packard et al. (2017) in Figure 3 appears to be more relevant as it assumes actions taken from absolute uncertainty, it has been decided by the author to utilize this instead of the framework presented by Milliken (1987). It is also beneficial as one is able to characterize the uncertainties perceived in an increasing manner, going through risk, ambiguity, creative -, environmental -, absolute uncertainty.

The author is also interested in the moderated mediation model presented by Schmitt et al. (2018), where high self-efficacy can be a valuable trait in an uncertain environment. As is it to look further into the startup's resilience (Ratten, 2020) and use of effectual logic (Sarasvathy, 2001). Research from Brown and Rocha (2020) might indicate that levels of uncertainty can escalate at such speeds, their impacts become crippling for both entrepreneurs and entrepreneurial actors such as banks and investors (McMullen and Shepherd, 2006; Packard et al., 2017), which will be important to explore. Finally, the actionable measures for startups and policy makers presented by Kuckertz et al. (2020) in Table 2 contains a multitude of measures that startups might utilize in a crisis event, and the author will look for this in the empirical data.

3.0 Methodology

3.1 Research Design

3.1.1 Qualitative Case Study

To answer the research questions presented in this thesis, the author decided to conduct a qualitative case study. This will allow the author to gain a high amount of details from a set of relevant startups. Interviews will allow the author to capture the subjective experiences and thoughts of the interviewees in their own words, from startups that have experienced the crisis.

3.1.2 Multiple Case Study

Due to the words of Yin (2003, p. 53): *"the analytical benefits from having two (or more) cases may be substantial"*, the author chose to conduct a multiple case study. Eisenhardt (1989) suggests having 4-10 subjects to interview, where the author decided to conduct the lower suggested number of interviews due to the author's inexperience with case studies and not to complicate the thesis further.

3.1.3 Selection Criteria

As a mean to find relevant cases of startups to gain data from, the following selection criteria were chosen:

- The startup is in the early phases.
- The startup has a small team of less than 20 employees.
- The startup existed for a minimum of one year before the crisis.
- The startup operates in the technology sector (physical product or digital service).
- The startup has survived the COVID-19 crisis at the time of the interview.
- The startup has been affected by the COVID-19 crisis.

Due to the large possible sample size of startups, and the limited number of startups to interview, it was necessary to have several relevant selection criteria for the startups that were included in the study. The author wanted to include startups that have yet to

cross the 'valley of death', but not so young that they haven't managed to establish their company before the crisis hit. Due to the author's network of startups, most operated in the technology sector, and this has therefore been a relevant selection criterion. It was also a criterion that the startups had managed to survive up to the point of the interview

3.2 Data Acquisition

3.2.1 Interview Scheduling

At the start of May, the author had decided which startups he would like to use as case firms. Each startup was contacted by email or Facebook Messenger, depending on whether or not the author knew the CEO or not. The author found it logical to interview the CEO of the case firms, as this would be the person that knew most of the day-to-day activities and the current status of the firm. Due to the flexible availability of the author, the CEOs of the case firms were able to schedule the interview when it was appropriate for them, and in three of four cases it was necessary to reschedule within a short time frame due to the CEO's availability suddenly changing.

3.2.2 Data Gathering

Due to the COVID-19 crisis and the widespread location of the startups, it was decided to conduct the interviews on the platform called Zoom. Here the main pieces of data were gathered by recording the online conversation with both video and audio. The audio files were later transcribed and coded by the author. The data was labelled with the company name and each interview lasted for 45 minutes to an hour, and all interviews were conducted within a two-week period to minimize the chances of any big event happening in relation to the ongoing crisis. The interviews were conducted in a semi-structured fashion, where the author was following an sectioned interview guide consisting of three sections: Opening questions, different domains where the uncertainty was experienced, and closing questions. This is shown in Table 3. Especially for the middle section of the interview, the author had to make selections on which topics and questions to follow in real time, depending on where the startups experienced uncertainty. The middle section consisted of uncertainty related to five different topics which were financial, customer, product, business partners, and team.

The author never had to ask all questions from the interview guide, as none of the startups experienced uncertainty for all these topics. This was intentional, and which questions to address was decided after the introduction where the author got to know where the startups experienced uncertainty. The full interview guide can be found in Appendix 1.

Opening questions	**Uncertainty domains**	**Closing questions**
Introduce startup Build timeline Explore uncertainty domains	Financial Customer Product Business partner Team	Expand on measures Expand on needs Interviewee opinions

Table 3: Structure of the interview guide.

3.2.3 Data storage

The recordings of the interview were stored locally on the author's personal computer, due to him not having a computer from the university. The recordings and the following transcripts of the interviews were uploaded to a secure folder on Google Drive for safe access to the data and sufficient backup. After the completion of this master thesis, all recordings will be deleted from the secure folder and personal computer, leaving only the transcripts and case studies in Chapter 4.

3.3 Data Analysis

3.3.1 Coding of the Data

Due to the way the questions were grouped, coding the transcripts, and separating the different uncertainty domains that a startup faced during the COVID-19 crisis was relatively straightforward. The different uncertainty domains that the startups were likely to face during this crisis were financial uncertainty, customer uncertainty, product uncertainty, business partner uncertainty and team uncertainty. The initial introduction with the CEO would give a good indication as to which of these uncertainty domains the startups were facing, allowing the author to ask more in detail on the topics of uncertainties. During the coding, important quotes were noted and highlighted, in order

to clearly present the story of the startups. The final case studies were sent to the case interviewees to confirm the data and make adjustments/corrections.

3.3.2 Analysis

The analysis of the case studies was carried out in a cross-case manner, where the author would compare the different startups within the different domains of uncertainties, entrepreneurial action and outcomes. This would decrease the amount of repetition of data, as there were startups that had similar approaches to uncertainty management, but more importantly it made a concise and easier to understand examination of the case studies and see the data with different lenses. The analysis focused on the similarities and differences of the startups, before finally conceptualized to answer the research questions for the thesis. The author also decided to rate the uncertainty domains the startups experienced on a three-level scale, from 'low' to 'medium' to 'high'. It was also considered to use a number within the 1-10 range, but due to the larger range it was deemed to be closer to guesswork by the author as it would be difficult to differentiate enough metrics to distinguish numbers that were closer together. It is worth noting that in the cases of startups not really experiencing an increase in uncertainty, their rating would be low even if it could be considered none by the startup.

3.4 Reflections and Limitations

Due to the fact that the author was inexperienced with both semi-structured interviews and case studies, the author relied on guidance from his supervisor to strengthen the case study. An important decision that was made early was to section the interview so that it wasn't necessary to address all questions for each startup, which allowed the interview to flow more naturally. In reflection of the actual questions, the author wish that some of the questions were presented in a more open-ended fashion, as the interviewee in some cases might have been unable to give a clear answer or just a simple yes/no before the author had to dig deeper into the question and reframe it during the interview.

There was also a risk for the interviews to have bias from the author affecting the interview process, in particular in regard to confirmation bias to have the interview confirming the theory presented in this thesis. The author was aware of this potential bias and tried to ask questions that allowed the interviewee to answer openly to the questions, although it was clear in hindsight to the author that some questions were too related to the literature. These questions did not sufficiently affect the interview process to color the answers from the interviewee in a degree that would be relevant. This is also why it was important to the author to confirm the case studies with the interviewees after it was completed. The author also believes a limitation was not being able to have more case firms included in this thesis. It would be beneficial to have even more empirical and qualitative data when conducting the analysis in this thesis, as even though there were similarities that can be shown, the startups were experiencing the crisis quite differently. That being said, it was good to have different cases, but it would also be great to have some cases that were closer in proximity to each other, to more clearly connect the dots and gain a deeper understanding of important measures that startups can utilize during a crisis.

Another important reflection is that the case firms that were interviewed had all survived the crisis to date. This leaves the data at risk of having survival bias. A valuable addition to the data would be a startup that failed due to the crippling uncertainty that the COVID-19 crisis induced, where the author also could analyze their measures and what they did/didn't do. This could possibly be solved by conducting a longitudinal case study over several months, which also saw the change in uncertainty and didn't rely on the memory of the interviewees to look back at what they have experienced. In this scenario there could possibly be startups that failed, which would present valuable data in the comparison and analysis.

It is also worth noting that the author had quite close connections with two of the interviewees for this master thesis, and were in the network of the other two, either through previous startup ventures or being fellow students from the NTNU School of Entrepreneurship. In a perfect situation, there would not be a previous connection between the author and the interviewees.

4.0 Case Studies

This chapter will go through the case studies and present the four startups that were interviewed for this master thesis. Each case will consist of a short intro, followed by a presentation of the interview that contain relevant findings that would help answer the research questions:

RQ1: How have tech startups handled the uncertainty induced by the COVID-19 crisis?
RQ2: Which measures have been essential for tech startups to implement in order to overcome the uncertainty during the COVID-19 crisis?

4.1 Ludenso

Ludenso is a spin-off from another startup named MovieMask, and their mission is to let all children become digital creators by exploring, learning, and creating with technology like 3D and Augmented Reality (AR). Ludenso was started in the end of 2018, and they are currently developing solutions to enhance science textbooks with 3D or AR. They have previously created software that allows children to create their own 3D drawings that they later can explore in AR. Their goal is to link their software with the learning plan/curriculum goals for schools in Norway. Representing Ludenso in the interview is their CEO Eirik Wahlstrøm. He was one of the founders of the previous startup that Ludenso spun off from. He first heard about the COVID-19 virus on an online image sharing website in January 2020. He was actually questioning whether this would be the next big thing, but thought that this was likely to be controlled or fade out as most of the potential pandemics we've heard about.

Ludenso developed an early MVP in the beginning of 2019 that was purely an AR product, and during testing in schools, they got feedback from the teachers that it would be great if the students could create something themselves. People like the idea of AR technology, but it was difficult to picture the long-term learning outcomes for the students. They wanted this to be more than something the students just used a couple of times because it was cool, and this is where it was essential to allow the students to create something of their own. During the spring of 2019, the team created another MVP where the students could create something in 3D and then experience their creations in

AR. After testing on three schools and 200 students, they improved their MVP substantially and received a project grant from Oslo municipality to develop the program further. This was a huge milestone, and at the same time they got multiple angel investors in a pre-seed funding round. During this process they also opened a dialogue with a large publisher, which had heard about their product. They were interested in a product that could enrich their textbooks with AR and build a bridge between digital and physically printed products. Wahlstrøm said: *"Here we could use a lot of our understanding of the technology as well as the Ludenso Create [the platform product they had developed]."* This resulted in a large grant from the Norwegian Directorate of Education as well as an equivalent sales agreement with the publisher, both in December 2019. They went from being bootstrapped to fully funded within a little more than a year, which was highly motivating for the team. This funding set the course for the startup for the next year and a half, with expectations to deliver both products by August 2021.

During the first months of 2020 leading up to the crisis, they were testing their solutions on schools to get valuable information to continue development. Wahlstrøm said: *"We were testing on schools every week, so when the lockdown from the COVID-19 crisis hit, we couldn't be in either the office or any school. It was bad because our solution was not ready to be digitally scaled out yet. We had a lot of trial and error that had to be done, which we had to find other ways to do."* The team had to spend a lot more time explaining to the teachers up-front how to use the software, as well as understanding how the team could conduct the essential tests in a digital classroom setting. Wahlstrøm continues: *"This was a difficult task. It is much better to be physically present in the classrooms."* They experienced high uncertainty relating to their room for maneuvering in relation to schools during the crisis. Many of the teachers were not comfortable conducting digital workshops with software that had bugs and errors. The startup was used to work with teachers that had time available and willingness to test new solutions in their classrooms. The current situation was teachers being stressed because they had to adjust to a new and ever-changing environment, and the willingness to try the software decreased on top of the increased difficulty to actually test the software. Wahlstrøm said: *"The way we develop our products is extremely user-driven. We travel to the schools to test the newest version, and we'll get quantitative feedback in the form of questionnaires*

after the class, as well as qualitative feedback from direct communication with students and teachers." This feedback is essential, as it is brought back to the rest of the team to make sure their software is developed in the correct direction. In a digital classroom setting, the startup experienced losing a lot of valuable feedback that would come naturally after the class, as well as making sure everyone filled out their questionnaires. They would also rely on a lot of 'silent feedback' which they would get from observing the students and teachers using the software, like where it stops, becomes hard to use, or mistakes made by the user. To tackle this new uncertainty, the team quickly introduced 'feature stop', where they rather focused on making the parts of the software that was frequently used simpler and free from bugs and errors. This was to make it easier to use in digital classrooms, where they in a normal situation would try to continue finding the most valuable features. Wahlstrøm added: *"This slowed us down, but it was something we had to do in face of bugs and errors that became present in the digital classrooms. We had to stop developing and focusing on fixing these issues."* Wahlstrøm emphasizes that the most important measure to keep their customers was to be adaptable and resilient. Still, he wished that they were better at getting feedback from users during the digital testing. This is yet something they are working to get as optimal as possible, as it is still far from what it was before the COVID-19 crisis hit.

Ludenso has been in a good position where they have been able to test and develop their software, as after the initial testing on a substantial number of schools, they started receiving requests to test the software as well. Schools could find them through their website, different groups on Facebook (typical educational groups), partners that have talked about them (like the publisher they have an agreement with), from school magazines/articles/blogs, or the best one by word of mouth between teachers. During the start of 2021, Ludenso has made changes in how they go about acquiring new customers/users. They have created different hypotheses for growth strategies that would increase the organic spreading of their software, which is a development of the latter of the mentioned ways that they can attract new customers/users. Wahlstrøm details: *"We've conducted experiments to test this. For example, an hypothesis is that if we certify a teacher within 3D and AR, their increased confidence would make them want to share with other teachers. We set up some criteria to become certified and conduct a webinar with some teachers, and we follow up with them to see if they have had an*

increased interest to share it with other teachers." He goes on explaining other hypotheses that they are testing. When asked about if this is a measure that has come due to the COVID-19 crisis, he believes that they would do this in either case, but that the crisis likely has hastened the initiation. They have experienced that the edtech market has increased in popularity, and that there are more investors, schools, and teachers that are interested in good edtech solutions.

Ludenso has been able to increase its team during the COVID-19 crisis. They have been working from home since the start of the crisis, but had weekly meetings outside. Wahlstrøm said: *"It was good to have a social check-in once a week. We had lunch, talked about our week and had 'watercooler moments' together. We also had a weekly optional workout where we either jogged, went skiing, or strength training. These measures have been important to maintain a face-to-face connection."* They also had daily check-ins on video. From May to October 2020, their offices opened up slightly, which allowed them to spend some time there, but mostly working from home after that. During the time of the interview, they have started to return to the office a couple of days during the week. A couple of team members have been very concerned about the COVID-19 virus, and according to Wahlstrøm: *"It affected the mental health to a certain extent for some of our team members."* They also had two team members catching the virus, but they were all working abroad (Ukraine and USA) and realized that they had it without experiencing any danger to their health. This did not affect the core team in Norway, as they were notified after the fact and it didn't affect the team members' work.

Due to the large project grant and sale agreement, Ludenso didn't have to do any fundraising in 2020 when the COVID-19 crisis hit. Wahlstrøm said: *"It seems that the startups that were dependent on physical meetings with investors were hit harder by the COVID-19 crisis."* As this was not an issue for Ludenso, they are currently planning to initiate a funding round soon. He was impressed by how easy it is to get in touch with investors at this point. Wahlstrøm continues: *"We have reached out to investors that now are more used to the new workday with digital meetings and less physical contact. Investor meetings are almost easier, if not easier to conduct online. It seems that there has been a change in the mindset of investors, as it appears to be easier to get a 25 minute online meeting than it was to get a 5 minutes meeting over a coffee."* Wahlstrøm concludes that

they were in a good position when the crisis hit, with long-term contracts and being in an industry that has received an upswing recently.

4.2 SammeVei

SammeVei is a technological startup that was established in 2016. At this point their main purpose was to build a 'peer-to-peer' ridesharing/carpooling app that was to integrate with public transportation systems. They had several ongoing pilots and negotiations with multiple public transportation operators in cities around Norway. In the start of March 2020, the company was planning to launch a large campaign with a public transportation operator in Stavanger, and the COVID-19 crisis hit. Representing SammeVei in the interview is their CEO Pelin Smines. She has been their CEO since the beginning of 2019, and has six years experience from another ridesharing company abroad. She first heard about the virus in December 2019, and jokingly told some friends that visited China at the moment to not come visit for a while.

As mentioned in the introduction, SammeVei was planning a large campaign together with a public transportation company in Stavanger. The campaign focused on a particular area where commuters were going to use the most expensive and deepest substrate tunnel in Europe that was soon to open. Smines stated: *"This was going to cost a lot [for private persons], more than 5000 NOK a month if you were going to commute daily. The idea was to offer people a more reasonable cost, while still offering the comfort of a car."* SammeVei had prepared the entire campaign down to the visuals, and soft launched it on the 5th of March 2020. On the 12th of March the crisis hit Norway with a subsequent lockdown, and most people had to start working from home. Smines continues: *"The crisis was stopping everything we were doing. Our app is commuting based, so you are only able to use it properly if you are commuting daily from A to B. That is where the critical volume is established, so when there is no commuting, there is no ridesharing, and our whole business stops."*

SammeVei was in 2019 accepted as one of the startups for a circular economy accelerator provided by Danske Bank and WeWork. This provided some support, as well as some additional support from partners in Sweden. Previously in 2018, the startup

had received funding from Innovation Norway to complete the projects with the public transportation operators. All these factors gave the project some runway, but Smines adds: *"I was thinking: What are we doing now? What should we do? I was thinking that we can't do anything with ridesharing, it's not the right moment."* The team did indeed develop a way for cohorts to use the app together as a way to adjust to the crisis, but it was decided to not be mentioned further as the general population, according to Smines: *"Just wanted to be home and wait until everything is over, like waiting one month and then everything is going to be fine."* What Smines and her team decided to do, just a week into the crisis, was to swiftly start developing a new application from a need Smines had picked up during some of her business meetings. Many people complained about how long it took to receive groceries that one ordered online. Existing services were overbooked due to the sharp increase of quarantines in the population, and when Smines tested herself the fastest way to get groceries delivered was 10 days. Smines said: *"[...] this is food, you need to get it immediately. Where I am from in Istanbul, we have had these home delivery apps for 5 years, and I started noticing that we don't have this here in Norway."* Together with an increased spike in requests for help to buy groceries through apps like the Norwegian 'Nabohjelp' (neighbours helping each other), the need for home delivery was substantiated. At the same time, taxi drivers were virtually unemployed as very few used their services in this period, which made Smines and her team see an opportunity. Their existing matching algorithm for ridesharing was easily adaptable, and within two weeks of the idea they had a MVP ready for testing. It was tested in both Oslo and Sweden, and then they started calling all of the different grocery chains in Norway. To the surprise of the team, neither of the chains were willing to jump on the idea. They therefore explored the opportunity to start their own marketplace, and ran two live tests in the end of May and middle of June with five pilot stores in an area of Oslo. They got their first official order around a week after the last live test. When their app started to be more and more picked up, they saw an increase in competition from large international actors like Foodora and Wolt. Despite the tough competition, their app managed to get a good name for itself, and this was how PickApp came to be a new venture for the startup. Already being partly funded by Innovation Norway, Smines could inform them that the project was temporarily set on pause and that they had a new venture to pursue. This allowed them to apply for a startup loan that Innovation Norway provides at very good conditions during the crisis. This helped

tackle the uncertainty substantially and do more than just running their day-to-day activities, but they went 'back to start' in terms of having to develop a brand-new product in an ever changing environment. Smines adds: *"We are still a startup without funding and a tight budget."* On the other hand, they do not feel stuck with their new venture, and have more room to maneuver. The ridesharing app is more vulnerable, while PickApp can easily be modified to a different time and place, which have made the startup feel more in control.

SammeVei is a particularly interesting case among the case firms for this master thesis, as they were the only ones experiencing their end-users no longer being able to use their product due to the COVID-19 crisis. Not only that, but their customers/business partners, the public transportation operators, were suffering heavily as they too experienced a drastic decline in customers. When this customer base was diminished, there were extremely few that could use the product created by SammeVei, since it is dependent on a critical volume of drivers and passengers. This was never SammeVei's intent to build up, as it requires extensive funding, which is why it was smart to use the customer base of the public transportation operators. In Smines' words: *"COVID-19 came and stopped it because no one needed to go anywhere, so the need was gone which is what creates the demand."* This became a long-lasting problem, as even when it started to open up a little, the public transportation operators were uncertain whether or not there was going to be a second or third wave of infections, and this halted the investment that they were willing to take at the time. Now we know that this was indeed the case, which is why the sharp and early pivot for the startup was an important decision.

During the early pilots, they were able to expand PickApp to more places than Oslo to acquire new customers. As the only Norwegian actor among larger international ones, they were able to focus on other places with less density. While their competitors focused on the bigger cities, PickApp with a small and flexible team was able to adapt to the specific needs of its customers. In particular they were able to create local marketplaces, unlike the larger centralized like the existing Kolonial which had to deliver from a large warehouse to a huge area. The local approach allowed the product to be a part of municipality projects, as they knew of the possibility to quickly adapt and

create a working home delivery service. They have currently four projects like this ongoing, which is good for such a young business. A good example of this is where they won a project grant together with some business partners to have a working home delivery service in Norefjell, a popular travel destination for Norwegians during the multiple winter holidays. SammeVei noticed that they had a drop in their core users during the holidays, and many people were traveling to Norefjell to spend their holiday here. In a short amount of time, SammeVei was able to onboard eight stores and made agreements with a local transportation company to deliver groceries to the cabins during the winter holiday. This was highly motivating for the team as they also received significant revenue from this action, and they were also proud due to the fact that every order that came in was one less household that had to travel to the city center and actually complete the shopping. This project generated interest from other municipalities, as they understand that not having services like these makes one more vulnerable to crises like COVID-19. SammeVei is now able to empower local stores with digital tools that they normally would not have access to.

When the crisis is over, Smines believe that the previous partnerships will continue, and the partners are still committed to the idea. It will likely contain new use cases and projects, so picking up exactly where they were before the crisis is unlikely, but it is highly likely that they will come up with something useful again with their partners. They are also clear on wanting to continue with PickApp after the COVID-19 crisis. Smines said: *"We don't want people to view [PickApp] as a corona service. Even if it would help during this time, corona was not the reason for [PickApp] to be established."* She goes on to explain that even though we saw a slight reopening in September when the spread of the virus went down and people were more relaxed, the service was still used a lot. Smines emphasizes that this is a service that has come to stay. They are still uncertain how long the crisis will last, and if this will have a positive or negative effect. Some aspects of the app could benefit from COVID-19 and some could not, and those are the things that they are trying to figure out. It is also uncertain if their competitors will continue with their services after COVID-19 ends, or if they will be phased out. Crisis aside, Smines had higher expectations for the number of users. The business plan was not particularly optimistic, but it was a disappointment that not as many as they hoped for took the time to sign up and use the new service. This was something that she would

have liked to be able to do, and believe that it was a matter of funding and capacity. During the crisis they hired four new employees while one left the startup. With more funding and capacity, Smines believe that they could have expanded faster and do things differently. Currently they have had to cut costs, optimize operations and create marketplaces where competitors can't tap in that easily. She was disappointed that they were not getting investors with them on the project. Investors were questioning the service and the demand, whilst their competitors invested hundreds of millions on international levels. Smines believe that it isn't COVID-19 that is the reason for investors to be reluctant, but that they possibly were a little bit too early in the market, as 'everyone' they presented the case to was saying it is too good to be true. Smines concludes: *"It will require some time before they realize that this is a real, funcional, profitable and feasible service. That is the part that is still haunting us."*

4.3 Cosgear

Cosgear develops and sells high-end technological cosplay gear for cosplayers. Their venture started in 2018, and they are currently producing their products in Norway and selling through their own website to cosplayers around the world. At the time of the interview they have two main products and 30 upselling products on their platform, and are currently planning to release a new main product in the summer of 2021. Cosgear received a market clarification grant from Innovation Norway in 2018 and won an entrepreneur competition later that year followed closely by an angel investor competition that they also won. It led to a commercialization grant from Innovation Norway in the start of 2019, followed by two additional grants the same year. They launched their first product in December 2019 through pre-orders on their website. The product was a digital skeleton of a tail that moved and followed the movement of its user, to move more organically like an actual tail. The users decorated the product themselves to fit the costume that they were wearing. The Cosgear team consists of seven employees, and representing the startup in the interview is their CEO Vilde Bergan. She first heard about the COVID-19 virus in December 2019, as they were in the middle of establishing a product line and talked with many different suppliers in China at that time.

When Cosgear launched their preorder in December 2019, they quickly reached their internal funding goal of 1 million NOK in sales. After this goal was reached, they paused marketing activities to focus on delivery. It was at this time they learned about the possible conflict of the COVID-19 virus. Despite the virus causing some problems, Cosgear was only three weeks delayed when they started delivering their products in June 2020. Bergan said: *"It is almost tradition that hardware startups experience delays in production, and we even had the COVID-19 crisis on top of that, so we're very happy [that we only had a three-week delay]. During the months from opening our preorder sale, we only had one cancellation due to COVID-19."* Bergan is excited for the future, especially to see how much COVID-19 has affected their sales, as the COVID-19 crisis has cancelled all conventions where cosplayers meet and show off their costumes. Many of their customers have been able to use their product in their own home, even posting it on social media. It is just the recent months since May 2021 that the team has received feedback from customers that have used their products on conventions, where it was very popular. The team are therefore expecting an increase in sales once the word of mouth for their product starts spreading. To date they haven't spent money or 'brainpower' on direct marketing, but they have tripled their initial funding goal. The team is looking forward to doing more direct marketing in the future as more cosplayers can travel to conventions and use the product live. Bergan said: *"We feel like the sales potential is the biggest uncertainty now, because we haven't had our product in the market at the same time as conventions were open. Our customers usually plan a lot of costumes that they intend to use for something, and many are saying that they are waiting and currently not motivated for this. At the same time the income of our customers has decreased, so we see the sales potential as a big uncertainty."* The marketing effect of their current customers has been low due to them not being able to show the product much, which makes the startup excited for the future. They see that a lot of costumes that cosplayers have created is only half finished, which has been due to them not being able to attend conventions. On top of that, when sharing on social media, the half-finished costumes might suffice, as they have the possibility to not show their entire body, but only the top. This makes the tail in these cases unnecessary, and has been a reason for the next products that Cosgear released to be focused on the head of the cosplayers, which always is displayed. They are arranging to launch ears that move on their own to sound, which would fit the segment of cosplayers that only show off parts of their

costume. It is also an easier 'plug-and-play' product that works straight out of the box, and is substantially cheaper than their tail product. To acquire new customers during the crisis, Cosgear has focused on collaborations with professional cosplayers. To their customers it is important to be able to conceptualize how they can use Cosgear's product. The tail itself does not have any artistic elements, which is why it is important to work with influencers that can use their creativity to develop innovative looks of the tail that then again help potential customers imagine how they themselves can use it. Cosgear has been satisfied with this approach so far, and look forward to focusing more on this when cosplayers attend conventions again.

Cosgear buys all their parts from China, but the actual production and composition happens in Norway. They did not imagine the extent that the COVID-19 virus ended up having, but were already in January 2020 preparing for the possibility that they were not going to be able to travel to China to oversee the production of an important tool that they were making there. The team had a meeting concerning this, and it was decided that they were going to continue the production process and planned for the possibility that they were not going to be able to travel. Bergan said: *"It was lucky that we prepared for some consequences, because our plan to travel to China got cancelled!"* They did not have trouble having the tool produced, and it was shipped to Norway according to plan. What the team could not prepare for, was that the manufacturer they had lined up in Norway, suddenly had to rent one of their own machines to a subsidiary in Sweden. The machine was going to make respirators there as the crisis hit Sweden hard and many got infected. Bergan asserts: *"This was not something that was up for discussion, and we had no issue understanding this!"* The issue was that this machine should make parts that Cosgear used for their product, and the manufacturer kept postponing the production, while promising weekly that they were going to be prioritized soon. After ten weeks of postponing, Cosgear called the manufacturer in for a meeting and informed them that they were switching manufacturers, and their tool was sent to another manufacturer in Stavanger that had capacity and swiftly produced the parts they needed. This was a manufacturer that they previously considered using, and that was interested in manufacturing the parts. Bergan said: *"The repercussions of having to inform our customers weekly of delays due to one manufacturer could have been huge, and it was a necessary measure to switch manufacturers to complete the production."*

Apart from this incident, the startup hasn't had much uncertainty regarding production - until recently. Bergan said: *"We are currently experiencing a chip shortage in the global market due to the COVID-19 crisis. One of the chips that is used in our product had a sharp price increase of 1000% during the crisis! This is an extreme increase in price, which has drastically affected our margins. We are also experiencing some other components that are increasing in cost as well."* Luckily, the product that Cosgear has developed has an interchangeable design. They have a list of components that could replace the components that they currently are using, so that in the worst case they can make changes when needed. The chip shortage affects many companies, including the larger companies. They have seen these companies delay launches of new products because of this lack in electronic elements. On top of that, a small startup is placed back in line and will be quoted a higher price due to the smaller order. Bergan said: *"Since the increase in cost of the components, we only have around 200 units in stock left, so we have stopped all marketing in an attempt to slow down the sales until we have successfully replaced the expensive components."* Cosgear does not have the liquidity to scale up their production and order 10.000 units to decrease the cost per unit, which has been an issue too. As a matter of fact, the team considered making a larger order of the components in question when the COVID-19 crisis was in early phase, but unfortunately decided not to do this. It was too risky when they were uncertain how the sale would develop throughout the crisis. The increased cost of production is highly affecting the margins for each unit, and it is not sustainable to manufacture and sell the units at the current cost structure. At the same time the team is focusing on increasing their upselling products, that is products where manufacturing is cheaper and margins higher, as it can be something that is without electronics and cheaper materials. Then they can work on increasing the value of each order they receive, as their customers can order more items with higher margins for the startup. This way they can also handle better increased production costs, as they don't necessarily need to depend on their main units.

In terms of financials, Cosgear has been managing OK during the crisis. They are making enough to keep the daily operations going, but this has also been where the team has experienced most uncertainty. Their first experience was that they struggled to get larger investors invested in the business, as they wanted to complete a funding round in June 2020. At this point of the crisis, it was evident that the potential investors were

affected by the COVID-19 crisis. The investors' existing portfolio of struggling companies was one factor, combined with Cosgear developing highly market specific hardware. Many investors don't usually invest in hardware companies, and they are not particularly familiar with the cosplay market. The larger investors have strict policies with their investment profiles, and if they don't have specialization in the industry of the startup, they struggle to see how they can help bring the startup forward with either knowledge or network. Bergan said: *"We were noticing that the investors were on the fence and afraid of the development of the crisis."* Cosgear decided to aim for more soft funding from Innovation Norway. They got a grant as well as a loan, where the grant was an extraordinary innovation grant that Innovation Norway had put in place because of the COVID-19 crisis. This has been a positive effect of the COVID-19 crisis, as that particular grant would not have been available before the crisis. They also applied for a growth guarantee solution with a bank to have some additional financial flexibility. This was in order to build inventory, as they do order rather large batches of products before selling the units. The soft funding was fully used to establish production lines and build inventory, and it would've been difficult to manage without this. At the time of the interview, Cosgear had just closed a successful crowdfunding investment round, where smaller investors and private persons could invest in their company. Bergain said: *"We chose the crowdfunding route as smaller investors invest with their gut and emotions, depending on what they consider interesting to be a part of."* They had previously intended to have a funding round around the onset of the COVID-19 crisis, but the readily available soft funding allowed them to delay the funding round and gain finance at a significantly increased evaluation. The newly acquired funds will go towards scaling their production capacity, and for their next investment round they are planning to include the larger investors. They are motivated to work towards this goal, and have a lot to prove in order to land the larger investments.

When asked why Bergan believed Cosgear survived the COVID-19 crisis, she said: *"Because we looked at it as a crisis from early on. We were careful about increasing our sales, and not aiming for a maximum number of sales. If we had to deliver thousands of products by the summer of 2020, we would've struggled. [...] We also got investors on our side because we proved that we could deliver. [...] The grant and support from Innovation Norway was also essential to allow us to manage the economics throughout the crisis."*

Their team has grown during the COVID-19 crisis, hiring three new persons, out of which one is a world-famous cosplayer. This is a key employee, as she is working with market and content, and has valuable insights into the industry and shopping patterns for cosplayers.

4.4 AUK

AUK is developing a fully automatic plant and herb grower for home use. It is a consumer product that you can put on your countertop to automatically grow herbs, tomatoes, etc. The company is at the time of this interview manufacturing and delivering their products, and have faced difficulties due to the COVID-19 crisis. They have had a pre-order sale in Norway and are currently scaling up production. They have a team consisting of six persons, and representing AUK in this interview is their CEO Didrik Dege Dimmen. He has been their CEO since the end of 2020, and has multiple years of startup on his record. Dimmen took over several years after the COVID-19 crisis hit Norway, and heard about the virus in December 2019 when he was working with a larger startup in Norway. One of his previous colleagues was from China and told him about it, and the supply chain of the previous company was also hit by the crisis. His first thought was that it sounded scary, but considered it not a big deal as it was still a very small thing at that time.

AUK was started in 2018 and received funding in October 2019 to start up production, and opened for pre-orders in December 2019. They were planning to travel to China to start production just when the COVID-19 crisis hit. China went into full lockdown, and they had to find alternative ways to work with the supply chain. Making a product in China seemed impossible for the small startup, and communication went from very good to up to two weeks before they got a reply. Dimmen said: *"There was no one that knew what happened and it was very chaotic in the beginning. On the other hand, we saw that we kept getting pre-orders, which was good. The delivery obviously got very delayed, so it has been a difficult time with many customers that have been waiting for a while."* Dimmen outlines that this has been a challenge for many companies during the crisis, but possibly especially small startups. Due to the order volumes they tend to be prioritized last by the manufacturers.

Dimmen would say that their customer flow has been least affected by the crisis. Many people spent less money as vacation wasn't an option anymore, and if anything, he believes that the number of customers they got increased as a result of the crisis. So there might not be a short-term negative effect, but there might be a long-term one that is yet to be experienced. Due to the many pre-orders and low rate of fulfillment, some customers started to cancel their orders. This affects the company brand name, and as Dimmen said: *"We're on borrowed time."*

The team experienced three major uncertainties related to the COVID-19 crisis, which was related to their finances, supply chain and team. One of the major changes in the financial situation has been that the Norwegian currency plummeted compared to the US dollar, which resulted in their product costing 20% more to manufacture at one point. If they were manufacturing in Norway and selling abroad, this would have been a positive change, but as they were manufacturing abroad and selling in Norway, this was just an additional cost that didn't add any value. The financial uncertainty was also related to the delayed supply chain not delivering products and some customers starting to cancel their orders. The startup did a multitude of important financial measures to keep afloat. Firstly, they continued their pre-order sale for a longer time than originally planned. Dimmen says: *"We originally wanted to get 1000 units in pre-orders, but ended up selling 4000 units. This might sound like a luxury problem, but the increased number of units elevates the risk significantly."* They were also approved for a startup loan from Innovation Norway, which had good conditions during the COVID-19 crisis. They also had two additional funding rounds with smaller investors, totaling in around 10 million NOK in additional funding. At the time of this interview, they were also applying for a growth guaranty scheme with one of the major banks in Norway. The increased capital and the low loan rates has been positive for the startup, and has decreased much of the uncertainty relating to finance as they now have a longer runway.

The supply chain for the startup has been the main uncertainty during the COVID-19 crisis, and the delays here are mostly the cause of the other uncertainties the startup has faced. As mentioned previously, their manufacturers in China were affected by the crisis, and the team experienced that China in general became very secretive and didn't want

to say anything regarding the pandemic and the status. Dimmen says: *"We were making some [injection molding] tools in China that took forever to get made. The manufacturer went completely silent, and it could take two to three weeks before they got back to us, which was extremely frustrating."* They ended up having to transport the tools to a manufacturer in Ireland where they now can injection mold the plastic components. This was also very expensive, and another cost that didn't add any additional value except finally being able to manufacture their product. They also made some changes to components that were used in the product, as some was sold out during the crisis. This led to them having to order many components up-front.

Uncertainty related to the team was also present for the startup. Dimmen says: *"We had multiple employees that had to be temporarily laid off during the crisis, and we were unable to hire new employees. Some of the main reasons for this were due to concern [for team members] and the lockdown, and that we had to stay isolated. There was a lot of uncertainty relating to a lot of things, which affected the team."* He continues to explain that they could not stay at their usual office at StartupLab (a Norwegian accelerator for tech startups), and that the startup went through many changes at once. One of the measures they took to be able to work better together was to move to a new office. Due to working with hardware, there was a need to be able to work together. It was a challenge to move and find new offices, and they used digital meetings when possible.

When asked why Dimmen believed that their startup had survived the crisis to this point, his reply was short and concise: *"Luck."* Although it is evident that the major measures that were put in place to decrease the uncertainty, was the startup's ability to access additional capital to create a longer runway for the startup, and slow down the sale so they didn't have too many orders to complete. They had to hold on while waiting for the crisis to calm down and being able to create a more robust and functional supply chain.

5.0 Analysis and Discussion

For this part of the thesis, the author will focus on analyzing the case firms to answer the research questions:

RQ1: How have tech startups handled the uncertainty induced by the COVID-19 crisis?
RQ2: Which measures have been essential for tech startups to implement in order to overcome the uncertainty during the COVID-19 crisis?

The analysis will focus on the key concepts from the theory outlined in Chapter 2.5.

5.1 Uncertainty

The case firms have experienced multiple and different kinds of uncertainties during the COVID-19 crisis. Table 4 gives an overview and compares the different topics of uncertainties that the case firms have experienced, based on the different findings from Chapter 4.

Uncertainty	Ludenso	SammeVei	Cosgear	AUK
Financial	Low	High	High	High
Customer	High	High	High	Medium
Product	Medium	High	Medium	Low
Business partners	Low	High	Medium	High
Team	Low	Low	Low	High

Table 4: Comparisons of domains of uncertainties experienced.

In the next sub-chapters, the author will evaluate their individual domains of uncertainties that the case firms have experienced. It is important to distinguish which uncertainties are related to starting up a business, and therefore would be present with or without COVID-19. Some uncertainties might have increased, which is of interest, but in particular new uncertainties that arose *due* to the COVID-19 crisis. For example, Cosgear experienced financial uncertainty, but this is something startups are extremely

likely to experience one way or another during business creation. The thesis is concerned about uncertainties that increased/appeared due to the COVID-19 crisis and how the case firms have handled this particular increase/appearance.

5.1.1 Financial uncertainty

Placed within the literature of the four domains of uncertainty presented by Packard et al., (2017), increased financial uncertainty can result in creative-, environmental- and absolute uncertainty.

Apart from Ludenso, the remaining three case firms reported that they had high uncertainty when it came to their finances during the COVID-19 crisis. In the case of Ludenso, it made sense that they did not experience uncertainty here, as they had just received funding from a governmental actor and a private actor. The funding was to last for a year and a half, just before the COVID-19 crisis broke out in Norway, in order to deliver a product that there still was a need for, crisis or not.

On the complete opposite corner was SammeVei, whose product was rendered unusable by the COVID-19 crisis. They were already in the middle of projects with Innovation Norway and business partners that due to the COVID-19 crisis had to be put on hold, which means that the flow of cash was about to diminish. To stay afloat, SammeVei decided to pivot and apply for a startup loan to account for their financial uncertainty, where they started from a position of absolute uncertainty. This was due to having to start searching for ways to become financially safe in a new market with a new product. They fortunately got the loan from Innovation Norway, at good conditions due to the COVID-19 uncertainty.

Cosgear also used Innovation Norway extensively, due to their original plan to get larger investors failed, partly due to the COVID-19 crisis. This is similar to the research conducted by Brown and Rocha (2020), where the impacts of uncertainty become crippling for entrepreneurial actors like investors. This was where Cosgear experienced financial uncertainty, and in particular creative uncertainty (Packard et al., 2017) as they were in need of funding, but had to find another route to reach this goal. They were

luckily approved for both a grant and a loan from Innovation Norway, and arranged agreements with banks for a more flexible financial situation. The reluctance from the larger investors also made Cosgear initiate a funding round with smaller and more willing investors, and one might argue that Cosgear has been better off financially due to the COVID-19 crisis, due to the increased availability of soft funding and the increased valuation of their startup because they could initiate a funding round at a later date. At the same time, it is uncertain how much they have lost in sales revenue and a year of lost passive advertisement from people using their product.

Similarly to Cosgear, AUK also had successful funding rounds with smaller investors, and they were also in the process of arranging an agreement with a bank. They were too awarded a loan from Innovation Norway, but this was a regular offer from Innovation Norway that only had better conditions due to the COVID-19 crisis. Interestingly, AUK reported financial uncertainty due to currency fluctuations, as the Norwegian Krone fell drastically compared to the United States Dollar. Because their manufacturers charge in USD while selling in NOK, this increased their financial uncertainty. Cosgear did not report this as an issue, which is likely due to them having their main production in Norway and charging in USD. In the case of the COVID-19 crisis, it would be beneficial if one had costs in NOK while charging customers in USD, although the opposite could be the case. Cosgear was 'lucky' that the fluctuation benefited them. On top of their funding round, AUK kept open their pre-order of products to handle the financial uncertainty, but this created another uncertainty due to a larger production volume. This was different from Cosgear, which tried to limit their sales during the COVID-19 crisis.

5.1.2 Customer uncertainty

When it came to the uncertainty relating to customers, one can easily see that SammeVei was hit hardest among the case firms. SammeVei experienced that the part of the population that was going to use their application, no longer were able to use their application due to working from home. This absolute uncertainty (Packard et al., 2017) was quickly dealt with as SammeVei decided to pivot to a new application that arranged home delivery. Much of their existing code could be used for this new application, so they were able to quickly get this new product into the market. As with any new

venture, there will be uncertainties when starting up, and the uncertainties this new venture experienced can't necessarily be related to the COVID-19 crisis. As a matter of fact, the need for home delivery and customers wanting this due to the COVID-19 crisis and quarantines likely helped their application gain customers faster.

The other startup that experienced their current product being desired at a higher level was Ludenso, as they had two ongoing projects related to educational technology in schools, and due to the shift to digital classrooms during the COVID-19 crisis, the entire industry of edtech experienced a boost. However, this didn't stop Ludenso from experiencing high customer uncertainty, due to their end users being less available and harder to conduct tests on. The uncertainties they experienced here are tightly interconnected with their product uncertainty, as it made it harder for Ludenso to develop the optimal solution of their end product. This will be covered further in Chapter 5.1.3. Ludenso's extreme user-driven approach to their product and customers were hit hard when the accessibility of teachers was affected by the COVID-19 crisis. The teachers went from being readily available and willing to give feedback, to stressed and limited due to an ever-changing environment of digital classrooms. Ludenso focused on fixing certain parts of their product to make testing and feedback less of a hassle, which slowed them down, yet being absolutely necessary. They also developed new growth strategies and hypotheses to increase the organic spreading of their product, though this was not a measure that necessarily was put in place due to the COVID-19 crisis. The most important measure Ludenso did to keep their customers was to be adaptable and resilient in the face of the COVID-19 crisis.

Cosgear was also clearly showing signs of being adaptable and resilient, as they were able to adjust to their customers' needs during the crisis. Their customer uncertainty has been rated at a medium level, due to a steady flow of orders and the startup intentionally not focusing on marketing during the COVID-19 crisis. Realizing that there was a decreased need for showing full-body costumes in an online setting, that their original product was dependent on, they developed products that focused on their customers' heads and that 'always' was a part of the costume. A major part of Cosgear's customer uncertainty was that their customers were no longer attending conventions due to the COVID-19 crisis measures, and hence not getting the important marketing

effects from customers. To attract more customers, they have been targeting influencers that develop costumes that utilize their products and show how it can be embedded into costumes, as a means to spark creativity among their potential customers until the passive advertisement from conventions is restored.

AUK took the other approach and aimed to attract more customers than they originally intended during the COVID-19 crisis. Among the case firms, their customer uncertainty has the lowest rating at medium, as they too have some customer uncertainty relating to the crisis. As introduced, they have been attracting more customers than originally intended, around 4000 instead of the intended 1000. This seems like a luxury problem for any startup, but having to deliver quadruple of the amount of units in an uncertain market places an uncertainty on the company. With many pre-orders and a low rate of fulfillment to date, AUK has experienced some customers starting to cancel their orders.

5.1.3 Product uncertainty

As with customer uncertainty, SammeVei experienced a high uncertainty in regard to their product, as they had to place everything on hold until the COVID-19 crisis is over and society return to a new normal, where the majority is travelling to work again. As for their new venture there is not much to add on this point, as the uncertainties relating to the home delivery PickApp product are related to new venture creation and not something that is affected by the COVID-19 crisis. As a matter of fact it has likely been beneficial and given the product a boost. It is clear that SammeVei has shown exceptional adaptability and resilience by pivoting their entire product line towards a new product while competing with large international actors in the home delivery sector. SammeVei was able to find their niches within the market, focusing on areas that are dense enough to be valuable to enter, while also being present in the larger cities as the international actors. Due to their adaptability, they were able to follow their customers to where they had holidays, keeping people away from city centers and decreasing the possibility of the virus spreading here. Their actions have resulted in multiple new and ongoing deals with municipalities that would otherwise be without digital solutions like these.

Developing digital solutions that have a projected time limit has proven to be an uncertainty that Ludenso has faced in the limited access to customers to give feedback to their product. As the startup is extremely user-driven, the new and uncertain environment of digital classrooms placed a strain on their testing. Ludenso had to focus on working out bugs and errors that would usually be manageable in a normal setting where they too were present in the classroom, and deprioritize to find new and better features for their product (feature stop). Testing went from a weekly activity to something that was more difficult to manage and gave less output per session. They got less feedback from their testing, both in the form of quantitative and qualitative feedback, as well as complete loss of the valuable 'silent feedback', which they got from observing the students and teachers using their software. Yet their product is sought for, and there has been no decrease in its interest, hence their product uncertainty has been rated 'medium'.

Cosgear has also received a medium rating for their product uncertainty, as they have seen no significant drop in interest for their product, and if anything, they have themselves tried to limit the order volumes themselves. That being said, their main product, the customizable cosplay tail, has received a degree of uncertainty relating to how customers can use it during the crisis. The need for their product has decreased, as no cosplayers are attending conventions to show off their costumes, and there are more half-finished costumes focused on the upper part of the cosplayer's body circulating online as a direct effect. This led to Cosgear also focusing their efforts on new products that targeted the upper body of cosplayers, in particular the head, being the most important part of a cosplay. Another reason for the new products is that the cost of producing the tail units has increased significantly due to parts of the product increasing beyond the team's understanding. The COVID-19 crisis has created a chip shortage, leading to this part's price in particular increasing ten-fold. Some other parts have also increased in price, eating away at Cosgear's margins for each unit. The units are designed to be interchangeable, with a list of units that can replace each part if need be. As for now, Cosgear has a stock of units that might last for long enough for the chip shortage to stabilize, or they can change the design to decrease the cost. They are also considering that increasing the upselling products on their site with higher margins can make up for the loss of markings for their main product, but this is something the

author believes they will handle in the future. Cosgear has maneuvered the uncertainties related to their products well and seems to be on top of the situation. It is interesting to note that they were considering buying in extra parts (including the part that increased ten-fold) due to the possibility of less availability in the future. Unfortunately, this was discarded due to not having the liquidity to do this. If the startup had solid liquidity, they could in theory have ordered the additional parts they needed and decreased their product uncertainty significantly.

AUK has as presented earlier increased their pre-order sale significantly during the COVID-19 crisis, and apart from an increase in the number of orders they have to fulfill, there uncertainty relating to their actual product seems low, as it is still popular even before they are able to deliver. There have been uncertainties relating to both the financials and business partners, respectively due to currency fluctuations and being prioritized last, but this is not something that is inherently related to their product.

5.1.4 Business partner uncertainty

Relating to business partner uncertainty, it is clear that yet again SammeVei had a high uncertainty, as their existing business partners (public transportation operators) had a major decline in customers. This decline in customers eradicated the critical volume of users that SammeVei needed in order to establish a working product. This would therefore not be a project that the public transportation partners would be able or interested in funding throughout the crisis. The project has been placed on hold due to this, but is expected to restart once the crisis is over as their business partners are still committed to the idea.

For the hardware startups Cosgear and AUK, there is a clear-cut indication that due to their size and order volumes, they were not being prioritized. Their business partners, mainly being the manufacturers of parts of their products, were also hit negatively by the crisis. In the case of AUK, it is not clear what the reason for the long time it took for their manufacturers in China to respond to them. AUK felt that they were very secretive, and when communication can take two to three weeks, it is reasonable to understand that it is not sufficient when components need to be manufactured. AUK had to bring the

tools that were made out of China and import it to a manufacturer in Ireland that could deliver parts to them. This was a costly move, but very necessary as the communication with their Chinese manufacturers was unacceptable. AUK has started delivering units and are working on scaling their production line to deliver units to their customers.

Similarly, Cosgear experienced not being prioritized as well, except they knew exactly why. They had successfully received their tools as planned from China and safely delivered them to Norway, where production should happen. Due to an understandable prioritization by their manufacturer to use one of their machines to be unavailable to manufacture parts to vital respirators due to the COVID-19 crisis, the team accepted a delay. After many weeks of delays and promises, Cosgear decided to ship the tools to another manufacturer in Norway. Although seemingly high uncertainty, the author has rated this to medium uncertainty as the team had the second manufacturer lined up and ready to manufacture their parts on short notice. With all this happening at once, the result was only a three-week delay, which in a hardware startup setting is rather amazing.

Due to the lack of business partner uncertainty for Ludenso, the author has rated this as low. There were no major changes to their ongoing contracts, and it is not expected to be either.

5.1.5 Team Uncertainty

Among the case firms, only AUK reported a high uncertainty for their team as a result of the crisis. Being a hardware startup, they were hit hard when their office was closed due to the COVID-19 crisis. They were also the only startup to temporarily lay off employees, as many larger companies had to do during the crisis. Concern for team members was reported as a reason why this was necessary, as they tried their best to avoid any team members catching the COVID-19 virus. Combined with not being in their office to work on their product, this was considered a high uncertainty for the team. They could not control the office, as it was a hub of offices connected to the accelerator StartupLab. An important measure they took was to get a new office where they could control the environment and get the valuable need to work together covered. As everyone else, AUK

used digital meetings where possible. Cosgear did not report a team uncertainty, and grew during the COVID-19 crisis. It is likely that they were more prepared for it, as they as a team prepared for a possible crisis at an early date, although it was pictured that it would be localized to China and not spread globally. Ludenso also grew during the crisis, and did neither report any uncertainty relating to their team. It was evident from the case study that they indeed focused on teamwork and staying in touch, independent of the lockdown. They had weekly in person meetings and activities together, and many short digital meetings per week to stay in touch. Finally, SammeVei also grew by three employees during the crisis. This was the only area where the startup didn't report any uncertainties, and it is likely due to their small and flexible team being able to adapt to the crisis and make something new when they were unable to continue their current path. They were able to move on and not get crippled by the uncertainty. Their new venture had its own uncertainties, but this was manageable and gave them room to maneuver. Along the way they also had multiple smaller milestones that kept the team motivated.

An interesting observation is that the startups that didn't report uncertainties were the ones that grew in size and didn't have to temporarily lay off customers. It might be a result of not experiencing the uncertainty in the same way, but it seems to align with the research conducted by Schmitt et al. (2018) that pointed towards entrepreneurs with high self-efficacy as a valuable resource when acting in uncertain environments. It appears that the startups with higher self-efficacy were able to overcome the uncertainty better.

5.2 Entrepreneurial action and Outcomes

Throughout the previous sub-chapter, there is evidently a lot of entrepreneurial action happening in the face of the COVID-19 crisis. The startups have faced a multitude of uncertainties during the COVID-19 crisis that could cripple the startup if it was allowed to happen, but the author clearly sees a continuous judgment process taking place, as explained in Packard et al. (2017), Chapter 2, Figure 1. The startups have adapted the effect of the exogenous factor that is the COVID-19 crisis and others that have affected

their outcomes, and pushed forward while either innovating, delivering their products, or both.

In the face of financial challenges, all startups that were negatively affected by the COVID-19 crisis were able to utilize the available government funding that was available through Innovation Norway. To increase the runway is a measure that is pointed out in literature by Kuckertz et al. (2020) as essential, and both of the hardware startups were able to complete funding rounds with private persons during the COVID-19 crisis to be able to increase their production capacity and deliver their products. However, we see a different approach by the hardware startup, where AUK focused on increasing their sales - Cosgear focused on decreasing it. It has yet to be decided which methods are most effective during a crisis for this data, but Kuckertz et al. (2020) points out that a measure to a crisis would be to downsize with the possibility to upsize again at a later point. This would be more according to Cosgear's strategy, as they focus on delivery first and then upscaling once the crisis is over. Cosgear also relied more on Innovation Norway, which might have decreased their capital needs where AUK had to keep sales open to keep the cash flow steady.

SammeVei proved their resilience and adaptability by literally within a week swiftly pivoting to a new product that combined a perceived need in both the home delivery sector and taxi sector, and taking on the challenge of large international actors with heavy funding entering their market. They created their own markets where they were less likely to meet competition, while making it harder to compete against them through projects with municipalities.

Same can be said for Ludenso, quickly adapting to their customer needs that found themselves in a new environment. As the company that experienced the least amount of uncertainty by the COVID-19 crisis, it is interesting to learn how they have been targeted working towards a goal while inspiring their customers and users. It is clear that they have not been relaxing on the fact that they were in no financial distress.

5.3 Discussion

5.3.1 Research question 1

How have tech startups handled the uncertainty induced by the COVID-19 crisis?

The uncertainties that the startups have experienced are many and varied. We see an increase and occurence of uncertainties that are presented within the four domains of uncertainty presented by Packard et al., (2017), that is creative-, environmental- and absolute uncertainty.

The author can confirm that the case firms presented in this thesis have handled the uncertainties that came their way with excellent form, and that they have managed to show a wide variety of ways to handle the uncertainty that can be linked to the data presented by Kuckertz et al. (2020), while staying on top of the continuous judgment process presented by Packard et al., (2017).

The case firms presented in this thesis have shown multiple ways to handle their experienced uncertainty related to the COVID-19 crisis, which is important empirical data for further research. Particularly significant is how the case firms have handled the financial uncertainty. To have the financials in order has been shown to be a crucial part of crisis management during the COVID-19 crisis, as it has been a significant part for all four cases. Except for Ludenso, which was already funded by a governmental and a private actor for a year and a half just months before the crisis was a reality, all remaining case firms were relying on Innovation Norway for parts of their financials. For the case firms, Innovation Norway has been and is an important actor to fall back on when a crisis is a reality. The hardware-heavy startups that were in need of more finance have also shown to be able to adapt to the new environments and receive funding from private persons and banks in order to access necessary funding to grow their businesses. Relaxing the need for more funding allows the startups to focus on what else needs to be done in order to handle uncertain situations in a crisis, and there are many clear signs of effectual logic (Sarasvathy, 2001) being utilized to handle the environmental uncertainty induced by the COVID-19 crisis.

It is also clear that the startups' ability to handle team uncertainty has been excellent, as it overall has been reported as low. The research has shown small and adaptable teams of entrepreneurs discovering ways to work together in an uncertain environment of limited physical contact. Their CEO's have learned early about the COVID-19 virus, and some of the startups even considered a possible pandemic to take place. Cosgear were exceptionally early, already preparing for a crisis in January in regard to their production. It is also an interesting finding that the startups that experienced low uncertainties in relation to the team were the ones to grow in size during the COVID-19 crisis. This aligned with research presented by Schmitt et al. (2018), with startups having higher self-efficacy were better equipped to handle uncertainty.

5.3.2 Research question 2

Which measures have been essential for tech startups to implement in order to overcome the uncertainty during the COVID-19 crisis?

Among the measures that have been discussed, there is one in particular that stands out: Financial security. The startups' ability to create longer runway in the face of the crisis has been essential, and this was clearly outlined as a challenge in Kuckertz et al. (2020) in order to avoid immediate failure. The three startups that didn't have an already existing runway that was to last for a long time, experienced uncertainty within the finance domain. Those three startups were all relying on the available support from the statutory corporation Innovation Norway, which would provide funding in form of grants or loans that is provided by the Norwegian government. Their existing offers received better conditions, like lower rent, and they were also quick to introduce new offers in relation to COVID-19. From the case studies, it is clear that the startups were utilizing some or more of these offers, and it is therefore considered an essential measure.

The startups' adaptability and resilience are also highly relevant when handling the uncertainty that arose within the domains of customer, product and business partners. All startups have shown this one way or another, either in the form of innovation and release of new products, deciding to change manufacturers, or finding new ways to

interact with customers in an uncertain environment. Kuckertz et al. (2020) suggests downsizing some activities and retaining the possibility to upscale at a later point when the crisis has calmed down. We saw this in action for three of the startups, where SammeVei and Cosgear put their current product on 'pause' and created something new, and Ludenso introduced 'feature stop' in order to focus on essential parts of their product. AUK decided to continue sales, which might have given them more customers due to their customers having better finance because they were not able to order expensive vacations. On the other hand, the increased number of customers introduced other uncertainties in relation to scaling up production and delivery. Interestingly, both hardware startups had to make important and necessary changes to their production line in order to cope with the uncertainty that was introduced through their manufacturers. They also had a different approach in terms of currency that put AUK in a more uncertain position than Cosgear. In order to better cope with a global crisis like the COVID-19 pandemic has initiated, one should be careful and try to not have manufacturing costs in one currency and payments in another. There are always losers and winners in currency fluctuations, and in the case of AUK they were at a disadvantage and Cosgear were at an advantage. SammeVei has shown exceptional ability to use resources at hand and discover opportunities, which are both measures suggested in Kuckertz et al. (2020). Their ability to pivot during the COVID-19 crisis has been praiseworthy, and they managed to turn an uncertain situation into an opportunity that they plan to continue developing in the future.

A critical measure that also appears to have been so obvious that it wasn't considered to have much uncertainty by the startups, was their teams. The startups were able to stay strong during the COVID-19 crisis, something that would have been a much greater issue if it wasn't already the case. Their ability to stay in touch was critical for this to be manageable, and as the only startup that experienced uncertainty here, AUK made sure that this was something they made possible by relocating their office. Measures like many digital meetings and physical contact where possible, while maintaining the restrictions that were put in place during the COVID-19 crisis, were essential for the teams to work together. Ludenso had a clear strategy here, and benefitted accordingly while they were pushing forward.

6.0 Conclusion

The purpose of this thesis was to look at how startups have handled and overcome the uncertainties induced by the COVID-19 crisis. The four case studies have led to some interesting findings to both support and challenge existing theory.

To expand on that, the author would like to reiterate the point that was made in Brown and Rocha (2020). They claimed that during shocks and crisis events, the uncertainty escalates to such speeds that their impacts become crippling for both entrepreneurs and entrepreneurial actors such as banks and investors. This was backed up in McMullen and Shepherd (2006), Packard et al. (2017), and Ratten (2020). As this might be true in many cases, the author did not find this to be true for the startups included in this thesis. If anything, the startups doubled down in terms of entrepreneurial action and proved empirical evidence of their ability to adapt and stay resilient in this new uncertain environment. We've seen indications of the crippling effects on investors, but the startups worked around this uncertainty by finding new ways and utilizing grants, loans and smaller investors to attain the necessary funding to make it through the COVID-19 crisis.

The startups have also succeeded in handling uncertainty experienced within the domains of customer, product, and business partners. The findings suggest that all startups have shown this one way or another, either in the form of innovation and release of new products, deciding to change manufacturers, or finding new ways to interact with customers in an uncertain environment.

The findings finally suggest that much of this could be attributed to the smaller teams that startups tend to have, which makes maneuvering and taking action a faster and easier process. If anything, this is the most valuable asset that a startup has, which makes it critical to handle and defeat potential team uncertainties that the startup face.

7.0 Implications for further research

The findings in this thesis have been useful in regard to providing empirical data on how startups, particularly in Norway, have handled and overcome the COVID-19 crisis. It has also been interesting to research how uncertainties within different domains have affected the startups, and the different ways to perform actions in an uncertain situation affects its outcomes. It is however challenging to assess how anecdotal the conclusion and findings are. Due to the rather small sample size and differences between the cases, the author can recognize that there is a possibility for finding conflicting evidence if one were to examine a larger sample size of 8-12 case firms.

For further studies, the author suggests conducting longitudinal case studies, to have the opportunity to see how uncertainty develops over time, rather than getting a snapshot of the current and previous uncertainties that the interviewees recollect. Due to the low likelihood of another extreme situation like the COVID-19 crisis to happen within the next few years, it would be valuable to look at the long-term effects that the crisis has on startups that have experienced the crisis, and not only the ones that have survived, but those that have failed too. This would handle survival bias, and it would also be beneficial to control for those that were born during its recession and after. The startup sectors should also be specialized further, as 'technology startups' is a rather broad term. It would for example be beneficial to look at startups that were developing software and hardware independently, due to the difference in product creation, scaling, and time to market.

It would also be valuable to look at countries where startups do not have access to a robust and government funded startup service like Innovation Norway, where financial uncertainty was likely to have been higher. On the contrary, it would benefit Norwegian startups and policy makers to have more in-depth studies on which government measures are most effective in handling uncertainty for startups in times of crisis like the COVID-19 crisis.

References

Ansell, C., & Boin, A. (2019). Taming Deep Uncertainty: The Potential of Pragmatist Principles for Understanding and Improving Strategic Crisis Management. Administration and Society, 51(7), 1079–1112. https://doi.org/10.1177/0095399717747655

Baker, S. R., Bloom, N., Davis, S. J., & Terry, S. J. (2020). COVID-Induced Economic Uncertainty. NBER.

Brown, R., & Rocha, A. (2020). Entrepreneurial uncertainty during the Covid-19 crisis: Mapping the temporal dynamics of entrepreneurial finance. https://doi.org/10.1016/j.jbvi.2020.e00174

Brown, R., Rocha, A., & Cowling, M. (2020). Financing entrepreneurship in times of crisis: Exploring the impact of COVID-19 on the market for entrepreneurial finance in the United Kingdom. https://doi.org/10.1177/0266242620937464

Doern, R., Williams, N., & Vorley, T. (2019). Special issue on entrepreneurship and crises: business as usual? An introduction and review of the literature. Entrepreneurship and Regional Development, 31(5–6), 400–412. https://doi.org/10.1080/08985626.2018.1541590

Ducharme, J. (2020). World Health Organization Declares COVID-19 a 'Pandemic.' Here's What That Means. Time. Obtained from https://time.com/5791661/who-coronavirus-pandemic-declaration/ (Accessed on November 3rd)

Eisenhardt, K. M. 1989. Building theories from case study research. Academy of management review, 14, 532-550.

Ellsberg, D. (1961). Risk , Ambiguity , and the Savage Axioms. The Quarterly Journal of Economics, 75(4), 643–669.

Herani, R., and Andersen, O. (2012). Does environmental uncertainty affect entrepreneurs' orientation and performance? empirical evidence from Indonesian SMEs. Gadjah Mada International Journal of Business, 14(1), 1–16. https://doi.org/10.22146/gamaijb.5435

Hebert, R. F. and Link, A. N., 1988. "The Entrepreneur – Mainstream Views and Radical Critiques", 2nd. Edition, Praeger, New York.

Howell, S. T., Lerner, J., Nanda, R., & Townsend, R. R. (2020). Financial Distancing: How Venture Capital Follows the Economy Down and Curtails Innovation. NBER.

Knight, F. H. (1921). Risk, Uncertainty, and Profit. LIBERTY FUND, INC.

Kuckertz, A., Gaudig, A., Hinderer, S., Brändle, L., Reyes, A. M., Prochotta, A., Steinbrink, K. M., & Berger, E. S. C. (2020). Startups in times of crisis – A rapid response to the COVID-19 pandemic. Journal of Business Venturing Insights.

McMullen, J. S., & Shepherd, D. A. (2006). Entrepreneurial action and the role of uncertainty in the theory of the entrepreneur. Academy of Management Review, 31(1), 132–152. https://doi.org/10.5465/AMR.2006.19379628

Milliken, Frances. (1987). Three Types of Perceived Uncertainty About the Environment: State, Effect, and Response Uncertainty. Academy of Management review. 133-143. https://doi.org/10.5465/AMR.1987.4306502

Mises, L. (1949). Human action. Fox & Wilkes.

Packard, M. D., Clark, B. B., & Klein, P. G. (2017). Uncertainty types and transitions in the entrepreneurial process. Organization Science, 28(5), 840–856. https://doi.org/10.1287/orsc.2017.1143

Ratten, V. (2020). Coronavirus (Covid-19) and entrepreneurship: cultural, lifestyle and societal changes. Journal of Entrepreneurship in Emerging Economies. https://doi.org/10.1108/JEEE-06-2020-0163

Sarasvathy, S. D. (2001). Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. Academy of Management Review, 26(2), 243–263. https://doi.org/10.5465/AMR.2001.4378020

Schmitt, A., Rosing, K., Zhang, S. X., & Leatherbee, M. (2018). A dynamic model of entrepreneurial uncertainty and business opportunity identification: Exploration as a mediator and entrepreneurial self-efficacy as a moderator. Entrepreneurship: Theory and Practice, 42(6), 835–859. https://doi.org/10.1177/1042258717721482

Sedláček, P., & Sterk, V. (2017). The growth potential of startups over the business cycle. American Economic Review, 107(10), 3182–3210. https://doi.org/10.1257/aer.20141280

Smallbone, D., Deakins, D., Battisti, M., & Kitching, J. (2012). Small business responses to a major economic downturn: Empirical perspectives from New Zealand and the United Kingdom. International Small Business Journal, 30(7), 754–777. https://doi.org/10.1177/0266242612448077

Williams, T. A., Gruber, D. A., Sutcliffe, K. M., Shepherd, D. A., & Zhao, E. Y. (2017). Organizational response to adversity: Fusing crisis management and resilience research streams. Academy of Management Annals, 11(2), 733–769. https://doi.org/10.5465/annals.2015.0134

Yin, R. K. (2003). Case Study Research: Design and Methods: SAGE Publications.

Zhao, H., Hills, G. E., & Seibert, S. E. (2005). The mediating role of self-efficacy in the development of entrepreneurial intentions. Journal of Applied Psychology, 90(6), 1265–1272. https://doi.org/10.1037/0021-9010.90.6.1265

Zhu, N., Zhang, D., Wang, W., Li, X., Yang, B., Song, J., Zhao, X., Huang, B., Shi, W., Lu, R., Niu, P., Zhan, F., Ma, X., Wang, D., Xu, W., Wu, G., Gao, G. F., & Tan, W. (2020). A Novel Coronavirus from Patients with Pneumonia in China, 2019. New England Journal of Medicine, 382(8), 727–733. https://doi.org/10.1056/nejmoa2001017

Appendix 1

Interview guide

General introduction:

1. Can you tell me about your startup?
   // Kan du fortelle meg om oppstarten din?
2. When did you first learn about the COVID-19 virus?
   // Når hørte du først om COVID-19-viruset?
3. What were your initial thoughts?
   // Hva var dine første tanker om dette?
4. Walk me briefly through your venture up until the COVID-19 crisis in March (timeline).
   // Gå raskt gjennom oppstarten din fram til COVID-19-krisen i mars (tidslinje).
5. Walk me through key events for your venture during the COVID-19 crisis (timeline).
   // Gå gjennom viktige hendelser for oppstarten under COVID-19-krisen (tidslinje).
6. Which parts of your startup were most/least affected by the crisis?
   // Hvilke deler av oppstarten var mest/minst påvirket av krisen?
7. What would you say made you the most/least uncertain about the crisis? (or list)
   // Hva gjorde dere mest/minst usikker av krisen? Evt en liste?

Financial:

1. How did the COVID-19 crisis affect your financial situation?
   // Hvordan påvirket COVID-19-krisen deres finansielle situasjon?
2. What was the reason for increased uncertainty for this part? (lockdown, meetings, etc)
   // Hva var grunnen for denne økte usikkerheten? (nedstengning, møter, osv)
3. Which changes/measures were implemented as a result of the uncertainty?
   // Hvilke endringer/tiltak ble implementert som et resultat av usikkerheten?
4. Did you get any financial aid from the government/Innovation Norway?
   // Mottok dere noen finansiell hjelp fra myndighetene/Innovasjon Norge?
5. Did you get any funding from other sources?

// Fikk dere noen annen finansiering fra andre kilder?

6. Could you elaborate further how you went about securing your financial situation?
   // Kan du utdype ytterligere hvordan dere klarte å sikre den finansielle situasjonen?
7. How did this help lower the uncertainty?
   // Hvordan hjalp dette med å minske usikkerheten?

Customer:

1. How did the COVID-19 crisis affect your customers?
   // Hvordan påvirket COVID-19-krisen deres kunder?
2. What was the reason for increased uncertainty for this part? (lockdown, spending, etc)
   // Hva var grunnen for denne økte usikkerheten? (nedstenging, forbruksmønstre, osv)
3. Which changes/measures were implemented as a result of the uncertainty?
   // Hvilke endringer/tiltak ble implementert som et resultat av usikkerheten?
4. How did you go about acquiring new customers during the crisis?
   // Hvordan gikk dere fram for å få nye kunder under krisen?

Product:

1. How did the COVID-19 crisis affect your product?
   // Hvordan påvirket COVID-19-krisen deres produkt?
2. What was the reason for increased uncertainty for this part? (new needs, etc)
   // Hva var grunnen for denne økte usikkerheten? (nye behov, osv)
3. Which changes/measures were implemented as a result of the uncertainty?
   // Hvilke endringer/tiltak ble implementert som et resultat av usikkerheten?
4. Did your startup have to make any changes/pivots during the crisis? Which ones?
   // Måtte dere gjøre noen endringer/pivoteringer under krisen? Om så - hvilke?
5. Did any of these changes successfully decrease the uncertainty?
   // Minket noen av disse endringene usikkerheten i bedriften?

Business partner:

1. How did the COVID-19 crisis affect your business partners?
   // Hvordan påvirket COVID-19-krisen deres samarbeidspartnere/leverandører?
2. What was the reason for increased uncertainty for this part? (factories, shipping, etc)
   // Hva var grunnen for denne økte usikkerheten? (stengte fabrikker, sending, osv)
3. Which changes/measures were implemented as a result of the uncertainty?
   // Hvilke endringer/tiltak ble implementert som et resultat av usikkerheten?
4. Did you have to source new suppliers?
   // Måtte dere få nye leverandører/samarbeidspartnere under krisen?

Team:

1. How did the COVID-19 crisis affect your team?
   // Hvordan påvirket COVID-19-krisen deres ansatte?
2. What was the reason for increased uncertainty for this part? (lockdown, health, etc)
   // Hva var grunnen for denne økte usikkerheten? (nedstengning, helse, osv)
3. Which changes/measures were implemented as a result of the uncertainty?
   // Hvilke endringer/tiltak ble implementert som et resultat av usikkerheten?
4. Was it necessary to let people go, or did you have to temporarily lay off members?
   // Var det nødvendig å si ansatte opp eller permittere noen?
5. Did any member of your team catch the COVID-19 virus? What happened?
   // Var det noen på teamet som fikk COVID-19 viruset? Hva skjedde?
6.

Closing questions:

1. Did you feel certain about actions to take during the COVID-19 crisis? (environmental)
   // Følte du deg sikker på hvilke handlinger du kunne foreta deg under krisen?
2. Did you know the result of actions you took during the COVID-19 crisis? (absolute)
   // Visste du resultatet av handlingene som du foretok deg under krisen?

3. Which of these changes/measures were most/least successful in lowering the uncertainty? Why?
   // Hvilke av endringene/tiltakene som ble implementert var mest/minst suksessfullt i å minske usikkerheten? Hvorfor var det eventuelt sånn?
4. Were there any changes/measures that you wanted to implement, but were unable to?
   // Var det noen endringer/tiltak du ønsket å implementere, men ikke fikk til?
5. Are there any changes/measures that you've planned to implement in the near future?
   // Er det noen endringer/tiltak som du har planlagt å implementere i nær fremtid?
6. What would be necessary in order to minimize the uncertainty for your startup at the onset of the crisis? What about now?
   // Hva ville vært nødvendig for å minimere usikkerheten for bedriften i starten av krisen? Hva med nå?
7. In your opinion, how did your startup survive the crisis?
   // Hvorfor tror du deres startup har overlevd krisen?
8. Anything you would like to add concerning uncertainty during the COVID-19 crisis that we haven't touched upon?
   // Noe du ønsker å legge til vedrørende usikkerhet rundt COVID-19-krisen som vi ikke har vært innom i dag?

NTNU

Kunnskap for en bedre verden