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Creating a Competitive Advantage from Underdeveloped General-Purpose Technologies

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The case studies in this thesis, apart from Hyperledger, have been anonymized.

ABSTRACT

In an age of ever faster technological development, we are presented with exciting new technologies that, as it seems, make the headlines daily. Innovations such as artificial intelligence and distributed ledger technologies seem to be the next big thing and promise to radically change the world as we know it. Yet, startups in these areas are faced with hard to overcome obstacles. pe, high potential disruptive impact, and technological immaturity force startups to build competitive business models without yet exactly knowing what is technologically feasible or economically viable. Research, especially empirical, is lacking in this area while the demand for a better understanding is growing rapidly.

This thesis tries to identify which challenges new ventures face when building a competitive business model in the context of underdeveloped general-purpose technologies and how they overcome them. Specifically, we employ an inductive exploratory research approach and interview seven startups in the area of distributed ledger technologies and artificial intelligence. We strive to improve the understanding of general characteristics of doing business with underdeveloped general-purpose technologies as well as the specific challenges these startups face regarding the design of their business model, the technology, and the environment.

Initially, we use existing academic frameworks to identify current potential general-purpose technologies. Based on these findings, we choose two technologies for our core analysis. In line with previous research, we find that startups within these technologies employ two distinct business model development approaches; either a business model centered or technology centered approach. Furthermore, we propose a "Business Model Development Matrix" to classify startups into one of these two approaches as well as an "Emerging Technology Triangle" to better understand the general economic characteristics of underdeveloped general-purpose technologies. Subsequently, we offer eight findings regarding the challenges these startups face in terms of business model design, and additionally three findings regarding their technology, and the business environment respectively.

An investigation into these two business model development approaches is novel and adds to the intersection between research in technology, entrepreneurship, and business model development. We believe that this thesis will encourage researchers to further dive into more detailed characteristics of the two aforementioned business model development approaches as well as better understand how and why they succeed in practice. We believe that research in this area is of equal importance to entrepreneurs, existing corporations, and policy-makers.

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ABBREVATIONS

AI – Artificial intelligence
BMC – Business model centered approach
BMD – Business model development
BMI – Business model innovation
DLT – Distributed ledger technologies
GPT – General-purpose technology
RQ – Research question
RSQ – Research sub-question
TC – Technology centered approach

1. INTRODUCTION

"The next Bill Gates will not start an operating system. The next Larry Page won't start a search engine. The next Mark Zuckerberg won't start a social network company. If you are copying these people, you are not learning from them."

- Peter Thiel

Ever since the cognitive revolution around 70,000 years ago, humans have continuously worked to invent more efficient and effective ways of doing things – so called technological innovation (Harari & Perkins, 2017). Among all the technological innovation that has happened since, some has been more transformative and some less. Especially those technological innovations that have seen widespread adoption and have acted as a basis for further innovation – so called general-purpose technologies – have been greatly transformative (Jovanovic & Rousseau, 2005).

General-purpose technologies (GPTs), also known as enabling technologies, can be characterized by their **pervasiveness** (they spread through almost all economic sectors), their ability to **spawn additional innovation,** and their own **improvement** (they get better over time) (T. F. Bresnahan & Trajtenberg, 1995). Good examples of such technologies in modern times are electricity, the semiconductor, and the steam engine. Going way back in time, we can see that technological innovations such as the wheel or the domestication of animals and plants (agriculture) also displayed exceptionally high degrees of pervasiveness, innovation spawning, and improvement over time.

GPTs have been of great interest to economic research, as it is argued that they play a key role in our economic development by enabling new technological and business opportunities (T. F. Bresnahan & Trajtenberg, 1995). Yet research from the viewpoint of individual companies on how to identify and adapt to emerging GPTs is scarce (Gambardella & McGahan, 2010; Thoma, 2008)

"…overall the evidence clearly supports the view that technological progress is uneven, that it does entail the episodic arrival of GPTs, and that these GPTs bring on turbulence and lower growth early on and higher growth and prosperity later." - (Jovanovic and Rousseau, 2005, p.7)

Especially due to the spawning of innovation dimension of GPTs, according to T. Bresnahan (2010), the disruptive potential of these technologies is often harder to assess compared with others. A famous and often repeated example of technological disruption is the case study of Eastman Kodak. The general notion is that Kodak failed to assess the relevance of digital photography on its business model – which is partly true. Given that Kodak was one of the first companies to invest into digital photography (Lucas Jr & Goh, 2009) it seems rather odd that this technology would subsequently lead to the company's downfall. Kodak's business model was built on the assumption that customers would, even with the advent of digital cameras, want to have their pictures developed in physical form (Lucas Jr & Goh, 2009). Due to the parallel improvement of the internet, a general-purpose technology, digital photography became more useful, thus leading to the rapid decline of analogue photography (Munir, 2005). This example shows that it could also be argued that Kodak underestimated the impact of an emerging GPT, the internet. Furthermore, this provides a good example of how GPTs innovation spawning dimension yields higher-order effects. In this case, the decline of analogue photography can be seen as a second-order effect of the internet. Third-order, fourth-order, or even higher-order effects of certain GPTs are thinkable and increasingly harder to foresee *ex ante*. This brief example should give a first short introduction on how the impact of GPTs can manifest and be hard to assess for individual firms.

Today, in 2018, we are seeing the emergence of some potential GPTs. Sundar Pichai, Google's CEO, talking about **artificial intelligence (AI)**, said that he believes that "AI is one of the most important things humanity is working on. It is more profound than, I don't know, electricity or fire" (Clifford, 2018). Artificial intelligence is broadly seen as a key enabling technology of our time, and its effects can already be felt in a wide range of derivative technologies such as self-driving cars, voice assistants or personalized recommendations on websites such as amazon.com. According to a McKinsey Global Institute report, companies spent between $26bn. to $39bn. on AI R&D in 2016 – a 3x increase since 2013 (McKinsey, 2017). Furthermore, the underlying technological limiting factors, data, and computing power, are growing exponentially. According to the same report, graphics processing units' (GPUs) speeds increased 40-80x from 2013 to 2017.

Another potentially disruptive GPT are **distributed ledger technologies (DLT)**, a "consensus of replicated, shared, and synchronized digital data geographically spread across multiple sites, countries, or institutions." according to Wikipedia. The blockchain is a form a distributed ledger technology. Although these technologies have not seen many practical applications so far (Economist, 2017a), the keyword **"blockchain"** saw a 100x increase in Google search interest from October 2013 to December 2017, and traditional media is rife with articles on how the blockchain might disrupt businesses in all fields (Economist, 2017a).

AI and DLT, although they are presently perhaps among the most hyped technologies (Panetta, 2017), are not the only emerging potential general-purpose technologies we are facing. Consider 3D-printing, robotics, quantum computing, augmented reality, virtual reality, the internet of things (IoT) and nanotechnology (Panetta, 2017). Will they become GPTs? How will they affect individual firms? In times of increasing technological innovation, firms need a thorough understanding of the underlying drivers of technological disruption and need robust frameworks on how to act upon emerging GPTs.

This thesis will analyze two novel approaches to business model development first discovered by Schmueck, Moellers, & Rogalla (2018). During a study looking at different DLT-based business models, they discovered that firms in the DLT ecosystem employ one of two different business model development approaches; a **technology centered** development approach or a **business model centered** development approach (Schmueck et al., 2018). This seems fascinating, as it shows that businesses are already positioning themselves in this area although we often have yet to see viable use-cases (Economist, 2017a). Considering that *ex-post*, we can observe similar behavior in internet-based businesses during the dot-com bubble, we might initially assume that this "phenomenon" stems from two factors, which will be discussed in more detail in Chapter 4.2.

1. The **underlying technology** is still **underdeveloped** and/or there is still **no market demand.**
2. The **technology** is widely expected to be **highly disruptive** (e.g. considered to be a potential general-purpose technology).

Specifically, firms with a **technology centered approach (TC)** develop the underlying technology without having a specific use-case in mind. Their competitive advantage lies in the fact that when the underlying technology becomes mature enough, and/or market demand starts increasing, they will have the strongest technology in place to either use on their own or sell to others (Schmueck et al., 2018). Within the DLT ecosystem this approach is, for example, utilized by firms working on underlying blockchain protocols, such as Ethereum.

Firms using a **business model centered approach (BMC)** are already positioning themselves for a specific use-case, knowing that the underlying technology is not yet mature enough and/or market demand is not yet high (Schmueck et al., 2018). Their competitive advantage lies in the fact that as soon as the underlying technology is ready and/or market demand is high, they are strategically positioned to serve a specific use-case (Schmueck et al., 2018), i.e. they have a thought-through value proposition, value chain and relationships to clients. Again, using DLT as an example, Schmueck et al. (2018) interviewed the startup Case #9, which uses blockchain for supply chain management.

These two approaches must not necessarily be limited to distributed ledger technologies. This thesis will also look at other potential general-purpose technologies and try to identify firms using one of these two approaches.

1.1 Objective and Research Questions

This thesis poses the following research question:

"Which challenges do new ventures face when building a competitive business model in the context of underdeveloped general-purpose technologies?"

research question (RQ)

This research question will be answered through a set of 5 research sub-questions. Firstly, we will ask which general-purpose technologies can be identified today, giving us a basis for where to look for additional companies to analyze. This leads us to our first research sub-question.

"Which emerging potential general-purpose technologies can we currently identify?"
research sub-question #1 (RSQ #1)

Secondly, we want to understand which general approaches startups in these areas utilize to create a competitive advantage. This second research sub-question is based on the work by Schmueck et al. (2018) as discussed previously. Specifically, we will analyze these two distinct approaches in other DLT-based startups as well as explore whether we can observe these approaches in startups working in a different potential general-purpose technology.

"Which general approaches to creating a competitive business model can we identify?"
research sub-question #2 (RSQ #2)

We then look at the specific challenges these startups face. For this we split challenges into three distinct areas; **business model**, **technology,** and **environment**. This leads us to our final three research sub-questions.

"Which challenges do ventures face when it comes to designing their business model?"
research sub-question #3 (RSQ #3)

"Which challenges do ventures face when it comes to the technology?"
research sub-question #4 (RSQ #4)

"Which challenges do ventures face when it comes to the business environment?"
research sub-question #5 (RSQ #5)

Given the nature of the research questions and the lack of research in this area, this thesis employs an **exploratory research design.** Thus, rather than offering definitive answers to the research question, the goal is to better understand the development approaches and challenges of these startups in the context of underdeveloped GPTs and identify further areas of research. The methods employed in this thesis will be discussed in Chapter 3.

2. THEORETICAL BACKGROUND

"All failed companies are the same: they failed to escape competition."
- Peter Thiel

The following chapter will explore the theoretical background needed as it relates to our research questions. Specifically, we will look at the following topics:

- **Business models** – what they are, and which frameworks can be used in practice
- **Competitive advantage** – what it is and how firms can think about it in practical terms
- **Disruptiveness of emerging technologies** – what framework(s) can be established to understand how technologies disrupt existing markets
- **General-purpose technologies** – how general-purpose technologies can be defined and identified, and why they are important
- **Business models and emerging technologies** – how emerging technologies and other innovations relate to business models

Due to this thesis touching a range of different topics and the constraints put on the written length, the aim is to introduce the most important concept in a brief yet understandable manner.

2.1 Literature Review & Value Added

This paper aims to contribute to business model, entrepreneurship, and technology management literature. Specifically, the intersection between business model development and technology.

Listed below is some of the most influential work done in these areas. This is no taxonomical listing, nor a definitive list of the most influential work. The publications listed below are all regarded as important contributions to their respective fields and have heavily influenced this thesis.

Area	Title	Author	Year	Focus	Citation Count
Business models & technology	Reinventing your Business Model	Johnson, Christensen et al.	2008	Overview on relationship between business model & technology and business model innovation.	2617
Business models & technology	What do business models do? Innovation devices in technology entrepreneurship	Doganova, L., & Eyquem-Renault, M.	2009	Analysis of functions of business models	605

				in entrepreneurship.	
Business models & entrepreneurship	Business model innovation in entrepreneurship	Trimi, S., & Berbegal-Mirabent, J.	2012	Looks at emerging developments in business model development within the field of entrepreneurship.	209
Business models & technology	The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies	Chesbrough, H., & Rosenbloom, R. S.	2002	Explores the role of the business model in capturing value from early stage technology.	4500
Business models	Business model innovation: it's not just about technology anymore	Chesbrough, H.	2007	The article provides a practical definition of business models and offers a business model framework that illuminates the opportunities for business model innovation.	1229
Business models	Business model generation: a handbook for visionaries, game changers, and challengers	Osterwalder, A., & Pigneur, Y.	2010	Discussed the application of the Business Model Canvas – probably the most prominent business model framework today.	5919
Business models & entrepreneurship	The four steps to the epiphany: successful strategies for products that win	Blank, S.	2013	Intersection of business models & customer development (i.e. iterative hypothesis testing). This book was important for the “Lean Startup” movement.	588
Business models & entrepreneurship	Business models: A discovery driven approach	McGrath, R. G.	2010	Discusses a ‘discovery driven,’ rather	831

				than analytical approach for business model development.	
Business models & entrepreneurship	Business models, business strategy and innovation	Teece, D. J.	2010	The purpose of this article is to understand the significance of business models and explore their connections with business strategy, innovation management, and economic theory.	4849
Business models & technology	Business Models and Technological Innovation	Baden-Fuller, C., & Haefliger, S.	2013	Analysis of business model relationship to technology	486
Business models	The business model navigator: 55 models that will revolutionize your business.	Gassmann, O., Frankenberger, K., & Csik, M.	2014	Taxonomy of distinct 55 business models	148
General-purpose technologies	Economic transformations: General-Purpose Technologies and long-term economic growth.	Lipsey, R. G., Carlaw, K. I., & Bekar, C. T.	2005	Thorough analysis of general-purpose technologies, partly based on the work of Bresnahan, T. F., & Trajtenberg, M.	626
General-purpose technologies	General-Purpose Technologies 'Engines of growth'?	Bresnahan, T. F., & Trajtenberg, M.	1995	First in-depth discussion of general-purpose technologies	2379
Business models & entrepreneurship	Blue ocean strategy	Kim, W. C., & Mauborgne, R.	2004	Discusses the "Blue Ocean" Strategy	1070
Business models & entrepreneurship	Business Model Design and the Performance of Entrepreneurial Firms	Zott, C., & Amit, R.	2007	Looks at how business model development affects the performance of entrepreneurial firms	1130

Table 1: Overview of essential literature

Specifically, as it relates to the intersection between business model development and technology, this thesis hopes to make an important contribution. The academic field of business model innovation, for example, has grappled extensively with emerging technologies (Baden-Fuller & Haefliger, 2013; Johnson, Christensen, & Kagermann, 2008). This should not seem all too surprising, as emerging technologies are one of the main reasons for the endangerment of existing business models. Business model development, in contrast, is a younger academic discipline and is still lacking empirical research (Trimi & Berbegal-Mirabent, 2012; Wirtz, Pistoia, Ullrich, & Göttel, 2016). Business model development has seen a shift away from a classical planning-oriented approach to a discovery-driven and customer-oriented approach (McGrath, 2010). This is especially evident through the success of the "Lean Startup" movement, which argues for minimum-viable-products and a tight customer-feedback loop to develop their value proposition. However, academic research in business model development has yet to produce empirically-backed studies when it comes to underdeveloped general-purpose technologies. This is especially critical as discovery-driven approaches simply do not work in such a context, as the technology is often simply not developed enough to create a working value proposition and/or market demand is barely existent.

This thesis hopes to lay some of this groundwork. Thus, we present an empirical study that deals with the challenges of developing a competitive business model within the context of underdeveloped general-purpose technologies. Previous work done by Schmueck et al. (2018) sets out two distinct business model development approaches, shortly discussed in the previous chapter. We will utilize this framework and assess whether it can be observed within other GPTs.

The following chapters will present the theoretical background necessary to understand and contextualize our findings, presented in Chapter 4.

2.2 Business Models

The first thing we need to understand when thinking about how we can gain a competitive advantage from emerging general-purpose technologies, is the concept of a firm's business model.

We can define a business model as the *"management's hypothesis about what customers want, how they want it and what they will pay, and how an enterprise can organize to best meet customer needs and get paid well for doing so"* (Teece, 2010, p.191). Another approachable way of understanding a business model would be as the *"rationale of how an organization creates, delivers and captures value."* (Osterwalder & Pigneur, 2010, p.14).

Business models are a relatively new field of academic inquiry, and there is a lack of consensus on the definition and components of the business model (Gassmann, Frankenberger, & Csik, 2013; Wirtz et al., 2016). Although the word "business model" was first mentioned around 50 years ago, it wasn't until the dot-com boom of the mid 90s that academic research into this field started emerging (Wirtz et al., 2016) – especially because the internet opened up a new variety of ways to create and capture value. Since then, more and more research interest has developed around this topic and over the past years academic viewpoints on business models seem to be converging (Wirtz et al., 2016).

Even though there is yet to be a common understanding within academia of a what a business model is, what it is comprised of and how it relates to a multitude of practical questions, there is a strong need for managers and firms to place more emphasis on understanding, reviewing and potentially innovating their own business model. That is, a lack of consistency among the business model frameworks does not mean that managers and entrepreneurs should not use any of them. Indeed, although Trimi & Berbegal-Mirabent (2012) criticize the lack of empirical research in this area, there seems to be a consensus that the lack of practical understanding (and lack of dedicated resources to innovate) of firms regarding their own business models is preventing businesses to effectively adapt to changes in markets and technology (Baden-Fuller & Haefliger, 2013). Especially in terms of technology, the traditional view was that better and more innovative technology leads to more profits, yet there seem to be considerable differences in terms of how successfully a company can employ novel technology (Baden-Fuller & Haefliger, 2013). Johnson, Christensen, & Kagermann (2008) argue that many of today's most successful firms used emerging technology and wrapped it around an innovative and effective business model. However, many managers do not seem to understand their own business model, or can't express it adequately, budgets for business model innovation are low and firms usually don't have dedicated business innovation teams (Gassmann et al., 2013; Johnson et al., 2008). It should also be noted that academically there is yet to be drawn a clear line between a company's business model and its strategy (Baden-Fuller & Haefliger, 2013). A helpful way of thinking of it is that *"the strategy of a firm outlines the way the organization will pursue its goals given the threats and opportunities in the environment and the constraints of its resources and capabilities"* (Nandakumar, Ghobadian et al. 2010, Trimi and Berbegal-Mirabent 2012). And business models have a broader scope than strategy in that they determine how firms can create value (Morris, Schindehutte et al. 2005, Trimi and Berbegal-Mirabent 2012). Thus, although there is no academic consensus, this thesis will view a business model and strategy (building and maintaining a competitive advantage) as two separate things, following the logic described by Teece (2010). In fact, whether strategy and business model are the same, or two different subjects – quite an important distinction to make – are two positions held by different academics (Massa, Tucci, & Afuah, 2017). Moreover, the exact scope of a business model, which we will see, depends on the framework used.

Nowadays, business model literature is converging towards the viewpoint of seeing the business model as a managerial tool for successfully running a company (Zott & Amit, 2013). And although much of the academic literature refers to business models in relation to already existing companies, how those business models can be innovated and which barriers exist, business model development in the context of new ventures is another newer field of inquiry with much work to be done (Trimi & Berbegal-Mirabent, 2012).

Academia offers a wide array of definitions for business models. In practice, there are some which are better geared towards application and companies will have to decide which one is the best fit for their needs. Perhaps the most popular business model framework is the **Business Model Canvas** based on the work by Osterwalder & Pigneur (2010). They break a firm's business model into the following components:

Component	Description
Value Proposition	The exact way of how the company creates value in the life of the customer. This is what distinguishes the company.
Key Partners	Which key partners are necessary so that the company can focus on its core value proposition. For Apple, as an example, these might be hardware manufacturers such Foxconn.
Key Activities	The most important activity to deliver on your value proposition. For a low-cost manufacturer, whose value proposition might be providing goods or services at the lowest possible cost, this might be an extremely effective production process.
Customer Relationships	The type of relationship the company wants to establish with its clients.
Channels	Through which channel the company will deliver its value proposition. Apple, for example, has its own stores, but also uses resellers and the internet.
Customer Segments	The clients the company wants to serve.
Cost Structure	Outlines the principles behind the firms cost-structure. That is, how fixed/variable costs will develop, if there are economies of scale etc.
Revenue Streams	How the firm creates income from its customer segments.

Table 2: Business Model Canvas

The Business Model Canvas is quite elaborate and based on similarities seen in a wide variety of different business model concepts. Alternatively, Gassmann et al. (2013) offer a more succinct model that is *"easy to use, but, at the same time, exhaustive enough to provide a clear picture of business model architecture."* – The **Magic Triangle**. Both of these models are designed, rather than being overly academic, as a practical tool for managers and entrepreneurs.

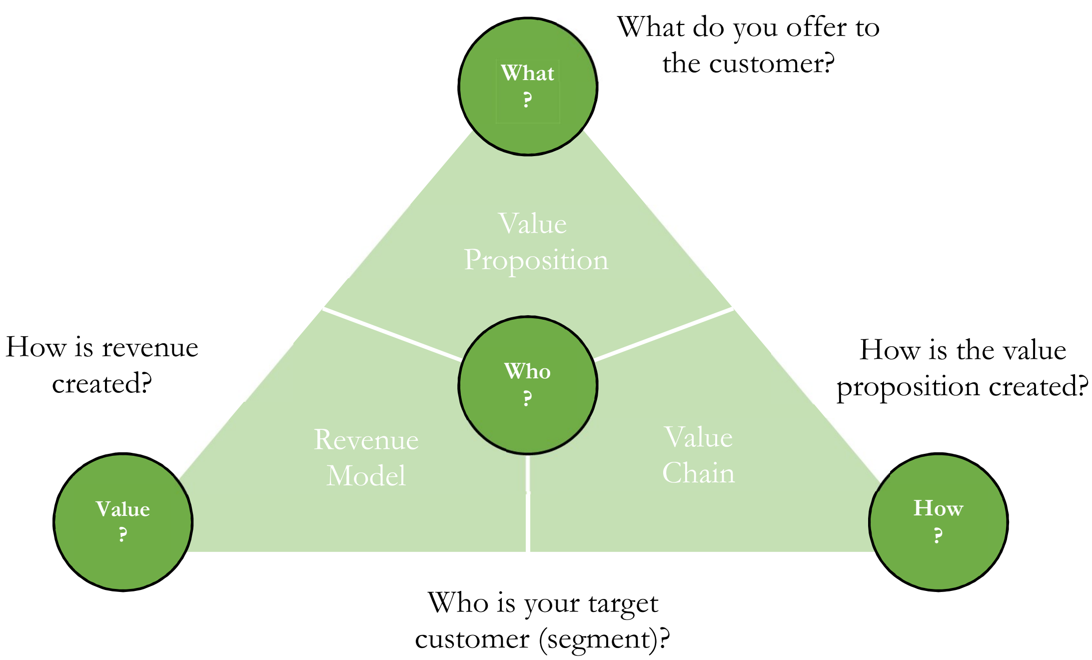

Figure 1: Magic Triangle (according to Gassmann et al., (2013))

Whichever business model framework companies, managers or entrepreneurs may choose in practice, these frameworks allow for the business model to become tangible, more understandable and it serves as the basis for the evaluation and evolution of their business model (Gassmann et al., 2013).

Indeed Chesbrough (2007, p.2) formulates 6 functions of a business model:

- "Articulate the **value proposition**, that is, the value created for users by the offering."
- **"Identify a market segment**, that is, the users to whom the offering is useful and for what purpose."
- "Define the **structure of the value chain** required by the firm to create and distribute the offering, and determine the complementary assets needed to support the firm's position in this chain."
- "Specify the **revenue generation mechanism(s)** for the firm and estimate the cost structure and profit potential of producing the offering, given the value proposition and value chain structure chosen."
- "Describe the **position of the firm within the value network** (also referred to as an ecosystem) linking suppliers and customers, including identification of potential complementors and competitors."
- "Formulate the **competitive strategy** by which the innovating firm will gain and hold advantage over rivals." – Thus, in contrast to other authors (Seddon, Lewis, Freeman, & Shanks, 2004; Teece, 2010) Chesbrough does consider competitive strategy as part of the business model.

Through the use and critical reflection of a business model framework a company can better understand itself and develop. Similarly, through the use of business model frameworks, entrepreneurs can better craft companies that successfully create and capture value (Blank, 2010).

However, what many business model frameworks do not do is describe what differentiates a good from a bad business model (that is, we assume competitive strategy is not part of the business model (Teece, 2010)). Every existing company has a business model, yet most neither define nor manage it correctly (Chesbrough, 2007). So why exactly do most restaurants barely make ends meet while Apple remains, year after year, one of the most profitable companies in history? This, of course, also remains an elusive question to which answers can be found in business books, microeconomics classes, business school lectures and everywhere else we look. And so, using a business model framework also requires a hypothesis about what differentiates a good from a bad business model. That is, which business model maximizes long-term profits through profitability and scalability, and which ones do not. Teece (2010) highlights the need for a successful business model to have a competitive advantage, i.e. something that increases economic profit of the firm and is hard to replicate. He also laments the lack of proper academic analysis of how such a business model would look (Teece, 2010). Microeconomics offer some suggestion on boundaries to the successfulness of business models; the commodity business and the monopoly. Creating a commodity business, one that makes virtually no economic profit, is a relatively simple task; open a restaurant (Thiel & Masters, 2014). Yet, it is the highly scalable, high profitability monopoly type business models that interest us – those that create and capture a great amount of value (Kim & Mauborgne, 2014). These types of profits are what entrepreneurs and incumbent firms strive for (Thiel & Masters, 2014).

2.3 Competitive Advantage

The standard view is that companies try to maximize their long-term profits (Besanko, Dranove, Shanley, & Schaefer, 2009). For the purpose of this chapter, we can define profit as:

$$Profit_t = Revenue_t * Profit\ margin_t$$

Whereby

$$Profit\ Margin = \frac{Revenue}{Profit}$$

We can thus see that our business model needs to be both **scalable** (Revenue), **profitable** (Profit Margin) and needs to **sustain** those two things over a long-period of time, at best indefinitely.

Profitable firms, or firms in profitable markets, will experience heightened market competition, e.g. through imitation, that will most often bring down their profitability to where these firms make no, or very little, economic profit (Besanko et al., 2009). Thus, a good business model does not only maximize profits in the short-term, but also ensures the company's long-term profitability despite steady market pressure. If a business can do that, we can say that its business model has a "competitive advantage" (Teece, 2010). Another definition would be: *"When a firm earns a higher rate of economic profit than the average rate of economic profit of other firms competing within the same market, the firm has a competitive advantage in that market."* (Besanko et al., 2009). A business model thus needs to provide a strong value-proposition that cannot easily be replicated by competitors (Teece, 2010), and thus ensures profitability over the longest possible time frame.

Of course, imitation is not the only market force that will threaten a company's profitability. Technological and market innovations can completely change an industry's logic and even make the hardest to replicate business models obsolete or significantly less valuable – e.g. the value of a natural railroad monopoly (nearly impossible to replicate) getting diminished by cars and planes. This is an important fact that should be kept in mind throughout this chapter and will be mentioned again later in the following chapter.

In fact, Columbia Professor Rita Gunter McGrath argues in her book "The End of Competitive Advantage", that a "sustainable" competitive advantage is an outdated concept, and that modern competitive forces and rapid technological change forces successful companies to constantly innovate and leverage temporary advantages (McGrath, 2013).

However, sustainable or not, developing and ensuring long-term profitability through establishing sustainable or temporary competitive advantages is one of the main *foci* of strategic management (Porter, 1996). There are different academic views that try to explain why and how certain firms "persistently outperform others." (Barney & Arikan, 2001). Traditionally, the two dominant views have been the **Industrial Organization Perspective (IO)** and the **Resource-Based View (RBV)** (Spanos & Lioukas, 2001).

Industrial Organization Perspective (IO) considers resources within the firms of an industry as homogeneous and mobile and therefore only an attractive positioning within the market can lead to a competitive advantage (Spanos & Lioukas, 2001). A firm's strategy is thus dependent on the respective industry. The most well-known representative of this school of thought is Michael Porter. His Five-Forces and Generic Strategies Framework have been hugely influential and have been used in practice for decades.

The second influential school of thought in strategic management is the **Resource-Based View (RBV)**. It argues that a firm's resources are idiosyncratic, and by virtue of having more valuable resources and capabilities within the firm, it can create a competitive advantage by doing things better than others. That is, a firm needs to build and exploit its core competencies (Prahalad & Hamel, 2000). Yet, even if the company has built a better value proposition than its competitors, it must be able to sustain this competitive advantage (Besanko et al., 2009). These ways of sustaining a competitive advantage is what Richard Rumelt, a prominent representative of the Resource-Based View, coined "isolating mechanisms" (Besanko et al., 2009; Rumelt, 2012). Famous Investor Warren Buffett calls them "moats" as they protect his proverbial castle from outside intruders (Schroeder, 2008). Essentially, a business wants to be protected from imitation (Besanko et al., 2009).

These isolating mechanisms can help managers understand whether their business models have, or will have, a competitive advantage (Teece, 2010). As such, it makes sense for managers to understand what types of isolating mechanisms there are, and how they work. There is no complete taxonomy of them and authors group them in different ways (Besanko et al., 2009). Some of the most common isolating mechanisms are described below.

Isolating mechanism	Description	Example
Economies of Scale	Economies of scale are the cost advantages that enterprises obtain due to their scale of operation.	Wal-Mart, UPS
Network effects	Additional users of a product increase its value to every existing user.	Facebook, Google, LinkedIn
Cumulative advantage	Having more customers leads to a faster improvement of the product, which in turn leads to more customers using the product (positive feedback loop).	Google Search
Brand reputation	Customers associate the brand of the product with positive emotions and are thus willing to pay a premium.	Coca-Cola, Tiffany, Apple
Patents	The sole right of making, using or selling an invention.	Pharmaceutical companies
High switching costs	It is costly or inconvenient for customers to switch to a cheaper alternative.	Retail banks, Apple
Platform lock-in	Multiple products of a firm work together to create value that is larger than the sum of its parts.	Apple
Know-how	Unique expertise that resides within the firm and is very hard to replicate.	Lockheed Martin
Location	A unique location that cannot be replicated by others.	Hotels
Efficient scale	When a company serves a market limited in size, new competitors may not have an incentive to enter. Incumbents	Airports

	generate economic profits, but new entrants would cause returns for all players to fall well below cost of capital.	

Table 3: Isolating mechanisms

Thus, any venture developed within the context of an emerging technology must not only think about the efficacy of its business model, but particularly also of the isolating mechanisms it will employ (Teece, 2010) – that is, how it will shield its business model from competition/imitation. Therefore, it needs to be able to create value, capture a large margin of value, and do so for an extended period of time, despite harsh competition.

In fact, very profitable businesses often employ multiple isolating mechanisms. Take Nespresso, a brand operated by Nestlé. Through the sale of capsules specifically designed for its proprietary machine, and direct selling to households, Nespresso brought aspects of business models from other industries to create a novel business model within its own (Gassmann, Frankenberger, & Csik, 2014). Nestlé does not officially provide financials for Nespresso, but in 2012 analysts estimated that the business had seen revenue growth rates of 30% year-on-year with operating margins of around 30% (Alderman, 2010; Revill, 2012); that is an incredibly scalable and profitable business model. Nespresso exploits at least three distinct isolating mechanisms: **brand reputation**, **platform lock-in** and **economies of scale**. By fostering its brand reputation through celebrity marketing and high-end stores, Nespresso is essentially a luxury-brand that can ask for high prices on its capsules. At the same time, which is unusual for luxury brands, it has a significant market share and can thus, through economies of scale, significantly lower its costs. Nespresso machines, until a 2013 patent expiry (Chaudhuri, 2016), only worked with its own capsules, creating a platform lock-in for its clients.

Depending on how you define a business model, an isolating mechanism might explicitly or implicitly be part of it. However, it does make sense that managers and entrepreneurs are explicitly aware of the underlying concept and have a reference list of some of the isolating mechanisms they could possibly consider and how they work. Just as managers should have robust frameworks for understanding, developing and innovating business models (Gassmann et al., 2014), they should also have a framework for understanding how to sustain a competitive advantage through isolating mechanisms.

It should be pointed out though that competitive advantage is a more dynamic and transient concept nowadays (Gassmann et al., 2013) as market and technological innovation is moving ever faster (McGrath, 2013). Isolating mechanisms might make it harder to imitate a value proposition (Teece, 2010), but it will not prevent some new innovation from completely changing the industry logic and rendering the value proposition useless or significantly less valuable. Therefore, companies must regularly "test their business models", "question today's pillars of success" and "prepare for the companies demise" (Gassmann et al., 2014). This fact will be the central topic of the next chapter.

2.4 Disruptiveness of Emerging Technologies

As discussed before, imitation is one reason why companies become less profitable or even fail. Yet, even companies that are nearly impossible to imitate due to strong isolating mechanisms are not safe from failing. New technologies or market innovations, such as novel business models, can completely change industry logics, rendering traditional business models or the industry as a whole redundant or significantly less value. Indeed, new technologies are one of the main factors of companies having to innovate their business model and for new business model development opportunities (Johnson et al., 2008). At the same time, academic literature in this area is still in its infancy and much research is needed (Baden-Fuller & Haefliger, 2013).

When analyzing emerging technologies, we need to relate them to their (potential) effect on existing markets. That is, how they will change the market in which a specific firm operates, and consequently, which reaction it requires. Christensen (2013) offers a way to categorize technological innovations. In fact, The Economist coined his views on the types of innovation, especially that of disruptive innovation, as *"the most influential business idea of recent years."* (Economist, 2017b).

Sustaining Innovation	
Sustaining: Evolutionary	Sustaining: Revolutionary
Disruptive Innovation	

Table 4: Types of innovation

According to Christensen's research, technological or market innovations can either be sustaining or disruptive. Sustaining innovations do not significantly change an existing market (i.e. do not change the dominant market logic), whereas disruptive innovations do. In fact, disruptive innovations actually create new markets that overtake existing markets.

Within the **sustaining innovations** we can see **evolutionary** and **revolutionary** ones. A **sustaining evolutionary** innovation improves an existing product in a market in a way that customers expect (e.g. CPUs becoming faster every year, an engine becoming more efficient). This means, there is a slight expected increase in the performance attributes these customers value. **Sustaining revolutionary** innovations are unexpected innovations that do not affect current markets, as they are not yet mature enough or simply cannot compete with existing products for most customer needs. As an example for this type of innovation Christensen (2013) uses the first automobiles. They were most certainly revolutionary (i.e. unexpected) innovations in the market for transportation, then dominated by horses. However, they were still too expensive and technically not sophisticated enough for widespread adoption. So in the early days of the automobile, the market for transportation by horse remained largely unchanged.

Disruptive Innovations, however, provide value far better than existing solutions. In Christensen's theory, eventual disruptive innovations initially start out as innovations that serve a different and smaller market. As the technology rapidly becomes better (as it progresses on the steep part of the S-

Curve) it suddenly overtakes the current solution as it now provides more value to existing customers of that older solution.

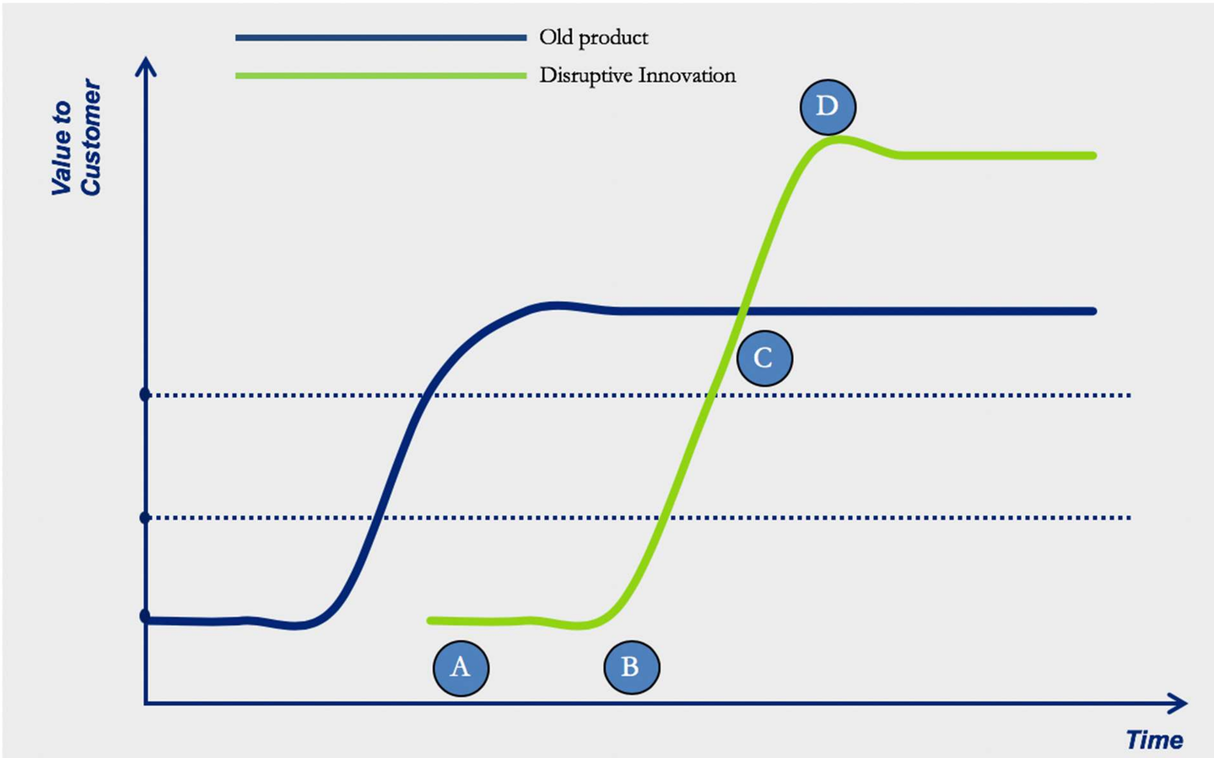

Figure 2: Disruptive innovation (according to Christensen (2013))

It is especially important to understand how these disruptive innovations work. Relating to the graph above we can see the trajectories of both the old product and the disruptive innovation. Both follow an exemplified S-curve form, which, although perhaps not exact for many technologies, seems to be the predominant view of technological development (Sood, 2010). On the Y-axis we can see the overall "value to customer" for an existing market – let it be the market for personals cars. In this case, the customer would be a person who owns a car for personal transport, and the graph can be interpreted from the viewpoint of an automobile manufacturer such as Ford. As a thought experiment, we will use ride-sharing as our disruptive innovation.

In **point A**, our first ride-sharing services become available. As Christensen points out, the disruptive innovation tends to be produced by outsiders (e.g. Uber) and they initially create a small new market that is uninteresting to incumbent firms. In this point, the value of this new innovation to Ford's overall customer base is still extremely low, as ride-sharing has many limitations and only appeals to a small subset of that customer group. We can imagine that for Ford's customer group, the main performance attributes of transport are 1) price, 2) flexibility, and 3) comfort. Especially on price and flexibility, ride-sharing still ranks much worse than owning your own car, if you use it daily – especially in the countryside. Therefore, the service initially speaks to affluent people in large cities. Ford will therefore tend to rightly focus on their current customer group and produce incrementally better cars through sustaining innovations – as this is what their customers want, and what determines much of their success in relation to other firms in the market (Christensen, 2013).

It should also be pointed out that the old product, in point A, is already quite advanced in its S-curve and therefore only incremental improvements are possible. This means Ford will only be able to incrementally improve the main performance attributes expected by the customer – e.g. price, flexibility, and comfort.

In **point B**, the disruptive technology, ride-sharing, is still way less valuable than personally-owned cars for Ford's customers. However, we can see that the technology is starting to enter the steep part of its improvement cycle. That is, many performance attributes of this technology are starting to progress ever faster – especially those 3 most valued by Ford's current customers.

In **point C** the technology has improved so rapidly that it actually matches the most valued performance attributes for Ford's existing customers. In this case, Ford's customers would be indifferent to buying a car or using ride-sharing.

In **point D** the technology has not only overtaken the old technology in terms of its most important performance attributes but has added new performance attributes previously impossible. In our case, ride-sharing is now cheaper than owning a car (through advanced algorithms, economies of scale and autonomous driving), more flexible (available in every part of the country in only a minute's notice; no parking necessary) and much more comfortable (a person does not need to drive the car; the interior can be refunctioned as there is no driver). In this point, the technology is superior even to Ford's classical customer base.

Now this is a quite obvious illustrative example – obvious enough that current car-makers are considering this scenario in their strategy (Boll, 2017). However, it does show the mechanics of disruptive innovation according to Christensen's theory.

It is important to note that incumbents firms, even though they might do everything correctly, seem to have a hard time responding to disruptive innovations (Christensen, 2013). Incumbent firms usually focus on the needs of their current customer groups by delivering sustaining innovations. Potential disruptive innovations are often too unsure and have too little impact on the firms bottom line (Christensen, 2013). This is what Christensen calls the **"Innovator's Dilemma".**

Thus, isolating mechanisms are not enough to protect an existing company from failing. A company must be aware of potential disruptive innovations.

2.5 Business Models & Emerging Technologies

As stated before, emerging technologies are one of the main reasons for incumbent firms to have to change their business model (Christensen, 2013) and business models are an important factor for new firms to gain competitive advantages from emerging technologies (Baden-Fuller & Haefliger, 2013). As such, we can look at these emerging technologies from the viewpoint of an incumbent firm or a new venture. New technologies might force incumbent firms to innovate their business model (business model innovation) and lead to the creation of new startups (business model development – sometimes also called business model design).

When comparing the two academically, there has been more written about **business model innovation** (Wirtz et al., 2016) and it is one of the main academic *foci* regarding academic literature concerning business models (Lambert & Davidson, 2013). There is a consensus that business model innovation, and not just technological innovation, is becoming more and more important for firms (Teece, 2010). In fact, as it relates to emerging technologies, one of the main goals of business model innovation is to keep an eye out for changes in technologies and markets (Adner & Kapoor, 2010). The traditional view of firms staying ahead through high R&D budgets has been replaced by the view that firms must also employ similarly systematic ways of innovating their value propositions, revenue models and value chains (Gassmann et al., 2013). In fact, as emerging opportunities are being utilized ever faster by market participants (Trimi & Berbegal-Mirabent, 2012), companies will need systematic approaches to innovate their business models effectively.

There is no clear consensus on what severity of a firms change constitutes business model innovation. Gassmann, Frankenberger et al. (2014) define it as modifying at least two of the four dimensions within their business model framework. This definition, of course, is only viable as it relates to the business model framework proposed by them, the Magic Triangle.

Much has been written about the difficulties of business model innovation in incumbent firms. There are inherent internal biases within firms that prevent incumbents from successfully changing their business models, which have been written about extensively (Chesbrough, 2010; Markides, 2000). Specifically, it can be noted that incumbent firms have trouble leaving their dominant logic (Gassmann et al., 2013). Dominant logic can be understood as the "mental maps developed through experience in the core business" (Prahalad & Bettis, 1986). Moreover, we can observe that such a dominant logic also exists for industries as a whole (Gassmann et al., 2013).

The reasons for firms having problems leaving their dominant logic are manifold and probably too broad for an exhaustive taxonomy. In "The Innovator's Dilemma" Christensen (2013) writes about firms missing disruptive innovations (which lead to a break with existing industry logic) because they are completely focused on sustaining innovations, i.e. incremental and expected improvements, for their current client base. In fact, multinationals tend to spend only about 10% of their innovation budget on business model innovation efforts (Johnson et al., 2008). Markides (2000) mentions, among other things, cultural inertia, rigid processes, politicking, conservatism, and vested interests as reasons why firms tend not to break out of their dominant industry logic. Furthermore, business models tend to also manifest themselves as logical constructs in managers heads, often limiting their ability to think outside of established rules (Chesbrough, 2010) – that is, business managers have spent their entire careers learning this logic, so it is hard to break (Gassmann et al., 2013). An often-cited example for the lack of business model innovation, as mentioned in the introduction of this thesis, is the example of Kodak. Kodak was at the forefront of R&D when it came to digital photography (Lucas Jr & Goh, 2009), but when the internet threatened its value proposition (printed photographs) and revenue model (selling and developing film), Kodak was unable to adapt (Munir, 2005). Kodak, exemplary for the traditional technically-driven view of innovation, failed to keep up with the emergence of a disruptive innovation. Thus, they might have had strong isolating mechanisms in place to prevent imitation in the current market logic but were unable to anticipate and adapt their business model for a totally different industry logic. In fact, it seems plausible that having strong isolating mechanisms and financial success within an existing industry might impair the ability to think in terms of new business models. In the context of emerging general-purpose technologies, the capability to effectively innovate the business model is especially important, as they have a strong potential of becoming, or spawning, disruptive innovations. General-purpose technologies have a high potential of changing an industry's dominant logic, that is, changing the way value is created, value is monetized or the value chain of the industry (Lipsey, Carlaw, & Bekar, 2005).

Another problem for incumbent firms is that there is a **lack of practical prescriptive literature** when it comes to the question of how to innovate their business model. Gassmann, Frankenberger et al. (2014) mentions the "lack of systematic tools" as one of three major challenges of business model innovation, the other ones being "thinking outside of one's own dominant industry logic" and "difficulty of thinking in terms of business models rather than of technologies and products". "The Business Model Navigator" by Gassmann, Frankenberger et al. (2014) and "Business Model Generation" by Osterwalder and Pigneur (2010) try to overcome the hurdle of practical inapplicability by setting out a framework that lays out the individual steps within the process of business model innovation.

Interestingly, research by Gassmann, Frankenberger et al. (2014) has found that "90% of new business models are not actually new" and that "they are based on 55 existing patterns." Thus, the authors offer a taxonomy of business models as a framework to help businesses in business model innovation. Similarly, this framework can be used by new ventures developing businesses models based on existing or novel technologies.

Business model development is a younger academic discipline that still lacks empirical research (Wirtz et al., 2016). Traditionally, the view of business model development was planning-oriented, that is, a firm analyzes customer needs, the competition and makes other relevant observations (McGrath,

2010) and then builds its business model based on those observations. Nowadays, because of more rapid competition and the ability to more easily get customer feedback, a discovery-driven and customer-centric approach is becoming the standard view (McGrath, 2010). That is, firms start with a hypothesis about what a successful business model would be and then, through prototyping and regular customer feedback, tests and adapts that business model. Similarly, new product development was traditionally done in secrecy, without much customer feedback, and then launched to the public (Trimi & Berbegal-Mirabent, 2012). The 2011 best-selling book, "The Lean Startup", describes business model development as an iterative process of hypothesis-driven product releases and learnings (Ries, 2011). Thereby, the methodology aims to reduce the amounts of initial funding required, reduce market risk, and prevent costly product launch failures (Ries, 2011). Such an approach makes sense given the fact that nowadays, due to technological innovations, more and more value propositions are feasible (McGrath, 2010) and the market exploits such opportunities ever faster (Trimi & Berbegal-Mirabent, 2012). Yet, there is still a lack of empirical evidence that this is indeed the case (Trimi & Berbegal-Mirabent, 2012).

However, the development of new ventures and especially the development of business models for new ventures lacks prescriptive methods or empirical research (Trimi & Berbegal-Mirabent, 2012). In fact, there is a lack of empirical research or general understanding in regard to how startups develop their business models or which process of developing business models is most successful. Steve Blank, who is regarded as one of the fathers of the Lean Startups movement, thinks of a startup as *"an organization formed to search for a repeatable and scalable business model."* (Blank, 2010). Rather than developing a quantitative business plan, startups should develop a business model (he recommends the Business Model Canvas) based on their initial hypotheses, and then iteratively test those hypotheses using tools such as customer development and agile development (Blank, 2010). The business model taxonomy created by Gassmann, Frankenberger et al. (2014) can help startups brainstorm possible business models. Another taxonomy can be found by Johnson (2010), who proposes 19 unique business models.

Yet, what if customer-centric development is not feasible? Trimi and Berbegal-Mirabent (2012) note that the shelf-life of "ideas" is becoming ever shorter – i.e. market participants are exploiting ideas faster and faster. This forces entrepreneurs or firms to act fast. Indeed, research by the Institute of Technology Management of the University of St. Gallen recently uncovered a new "phenomenon" in the area of business model development in the context of distributed ledger technologies. Interestingly, distributed ledger technologies have yet to find a viable commercial application but they are nonetheless often touted as one of the most transformative technologies of our time (Economist, 2017a). Schmueck et al. (2018) found that "sometimes technological innovations cannot be integrated into business models" when "technological innovations are not yet fully developed or there is no market demand.". They have observed that because of the technological immaturity and the applications of this technology still being so unsure, new ventures are employing two distinct approaches to developing their business model; a technology centered development approach and business model centered development approach. The former ventures, employing a technology centered development approach, are working on the advancement of the core technology. Their competitive advantage lies in the fact that they would be one of the first to recognize when the technology can be implemented into an associated business model (Schmueck et al., 2018). The latter ventures, employing a business model centered approach, build a business model around a specific use-case. Their competitive advantage lies in the fact that as soon as the technology has matured they already have a business model and all that comes with it, built around it. It should also be noted that the skillset required to develop a technology are quite different from the skillset required to commercialize a technology (Gambardella and McGahan 2010).

2.6 General-Purpose Technologies (GPTs)

2.6.1 An overview

The term "general-purpose technology" or "enabling technology" springs from the idea that not all technological change is created equal. GPTs are a fairly new field of (economic) research, as economists started giving the topic attention during the mid-1990s (T. F. Bresnahan & Trajtenberg, 1995). Reason for this new-found interest was the empirical observation that technological progress has historically happened in a non-linear fashion (Cantner & Vannuccini, 2012) and that certain technologies seem to play a stronger role in economic growth than others (T. Bresnahan, 2010). Economic historians observed that technologies such as the steam engine or electric motors had an enormous impact on the economy as well as the society more broadly, whereas other technologies did not. Furthermore, the mid 1990s saw the beginning of the dot-com craze, and more and more people around the globe started conversing about the disruptive impact of a new technology; the internet. This, in turn, further bolstered interest in research on GPTs. Indeed, as we know today, the internet did significantly enhance the economic and social impact of information technology (IT) and has rapidly changed the world we live in today.

By looking at historical transformative technologies such as the steam engine and electricity T. F. Bresnahan & Trajtenberg (1995) put forth one of the first definitions of a GPT as well as defined its dimensions/characteristics. This seminal work inspired many following definitions (Lipsey et al., 2005).

Definition of a GPTs according to Bresnahan and Trajtenberg (1995)
"GPT's are characterized by pervasiveness, inherent potential for technical improvements, and 'innovational complementarities', giving rise to increasing returns-to-scale."

Dimensions of GPTs according to Bresnahan and Trajtenberg (1995)

1. Pervasiveness
The GPT performs some generic function that is vital to the functioning of a large number of derivative technologies or technological systems (Bresnahan and Trajtenberg 1995).
Example: **Electricity** provides the generic function of transmitting energy.

2. Technical improvement
The GPT is continuously improved so that the generic function gets better over time, prompting more users and economic sectors to adapt it (Bresnahan and Trajtenberg 1995).
Example: Our understanding of power transmission via electricity become better over time, thus enabling other technologies to use electricity (e.g. the steam engine was replaced by an electrical motor).

3. Innovational complementaries
As the GPT gets better, it becomes more profitable and attractive for other users to innovate and improve their own technologies which are based on the GPT (Bresnahan and Trajtenberg 1995).
Example: Manufacturing could replace steam motors with electrical motors, thus making the manufacturing process much more effective.

Subsequent research proposes similar dimensions for the classification of GPTs (Cantner & Vannuccini, 2012).

This thesis will use the GPT framework set out by Lipsey et al. (2005). Their book "Economic Transformations: General-Purpose Technologies and Long-Term Economic Growth" is one of the most in-depth explorations of this topic, and it builds heavily on prior research, including that of T. F. Bresnahan & Trajtenberg (1995).

Definition of a GPTs accordingto Lipsey, Carlaw et al. (2005)

A GPT is a single generic technology, recognizable as such over its whole lifetime that initially has much scope for improvement and eventually comes to be widely used, to have many uses, and to have many spillover effects.

Dimensions of GPTs according to Lipsey, Carlaw et al. (2005)

1. Scope of improvement
The GPT goes through a process of improvement and evolution.

Example: **Information technology** – the number of transistors in a dense integrated circuit doubles about every two years (Moore's Law). This has been fairly accurate since around 1970.

2. Range of use
Proportion of the economy in which the GPT is used. This proportion will increase over time as the GPT improves and diffuses throughout the economy.

Example: **Information technology** - whereas the first purely electronic computers were invented in the 1940s and served specific use-cases, they are now used in almost *every part of the economy*.

3. Variety of use
Number of distinct use-cases for the GPT.

Example: **Information technology** – computers have countless use-cases.

3. Spillovers
GPTs impact existing technologies, creating the opportunity, or need, to alter them.
They expand the space of possible inventions and innovations.

Example: **Information technology** – information technology spawned the Digital Economy. It has been incredibly disruptive to traditional technologies and processes and has spawned countless new inventions.

It is important to note that these dimensions are to be seen *ex post*. This means that a GPT can be identified only after it has matured and displayed a strong degree of development for all four of the above mentioned dimensions (Lipsey et al., 2005). Also, whereas it is very easy to identify potential emerging GPTs, it is very hard to rule them out (Lipsey et al., 2005)

Along with the four dimensions, there are certain characteristics that GPTs tend to display:

- They start off as innovations in certain application sectors where they solve a specific use-case. After continuous improvement of the technology they start spreading to other sectors (T. Bresnahan, 2010).
- Often its diffusion is slow due to specific limiting factors, which tend to get less limiting as the technology improves (T. Bresnahan, 2010) (Example machine learning: GPU speeds and data).
- The emergence of the GPT may lead to additional innovation efforts in already existing competing technologies. This can lead to an additional slowing of diffusion, as competing technologies become slightly better (T. Bresnahan, 2010).
- GPTs are often use-radical rather than technology-radical (Lipsey et al., 2005). This means that the technology has existed for some time already but as it improves it suddenly opens up radically new use cases in certain economic areas (sophisticated machine learning algorithms (e.g. deep learning) have existed for decades but was practically of no use due to the limitations of computing power and data to train models).

2.6.2 Understanding GPTs in practice – steam power

Steam power is a good example for understanding how GPTs work. This thesis will provide a short overview of the technology, and then analyze it according to the four dimensions from Lipsey, Carlaw et al. (2005).

The first commercial utilization of steam power happened in the early 18th century. This era saw an increased hunger for coal in most developed countries, and as coal mines often flooded, a technology was needed to effectively pump the water back out (Lira, 2013). Prior technology was insufficient, as it relied on a series of buckets pulled by horses. A first steam engine was invented in 1712 that allowed pumping by creating a vacuum (Ferguson, 1964). Yet the technology still had three major limiting factors that prevented widespread diffusion, according to Bresnahan (2010):

- Unreliable, unpredictable, and inconsistent output
    - e.g. factories' machines needed consistent and predictable energy output
- Rotary motion was technically not feasible
    - e.g. no forward movement (e.g. trains) was possible
- High weight/horsepower ratio
    - e.g. sails were still more efficient for ships

It took until the end of the 18th/middle of the 19th century for the steam engine to overcome these limitations (Lira, 2013). It was then that the steam engine completely transformed the economy by providing a flexible, reliable, high-powered engine that could also produce rotary motion. Watermills and windmills became largely obsolete. It greatly reduced travel and times by spurring inventions such as the railroads and steam-powered ships, thus bringing the world closer together (Lipsey et al., 2005). The factory system was transformed and the prices of many goods fell dramatically, as it was no longer necessary to produce near flowing water and the steam engine had a much greater efficiency (Lipsey et al., 2005). The steam engine was largely replaced by the electric motor and the internal combustion engine during the early 20th century (Lipsey et al., 2005). Overall, it can be said that the steam engine was one of the main drivers towards "scale-based industrialization and urbanization" in the 20th century (T. Bresnahan, 2010).

In regard to the 4 dimensions outlined above, steam-power displays high degrees of development of each of them and can thus be identified (*ex post*) as a GPT. If we look at the individual dimensions:

1. Scope of improvement

low | medium | **high**

The steam engine was not a technology that appeared overnight and suddenly lead to disruption across all industries. In fact, it took the technology many years to fully develop.

The first commercial version of the steam engine, the Savery Pump in 1698, was able to pump water out of shallow depths by creating a vacuum (Lira, 2013). It was not until 1712 that the Englishman Thomas Newcomen developed the first truly viable steam powered pump (Ferguson, 1964). For nearly 50 years, until 1765, Newcomen's steam pump was the best technology available, until James Watt significantly improved upon Newcomen's model and made it more energy efficient (Lira, 2013). It took Watt until 1783 for his steam engine to be able to create controlled rotary motion, which was then used in factories. Yet the technology was still improving. In the early 19th century, the first high-pressure steam engines were developed, which made them more powerful and efficient in terms of weight (Ferguson, 1964). It was not until around 1870 that the steam engine made the waterwheel completely obsolete (Lipsey et al., 2005).

2. Range of use

low | medium | **high**

Although it took some time to diffuse, the steam engine was used in much of the economy after the first industrial revolution. "By the last quarter of that century, steam power had penetrated virtually every corner of the economy, creating Britain's Victorian Age of steam." (Lipsey et al., 2005, p. 182). By the late 19th century, steam power became the dominant power source for industrial nations (e.g. 80% for the US) (Fenichel, 1966).

3. Variety of use

low | **medium** | high

Steam power was mainly used as a replacement of water, wind and muscle power through pumping or creating controlled rotary motion (T. Bresnahan, 2010).

The two most important uses were in the **factories** and **transportation**. In factories, steam power was used, for instance, for the production of textiles, iron manufacturing and brewing. In **transportation**, steam power was used for railroads and ships (White, 2009).

4. Spillovers

low medium **high**

As it relates to spillover, the possibility of "expanding the space of possible innovations and innovations" steam power had a profound impact on the economy as well as society (Lipsey et al., 2005). In fact, steam power is considered a crucial technology, which led to the first industrial revolution, influencing nearly every aspect of people's lives (White, 2009).

Railway transportation opened markets on land and made transport of goods and people much more efficient. **Transport by ship** was no longer dependent on favorable winds and one could now sail against a river's current. Steam power in the navy turned Great Britain into a world superpower. The **factory system** led to a large increase in productivity, the creation of new economic hubs and turned Great Britain from an agricultural society to an urban society. New production machines based on steam power were invented and they produced a wide variety of new and cheap products.

2.7 Summary of Theoretical Background

Firstly, through the work of Lipsey, Carlaw et al. (2005) we understand how to **classify** and **identify general-purpose technologies**. We know that they go through a **process of continuous improvement**, eventually leading to a **wide variety of uses** by a **large part of the economy**, which leads to **many new innovations** built on top of them.

With this knowledge, we can **try to identify current general-purpose technologies** along the dimensions set out by Lipsey, Carlaw et al. (2005). We also know that an actual identification is only possible *ex post*, and that it is easier to include potential general-purpose technologies than to exclude them.

Because of these innovations built on top of the generic technology, as well as its wide spread throughout the economy, general-purpose technologies are likely to be **disruptive innovations.** Through the framework set out by Christensen (2013) we know that technologies, and innovations in general, can be separated into evolutionary and disruptive. We know that **disruptive innovations** start off by servicing/creating a small particular market and through rapid improvement along the S-Curve overtake and replace other technologies.

Research by Schmueck et al. (2018) shows that business model development for DLT-based businesses run along two different approaches: technology centered and business model centered development approaches. Although DLT are still underdeveloped (Economist, 2017a), yet often regarded as potential general-purpose technology, companies are already trying to position themselves without yet having real functioning use-cases or real market demand.

Through the work on Johnson, Christensen et al. (2008) and Chesbrough (2007), we know that in order to succeed monetizing a new technology, we need an appropriate **business model**. Business model literature still has not found common ground concerning what a business model looks like, and there are different **business model frameworks** available to practitioners. The most famous model is the Business Model Canvas by Osterwalder and Pigneur (2010). Another useful but leaner business model framework is the Magic Triangle by Gassmann, Frankenberger et al. (2014).

Because **general-purpose technologies** can **change the dominant industry logic**, incumbent firms might need to **innovate** their business model. As changing the dominant industry logic opens up new ways of creating and capturing value, new firms are able to **develop** new business models. Business model innovation, but also business model development, are still academic areas that need considerably more study and there are only a few prescriptive methods for doing either. In terms of business model development, Blank (2010) suggests using the business model framework set out by Osterwalder and Pigneur (2010), the "Business Model Canvas", and iteratively test hypotheses about each dimension using **customer development** and **agile development.**

Yet following the logic set out by Teece (2010), a business model alone does not create a **competitive advantage.** Firms still need to **put isolating mechanisms in place** to prevent the competition from imitating its value proposition. Isolating mechanisms will only, to a certain degree, prevent firms from imitation; it will not prevent new disruptive innovations from changing the dominant industry logic. Consequently, even with a strong business model and strong isolating mechanisms, we must constantly be able to innovate our business models to face disruptive innovations (Gassmann et al., 2014).

3. METHODS

"Advances in knowledge that are too strongly rooted in what we already know delimit what we can know."
- Dennis A. Gioia

3.1 Methods & Research Design

This thesis uses an exploratory research design. An exploratory research design is suitable when the problem in question is still at the early stages of discovery (Babbie, 2007). It can be used to gain experience regarding a certain question and help formulate further research questions (Babbie, 2007), establish priorities, and improve subsequent research designs (Shields & Rangarajan, 2013). Conclusions gained within an exploratory research design are not meant to be definitive – rather they should be interpreted as an initial insight into the research question at hand.

Specifically, we will try to answer our research question: ***Which challenges do new ventures face when building a competitive business model in the context of underdeveloped general-purpose technologies?*** by means of an **interpretive multiple case study design** (Bhattacherjee, 2012). The research question, as well as the research sub-questions, lend themselves well to a case study approach, as it is an inductive technique where evidence is collected, analyzed, and synthesized to allow concepts and patterns to emerge for the purpose of building new theories or expanding existing ones (Bhattacherjee, 2012) and its inherent ability to capture a rich array of contextual data (Bhattacherjee, 2012). Case study research focuses on the "why" and "how" and they are an appropriate tool for an exploratory research design (Myers, 2013). Furthermore, a case study design can be particularly useful for theory building in areas where a theoretical framework is insufficient or lacking (Chetty, 1996).

To give a succinct overview of our process, we can visualize our research design as follows.

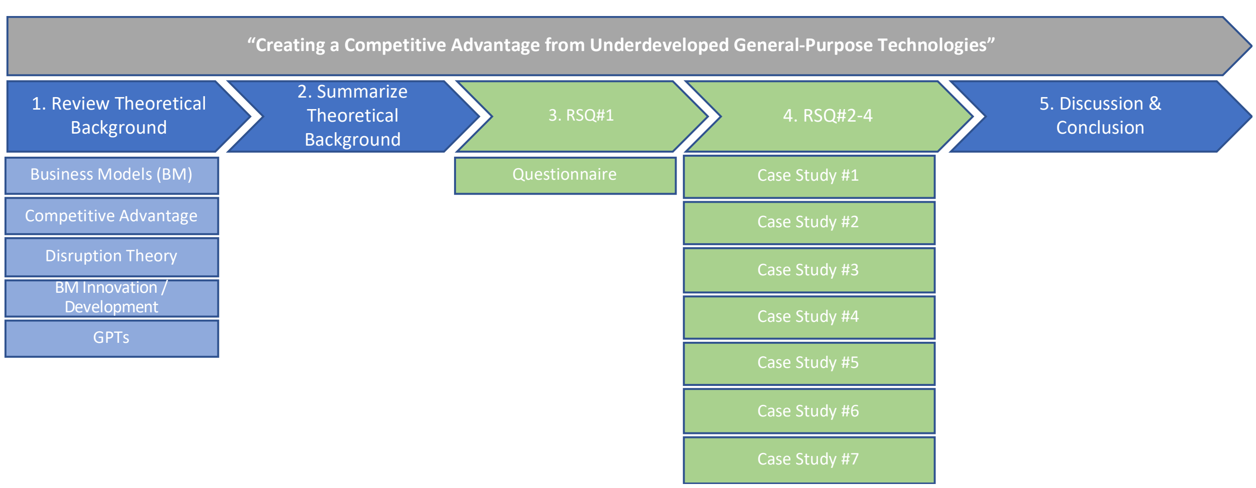

Figure 3: Research design

1. **Review theoretical background:** In the previous chapter, we started off by reviewing the current academic literature coming from the fields of business models, competitive advantage, disruption theory, business model innovation/development, as well general-purpose technologies. We identified and discussed main findings within the literature and drew upon models to further guide us in our process.

2. **Summarize theoretical background:** We summarized the theoretical background to one coherent framework as it pertains to the development of business models for emerging general-purpose technologies. This serves as the cognitive basis for conducting the case study interviews as well as their interpretation.

3. **(RSQ#1) "Which emerging potential general-purpose technologies can we currently identify?"** Using an identification framework set out in our theoretical background, we disseminate a questionnaire among knowledgeable participants regarding the identification of current potential general-purpose technologies. The results help us find another potential general-purpose technology, aside from DLT, to gain insight into our research question.

4. **(RSQ#2-4)** Having identified the most promising potential general-purpose technologies in our first research sub-question, we conduct case study interviews with seven different startups. The following research sub-questions will be answered;

    a. ***"Which general approaches to creating a competitive business model can we identify?"***
    b. ***"Which challenges do ventures face when it comes to designing their business model?"***
    c. ***"Which challenges do ventures face when it comes to the technology?"***
    d. ***"Which challenges do ventures face when it comes to the business environment?"***

As it relates to the gathering and analysis of data stemming from the interviews which are part of our primary research question, we will employ the methodology put forward by Gioia et al. (2013). This method's aim is to *"imbue an inductive study with "qualitative rigor" while still retaining creative, revelatory potential for generating new concepts and ideas for which such [inductive] studies are best known."* (Gioia et al., 2013, p.1). Specifically, this method puts forward basic assumptions together with a comprehensible and graphical link between interview data (quotes) and second-order themes (findings) derived by the researcher. The results should be comprehensibly documented and coherent and logical for the reader, all while retaining much of the interviewee's original words. Thereby, the methodology tries to allow the emergence of novel insights, without the use of existing knowledge-frameworks, while retaining a maximum of academic thoroughness (Gioia, Corley, & Hamilton, 2013).

5. **Discussion & conclusion:** In final step, we summarize our findings. This involves relating the research sub-questions to the primary research question, giving a conclusion, and looking ahead to further research in this area.

More detailed explanations to the research sub-question are provided in beginning of their respective chapters.

3.2 Limitations

Much has been written about the limitations of a case study approach. Although a case study approach has become widely accepted in entrepreneurial research (Ponelis, 2015), there are common criticisms of this method (Yin, 2009). Among the most common criticisms are the potential for insufficient design on data collection and analysis of the author, lack of ability to generalize, and potential for conscious or unconscious bias (Yin, 2009).

Specifically, when it comes to the research design set out for this thesis, there are multiple limitations we must keep in mind. The case interviews were conducted with only seven ventures, excluding another two interviews performed by Schmueck et al. (2018) which we also included into our findings. Therefore, it is questionable whether the results are **representative** and **generalizable.** As this is an explorative study, it does not necessarily seek out to be generalizable, yet in order to learn something for future research, the ventures should at least be representative of their peers. We believe they are.

Furthermore, limitations arise from the **depth of analysis**, which is limited to a 45-60-minute interview, and the **questions posed within the interview**. We might get insightful answers to our questions, but this does not mean that the questions posed were optimal to find the desired insights. The questions were initially devised in collaboration with Kilian Schmueck, a doctoral researcher at the Institute of Technology Management in St. Gallen, who also partook in much of the interview process. After each interview we reviewed the questions and, if deemed appropriate, made some adjustments. We therefore believe that the questions that were posed in the interviews were effective at getting insights to our research question.

Lastly, limitations arise when it comes to the **interpretation** of the data collected in the interviews. Any author of a case study is susceptible to unconscious biases, i.e. to interpret findings according to preconceived notions. Especially in regard to this limitation, the use of the method set out by Gioia et al. (2013) should make the interpretation of the interviews as comprehensible and rigorous as possible.

4. FINDINGS

"Startups should be based on radical ideas. There should be a high failure rate for start-ups, because if there isn't their ideas aren't bold enough."
- Marc Andreessen

In Chapter 4.1 we will analyze our first research sub-question "Which emerging potential general-purpose technologies can we currently identify?" This will give us one or multiple additional emerging technologies on which we can base our subsequent research sub-questions.

Following this, Chapter 4.2 will set out to answer our research sub-questions #2-5 by interviewing startups within the field of these emerging technologies.

- *"Which general approaches to creating a competitive business model can we identify?"*
- *"Which challenges do ventures face when it comes to designing their business model?"*
- *"Which challenges do ventures face when it comes to the technology?"*
- *"Which challenges do ventures face when it comes to the business environment?"*

Finally, in Chapter 4.3 the research sub-questions will be consolidated to answer our primary research question: *"Which challenges do new ventures face when building a competitive business model in the context of underdeveloped general-purpose technologies?"*

4.1 Research Sub-Question #1: "Which emerging potential general-purpose technologies can we currently identify?

4.1.1 Introduction & methodology

Schmueck et al. (2018) show that for DLT-based businesses, two distinct ways of business model development can be observed:

- A business model centered approach
- A technology centered approach

We believe the reason for these two distinct approaches is that distributed-ledger technology is **underdeveloped** and therefore we cannot see any viable business cases as of yet (Economist, 2017a). At the same time, the technology is **rated as extremely promising** by the public (Mims, 2018). In fact, Google search interest for the term "blockchain" increased 100-fold between May 2015 and December 2017 (Google, 2018). Funding for DLT-based startups increased 10-fold from 2013 to 2017 (Statista.de, 2018).

It seems apparent that these two factors, **technological underdevelopment** and **high perceived potential,** are forcing new ventures to strategically position themselves, although a viable business case is not yet possible (Schmueck et al., 2018). We can therefore assume that DLT is not the only emerging technology for which these two approaches can be observed. Indeed, nowadays there seems to be a plethora of new promising technologies about to disrupt the economy (BCG, 2017). In fact, a new wave of venture capital funding into "deep-tech" startups can currently be observed (BCG, 2017) – whereby "deep-tech" stands for startups operating in emerging technologies and they face, among other things, high R&D costs and high technological risk. Furthermore, in 2018 the European Investment Bank published a report outlining how important these "deep-tech" ventures are to the European economy and outlined that there exists a reluctance of institutional investors to fund these startups due to inherent business and technology risks of these ventures (European Investment Bank, 2018). Given the importance of these startups to our economic process, it seems diligent to understand which technological areas are of particular interest to us and what challenges startups in those areas face when building competitive business models.

Furthermore, if the rate of technological change is increasing, for which there are arguments to be made (Berman, 2016), we might see more emerging technologies in the future, thus more ventures operating to monetize them.

And so, in our first research sub-question, we will attempt to identify the most promising current underdeveloped general-purpose technologies. The findings from this chapter will guide us in in our following research sub-questions, as it will point us towards which other technology we will analyze in regard to the phenomenon first discovered by Schmueck et al. (2018).

Generally speaking, the literature on current potential general-purpose technologies from an academic standpoint is scarce and limited to the discussion of single technologies. To the author's best knowledge, there is no summarized discussion of current potential GPTs.

According to Lipsey, Carlaw et al. (2005), identifying general-purpose technologies before they are fully matured is not an easy task. Indeed, they state that *"It is far easier to identify some emerging technologies as potential GPTs than to rule out others."* and *"So while we may be able, with some confidence, to put some new technologies into the class of potential GPTs, we cannot with equal confidence assert that all of the remainder have no promise of developing into GPTs."*

Keeping this in mind, we tried to identify which, from a short list of promising technologies, is most perceived as having the potential of being a general-purpose technology. For this we devised a short list of potential GPTs and let selected participants of a questionnaire rate their dimensions according to Lipsey, Carlaw et al. (2005). The following sub-chapters will describe how this was done in detail as well as present the results.

4.1.2 The technologies

First, a list of relevant technologies was selected from Gartner's 2015-2017 "Hype Cycle for Emerging Technologies" report (Panetta, 2017). The technologies were selected if they were identifiable as a "single generic technology" and subsequently the list was reduced to six highly promising technologies. The definitions used were provided to the participants of the survey.

Artificial intelligence (AI)/machine learning (ML)

- **Definition (AI):** "Study of "intelligent agents" that perceive their environment and take actions that maximize their chance of successfully achieving their goals."
- **Definition (ML):** "Statistical techniques to give computer systems the ability to "learn" (e.g., progressively improve performance on a specific task) with data, without being explicitly programmed."

Virtual reality (VR)/augmented reality (AR)

- **Definition (VR):** "Virtual reality (VR) is a computer-generated scenario that simulates experience through senses and perception."
- **Definition (AR):** "Augmented reality (AR) is a direct or indirect live view of a physical, real-world environment whose elements are "augmented" by computer-generated perceptual information, ideally across multiple sensory modalities, including visual, auditory, haptic, somatosensory, and olfactory"

Distributed ledger technologies (DLT)/blockchain (BC)

- **Definition (DLT):** "A distributed ledger is a consensus of replicated, shared, and synchronized digital data geographically spread across multiple sites, countries, or institutions. There is no central administrator or centralized data storage."
- **Definition (BC):** "A blockchain is a continuously growing list of records which are linked and secured using cryptography. Blockchain is only one type of data structure considered to be a distributed ledger."

Quantum computing

- **Definition:** "Quantum computing is computing using quantum-mechanical phenomena, such as superposition and entanglement."

3D printing

- **Definition:** "3D printing is any of various processes in which material is joined or solidified under computer control to create a three-dimensional object, with material being added together".

Nanotechnology

- **Definition:** "Nanotechnology is manipulation of matter on an atomic, molecular, and supramolecular scale."

4.1.3 The questionnaire

The participants were asked to answer a questionnaire which contained five questions for each of the selected technologies. The questions pertained to the overall perceived disruptiveness of the technology as well as the four GPT dimensions according to Lipsey, Carlaw et al. (2005). The participants were asked to rate these dimensions on a Likert scale from 1-5, whereby 1 was the lowest (worst) and 5 was the highest (best) score. Definitions for the technologies were provided. The participants were asked to refrain from answering a specific question if they felt they did not have enough insight. The questions were:

1. **"Please state how you rate the disruptive potential of the following technologies on the broader economy"**

This question was posed to understand how the participants felt about the potential of the technology. Another way to look at it is to see how "hyped" this technology is among practitioners. If a technology is rated high here, it is thinkable that there is also a good chance of ventures trying to position themselves very early.

The **following four questions** analyzed each of the four general-purpose technology dimensions according to Lipsey, Carlaw et al. (2005). These four questions together can be seen complementary to question 1. The thought behind it is that technologies rated highly in terms of their potential to become a general-purpose technology, might also lead ventures to position themselves very early.

2. **"In your opinion, what is the current potential for improvement regarding these technologies?"** (Dimension "Scope of improvement" according to Lipsey, Carlaw et al. (2005))
3. **"In your opinion, what percentage of the economy will eventually employ this technology?"** (Dimension "Range of use" according to Lipsey, Carlaw et al. (2005))
4. **"In your opinion, how many different use-cases will these technologies eventually find?"** (Dimension "Variety of use" according to (Lipsey et al., 2005))

5. **“In your opinion, how many new innovations/technologies/applications will eventually be built on top of these technologies?”** (Dimension “Spillovers” according to (Lipsey et al., 2005))

The results of question 1 (Disruptive potential) and question 2-5 (Dimensions of a general-purpose technology) were taken together to choose an additional technology to analyze.

4.1.4 The participants

The goal was to get a range of opinions from informed market participants. Rationale behind this was that it should generally reflect the overall market sentiment when it comes to these technologies and should give a sense for how high people rate the technology’s potential for becoming a general-purpose technology. It was important that each of the participants has experience in the intersection between technology and business strategy – either from an academic or a professional standpoint.

The participants were therefore selected from the following groups:

- Business students in the area of (technological) innovation or strategy.
- Professionals in the area of (technological) innovation or strategy.

In total 25 participants answered the survey. Of those, 10 were business students in the area of innovation/strategy. 15 were professionals in innovation/strategy.

4.1.5 Results

Question 1 – “Please state how you rate the disruptive potential of the following technologies on the broader economy”

Overall Disruptive Potential						
	AI/ML	VR/AR	Blockchain	Quantum Computing	3D Printing	Nanotech
	4.64	3.56	3.72	4.00	3.36	3.80

On average, participants rated artificial intelligence/machine learning as the technology with the highest potential for disruption (4.64 of 5), followed by quantum computing (4 of 5). Most striking here is that artificial intelligence/machine learning enjoys a strong lead even to quantum computing. It seems evident that the participants by far ascribe the highest disruptive potential to this technology over the others.

Question 2-5 – General-purpose technology dimensions according to Lipsey, Carlaw et al. (2005)

GPT Dimensions						
	AI/ML	VR/AR	Blockchain	Quantum Computing	3D Printing	Nanotech
Potential for Improvement	4.32	3.92	3.68	3.92	3.20	3.83
Range of use (Scaled to 5)	4.14	2.40	2.70	2.48	2.32	2.54
Variety of Use	4.60	3.36	3.48	3.33	3.24	3.63
Spillover Effects	4.64	3.64	3.88	3.33	2.84	3.50

Again, artificial intelligence/machine learning was rated the highest on all the dimensions proposed by Lipsey, Carlaw et al. (2005). Also, it is again striking by what a large margin this is the case.

Ranking GPT Dimensions	AI/ML	VR/AR	Blockchain	Quantum Computing	3D Printing	Nanotech
Potential for Improvement	1	2	5	3	6	4
Range of use (Scaled to 5)	1	5	2	4	6	3
Variety of Use	1	4	3	5	6	2
Spillover Effects	1	3	2	5	6	4
Average Ranking	**1.00**	3.50	**3.00**	4.25	6.00	3.25

When ranking the technologies according to their average ranking per dimension, it is clear that artificial intelligence/machine learning takes the first place, and 3D printing the last. Blockchain/DLT takes the second place, but only with a small margin to nanotech.

4.1.6 Conclusions & limitations

In conclusion, the participants clearly gave artificial intelligence/machine learning the highest disruptive potential as well as the highest potential of becoming a general-purpose technology according to the GPT dimensions (Lipsey et al., 2005).

These results can be interpreted in **absolute** or **relative** terms. Interpreting the results in absolute terms would mean that AI/ML is given a high disruptive potential and high potential as general-purpose technology regardless of the other technologies. Interpreting the results in relative terms would simply mean that AI/ML is rated the highest among the technologies, regardless of the absolute value. Both interpretations can be considered.

The following limitations should be noted:

- We should be careful when interpreting these results in **absolute terms.** The participants might have been biased in a way that they often rated AI/ML as "5" simply because they needed to rate it better than the others.
- 25 participants is not generalizable as it pertains to the broader economy/ population. However, it is quite challenging to find a large enough sample of participants with the right background.

- These results might simply show the **current hype** around these technologies, rather than an "objective truth". However, this is not a problem, as hype is a motor for new venture creation – which is what we are analyzing here.

Given these results, our interviews for answering our research sub-question #2-4 will focus on ventures in the **artificial intelligence/machine learning** area as well as further the research in the **blockchain/DLT** area. Artificial intelligence is both rated as being the most disruptive as well as having the highest potential of becoming a general-purpose technology. Furthermore, it is given the highest potential for improvement, and so it seems underdeveloped in regard to its mature form.

4.2 Research Sub-Questions #2: "Which general approaches to creating a competitive business model can we identify?"

4.2.1 Introduction & results

As discussed in the previous chapter, Schmueck et al. (2018) found that for DLT-based ventures, there seems to be two distinct ways startups build their business-models: a **business model centered development approach** and a **technology centered development approach**. It is important to distinguish these two approaches from a classical technology-push and market-pull approach. These two approaches are novel and Schmueck et al. (2018) were the first to describe them. In this short chapter we analyze whether we can find these approaches in other GPTs and if so, we try to add further insight to them.

The results of this research sub-question are based on the interviews conducted. The exact interview process and results will be discussed in detail in Chapter 4.3.

In a classical **market-pull** orientation, a startup would search for an articulated need in an existing market segment (Lubik, Lim, Platts, & Minshall, 2012) and develop products to specifically meet that need. In contrast, in a **technology-push** orientation, a startup would be "set up to commercialize a specific technology, drawing product ideas from an existing or developing technology" (Lubik, Lim et al., 2012, p. 13).

Analogously, Schmueck et al. (2018) show that startups with a **business model centered** development approach make an **assumption about a possible use-case** and use or adapt the developing technology to develop that use-case. In contrast, a startup with a **technology centered** business model development approach would **further develop the underlying technology without an assumption about the use-case.**

Thus, the differentiating factor between market-pull and technology-push is **market demand.** Market-pull *analyses* existing market demand; technology-push *creates* market demand. Differentiating factor between business model centered and technology centered is not market demand, but rather an assumption regarding the **use-case.** An underdeveloped general-purpose technology (possibly) creates a new set of use-cases (value propositions); yet there is still much uncertainty which use-cases will work technologically or economically. Therefore, business model centered startups *make an assumption* about a use-case, whereas technology centered startups *do not*.

Based on the results of our interviews, described in Chapter 4.3, we set forth the hypothesis that there are three defining dimensions startups face when working with underdeveloped general-purpose technologies. We call this the "**Emerging-Technology Triangle**".

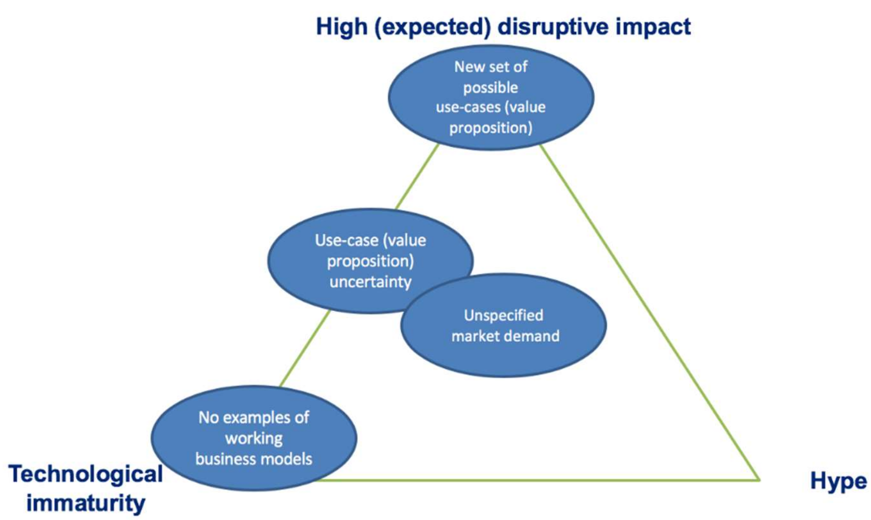

Figure 4: Emerging-Technology Triangle (ETT)

Emerging Technology Triangle		
Primary Dimensions		
High (expected) disruptive impact	Technological immaturity	Hype

Table 5: ETT - primary dimensions

The Emerging Technology Triangle is based on our interview findings, which are discussed in detail in Chapter 4.3. The following figure shows how the primary dimensions lead to the secondary dimensions as well as their evidence from our interview findings.

Emerging Technology Triangle		
Secondary Dimensions		
Source (Primary Dimensions)	**Secondary Dimension**	**Evidence (See Chapter 4.3 or Appendix)**
High (expected) disruptive impact	New set of possible use-cases (value proposition)	Finding 1.1 Finding 1.3 Finding 1.6 Finding 2.2
High (expected) disruptive impact Technological immaturity	Use-case (value proposition) uncertainty	Finding 1.1 Finding 1.3 Finding 1.6 Finding 2.1
Technological immaturity	No examples of working business models	Finding 1.2 Finding 1.7
Technological immaturity High (expected) disruptive impact Hype	Unspecified market demand	Finding 1.1 Finding 3.1

Table 6: ETT - secondary dimensions

We can see that the differentiating factor of **market demand**, which characterizes either a market-pull or technology-push orientation, is problematic in the context of building a startup within an underdeveloped general-purpose technology with its dimensions displayed in the Emerging Technology Triangle. As Table 6 shows, all three primary dimensions together lead to **unspecified market demand.** This means that many market participants want to use the technology, yet it is unclear for which value propositions it makes sense, is technologically feasible and will be economically viable. Thus, we can see that rather than *analyzing or creating* market demand, startups will *make an assumption about use-cases or not.* This hypothesized model is an addition to the work done by Schmueck et al. (2018) and puts their and our own results into more context.

We therefore analyze whether our case studies, described in detail in Chapter 4.3, adhere to the two approaches set out by Schmueck et al. (2018). For this, we built a two-dimensional "**Business Model Development Matrix"** and subjectively, based on the information gathered in the interviews, placed our case study startups into this framework. The dimension "Assumption of use-case" shows to which degree the individual startup makes an assumption about a specific use-case. The second dimension "Technological development" illustrates to which degree the individual startup is involved in ground-up technological development.

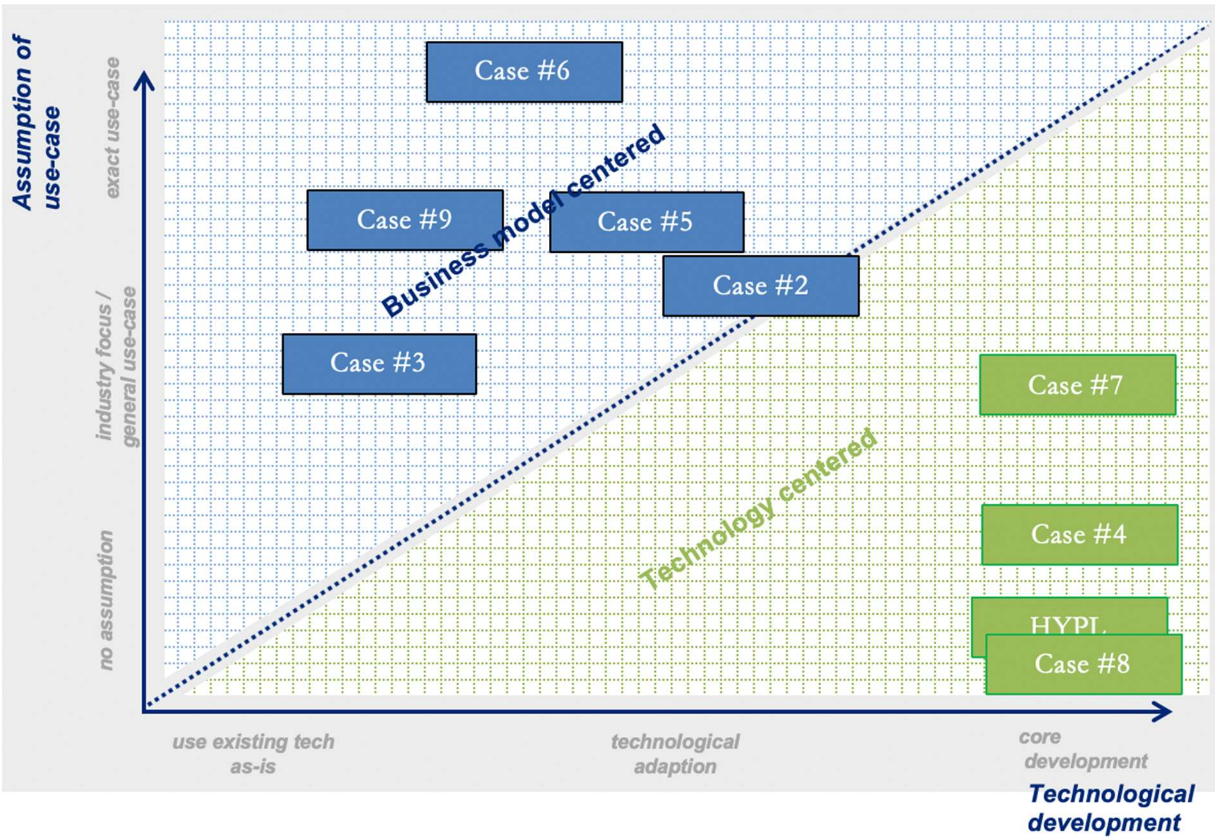

Figure 5: Business Model Development Matrix

And indeed, in line with findings by Schmueck et al. (2018), we too see a dichotomy of general approaches of creating a competitive business model that manifest themselves in a business model centered and technology centered approach. Yet whereas some startups are at the extreme of their approach (e.g. Case #8 or Case #4 for the technology centered approach), others show degrees of both use-case assumption and ground-up technological development (e.g. Case #2).

4.2.2 Conclusions & limitations

Firstly, during our interviews we also observed the two distinct business model development approaches first described by Schmueck et al. (2018). We add to this by proposing the Emerging Technology Triangle, which puts these two approaches into more context and explains their existence. Moreover, we propose the Business Model Development Matrix to classify startups along the two approaches.

As limitations regarding the Emerging Technology Triangle it should be stated that it is only based on the findings of seven interviews. Therefore, it is unclear whether it is generalizable and broadly represents the characteristics firms face within these potential GPTs. Furthermore, this framework is possibly subject to inherent bias by the authors of this thesis, as findings of the interviews were connected to a "big-picture" framework. We do believe that this framework yields value to this field and additional empirical research should be done.

Limitations to the Business Model Development Matrix are similar to those of the Emerging Technology Triangle. Firstly, the findings are based on the interviews of only seven startups, so they might not be generalizable and might not reflect the business model development approaches of the broader ecosystem. Furthermore, the dimensions of the matrix, as well as the placement of startups within the matrix, are not based on quantitative data but mostly on subjective classification.

4.3 Research Sub-Questions #3-5: business model, technology, environment

This chapter will present a deep-dive into the methodology applied for our interviews and analysis, introduce our case-studies, and then go over the findings of final sub-research questions.
Specifically, this chapter will answer the following questions:

"Which challenges do ventures face when it comes to designing their business model?"
research sub-question #3 (RSQ #3)

"Which challenges do ventures face when it comes to the technology?"
research sub-question #4 (RSQ #4)

"Which challenges do ventures face when it comes to the business environment?"
research sub-question #5 (RSQ #5)

4.3.1 Methodology

In answering RSQ #3-5 we will employ an **inductive and exploratory research design**, as this type of design has a "creative, revelatory potential for generating new concepts and ideas" (Gioia, Corley et al., 2013 p. 1). When conducting inductive research, much emphasis needs to be put retaining as much academic rigor as possible (Gioia et al., 2013), as a lack of academic standards is a common criticism of inductive methods (Bryman, 2003).

To counter this common criticism, we used the method set out by Gioia, Corley et al. (2013). Goal of this approach is to set out a method of inductive concept development that meets high academic standards. The following will be an overview of the method.

4.3.1.1 The interviews

Firstly, we assume that our interviewees are "knowledgeable agents", which means that they are *"people in organizations (who) know what they are trying to do and can explain their thoughts, intentions, and actions"* (Gioia, Corley et al. 2013, p. 17). Secondly, we also consider ourselves as knowledgeable people, able to *"figure out patterns in the data, enabling us to surface concepts and relationships that might escape the awareness of the informants, and that we can formulate these concepts in theoretically relevant terms"* (Gioia, Corley et al., 2013, p. 17).

Our first task was to find interesting case-studies. These were mostly found through crunchbase.com, a database of startups, as well as diverse industry coverage found online. We wrote invitations only to interesting startups in a balanced number of, what appeared to be, technology centered and business model centered approaches. Interview-requests were both sent to startups in the DLT as well as machine learning sphere. In total, we conducted seven interviews. Additionally, we had two prior interviews we could draw upon: Case #9 and Case #8, which were part of the research by Schmueck et al. (2018).

Secondly, we needed to set up the interview questions. These were devised together with Kilian Schmueck, a PhD researcher at the Institute of Technology Management at the University of St. Gallen and advisor to this thesis. In accordance with the method set out by Gioia, Corley et al. (2013), we sought to create strong initial standardized questions but then aimed to deviate from those if we felt that it was appropriate and interesting for the research. The set of questions had to be thorough, oriented towards the research question as well as contain no "leading-the-witness" questions. As the research progressed, questions were added, subtracted, or refined. Our initial questions were as follows.

- Who are your clients?
- What is your company's value proposition to the client?
- What is your company's revenue model?
- Which other key resources are necessary for you to deliver this value proposition? (value chain)
- Why was your venture initially created? What opportunity did you see?
- Do you see your business model development approach more technology or business model driven?
- When and how did you first evaluate potential business cases as well as the underlying technology?
- How mature is your underlying technology? To which degree can it already fulfill the client's value proposition? How much potential for improvement is there?
- Where does the company see the underlying technology (DLT or machine learning) heading, as it relates to your business model?
- How do you intend to gain a long-term competitive advantage?

Interviews were usually around 60 minutes long and were conducted via Google Hangouts.

4.3.1.2 The analysis

Both the design as well as the analysis of the interviews adhered strongly to the method put forth by Gioia, Corley et al. (2013). The analysis was conducted in three separate steps.

Firstly, we conducted a **1st-order analysis.** This step focused firmly on the interviewee and the information they provided, without making any judgements or assumptions on our part. During this, we walked through the transcripts of the interviews and coded everything that could potentially be interesting for further analysis. Here we made it a point to stay with the original phrases the interviewees used as well as to make no assumptions about the outcome of the 2nd-order analysis. For our 1st-order analysis we ended up with **290 1st-order concepts** – i.e. citations from the interview.

Secondly, we conducted a **2nd-order analysis**. In this step *"we treat ourselves as the knowledgeable agents"* (Gioia, Corley et al., 2013, p.20) by looking for a deeper structure and narrative within the 1st-order concepts. Here we tried to answer the question of "What's going on here?" (Gioia et al., 2013). Our initial 290 1st-order concepts led to **14 2nd-order themes.** These were structured in so-called "aggregate dimensions", relating to the RSQ #3-5, "business model", "technology", and "environment".

Finally, we use our 1st-order concepts, 2nd-order themes, and aggregate dimensions to build a **data structure.** This data structure serves as a visual aid in the analysis as well as graphic representation of our progression from the interviews to the outcome of our analysis and is thus a key component of showing academic rigor within the analysis. A sample of such a data structure is shown in Table 9. The entire data structure can be found in the Appendix.

4.3.2 Our cases

In total we interviewed seven individual startups. Two additional startups, Case #8 and Case #9, were taken from research by Schmueck et al. (2018), where a description of them can be found. In the following pages, we will provide a short description for each of the seven ventures we interviewed. It will feature two parts. The first part is a short overview of the current or envisioned business model placed into the "Magic Triangle" business model framework by (Gassmann et al., 2014). (We left the dimension "Value Chain" out, as there was not enough time during the interview to discuss it. We do not believe this to be of material impact for the understanding of the startups.) The second part is a discussion on the more interesting points of the interview.

Technology	Approach	Company
Blockchain	Business model centered	Case #3
		Case #5
	Technology centered	Hyperledger
		Case #4
Machine learning	Business model centered	Case #6
		Case #2
	Technology centered	Case #7

Table 7: Overview of interviews

HYPERLEDGER

Hyperledger: DLT, technology centered

Value proposition

Hyperledger brings together enterprises (Hyperledger members), helps them with Marketing, PR, and legal infrastructure to work with an open-source community and open-source framework in the blockchain sphere. Hyperledger fabric, the open source blockchain framework, is developed by the Hyperledger community.

Clients

Hyperledger does not have "clients" but "members", ranging all the way from big names like Deloitte, IBM, Accenture, Intel, Cisco, Oracle, ... all the way to smaller players and startups.

Revenue model

Hyperledger members pay an annual fee based on the size of the enterprise in terms of its number of employees.

Most notable points made during the interview

Hyperledger is a non-profit organization. Thus, it does not see itself as competitive towards other market participants. As Hyperledger has more than 200 members, they have good insight into how the market for blockchain is developing. Specifically, they mention that blockchain should be understood as a technology rather than a solution. Many firms expect blockchain to solve their problems, yet blockchain should rather be used as a technology that supports a company's overall solution.

Case#2: Machine learning, business model centered

Value proposition

Case #2 creates machine learning applications for what they call "personal development" in the areas of work and education. These applications can be run and trained on a device as to mitigate any privacy concerns.

Clients

Case #2 strives to become a B2C business. Currently they are still working B2B.

Revenue Model

Case #2 is still working on devising a revenue model for their eventual B2C based value proposition. Until now they have still been running B2B pilots to get revenue.

Most notable points made during the interview

Firstly, it was stated that they started with the business-model in mind but then found existing machine-learning stacks to be insufficient to cover their value proposition. Thus, they began developing their own. This is something we have seen as a distinctive feature for business model centered startups and has come up during several interviews. Interestingly, Case #2 seems to develop their own technology stack to quite an extensive degree, which moves them closer to a technology centered startup (see Figure 5). This can also be seen in the fact they themselves are struggling to decide whether they are a business model centered or technology centered startup, though in our framework they would rather qualify as the former, as they see themselves competing on the use-case rather than the technology. Case #2 is currently challenged with finding a suitable B2C business model and has so far only generated B2B revenue through individual and application-specific projects. Such an **interim business model** is typical for business model centered startups (see Finding 1.2), as their envisioned use-case might not yet be completely clear, technologically feasible, nor economically viable. Furthermore, Case #2 sees time-to-market as a crucial strategy. This makes sense especially as they are planning on creating a competitive advantage through **network effects** (e.g. the more people use their applications, the more data is generated thus the algorithms are better trained). Network effects have been something we encountered in several interviews (see Finding 1.5).

Case#3: DLT, business model centered

Value proposition

Case #3 is creating a blockchain-based reward scheme (Case #3 Token) as a means to incentivize individuals within the transportation ecosystem to exhibit certain behavior, such as transmitting valuable data to companies, partly switching to public transport, etc.

Clients

Case #3 is currently working with around 75% of the tier 1 automotive manufacturers with whom they are running pilot projects to test use-cases. Nevertheless, they see their client base as all companies that provide means of transportation.

Revenue model

Case #3 plans to gain revenue through a small transaction fee for the use of their network (i.e. exchange of Case #3 tokens). The economics behind such a revenue model are still complex and they are currently working with KPMG to better understand them.

Most notable points made during the interview

Case #3 has defined a rather broad use-case (industry specific incentivization), which makes sense given that uncertainty regarding specific use-cases is high for underdeveloped general-purpose technologies (see Figure 4). Specific use-cases are now developed together with corporations, which has also been typical for business model centered startups. Case #3 needs to adapt existing blockchain technology for their use-case, as scalability issues (i.e. number of transactions per second on the network) are still one of the main limiting factors for this technology. Case #3 also mentioned that corporations often do not understand blockchain technology and yet are still hyped to use it (see Finding 3.1) – something that is also reflected in their sales pipeline which makes it easy to get work started with new partners (see Finding 1.1). Having a first-mover advantage in this area is very important to them – this makes sense, as network effects is a primary candidate of competitive advantage for such a token network (see Finding 1.5).

Case#4: DLT, technology centered

Value Proposition

Case #4 is creating an open-source scalable DLT database. This means that Case #4 can process vastly more transactions per second as, for example, the Bitcoin blockchain or Ethereum.

Clients

Case #4 works with governments, large enterprises, startups as well as dApp (decentralized application) developers. Yet they are not quite sure which industry verticals to focus on for the future (i.e. where Case #4 would create the most value).

Revenue model

Case #4 is open-source. They are currently mostly generating revenue through consulting services.

Most notable points made during the interview

Case #4 is solving a purely technical problem (i.e. scalability of DLT technology) without any or minimal assumptions about the use-case (see Finding 1.7). Therefore, we clearly see them as technology centered. Nevertheless, Case #4 is making some effort to find the industry verticals in which their software would generate the highest value. Similarly, they are also still looking for a good revenue model, which is currently mostly based on consulting services. Both of these tasks are challenging because the environment changes so fast, and successful use-cases are not yet evident. This also leads to them finding it hard to assess their competition (see Finding 3.2). Because the technology is hyped, and the founders are well connected, Case #4 has so far had no problems finding clients – although, as they state, many of them do not understand the technology well.

Case#5: DLT, business model centered

Value proposition

Case #5 uses blockchain technology together with sensor-based information in order to let people know about the history of the food and medicine they are consuming, in a way that it cannot be changed by any participant along the supply-chain.

Clients

Currently Case #5 is running B2B pilot projects with clients in food manufacturing, pharmaceuticals, and retail.

Revenue model

Case #5 is planning to generate revenue through the usage if its network. Currently they are generating revenue through pilot projects.

Most notable points made during the interview

Case #5 specializes on tracking product information across the supply-chain but focusses on different industries. They are quite active, compared to other business model centered startups, in technological development. This is due to the fact that DLT not only has a scalability issue, but also is not built for taking data from physical sensors. They are currently running paid pilot projects with large corporates to better understand potential use-cases and generate revenue. Both of these purposes, finding use-cases and creating revenue with an interim business model, are typical for business model centered startups. Case #5 puts much emphasis on the fact that they are not a purely technical team, but also have much expertise in the areas of supply-chain, which helps them anticipate use-cases and technological requirements. They plan to have network effects as a long-term competitive advantage inherent in their business model. Furthermore, they mention that it is quite easy to get into first talks with clients but finding actual use-cases and large-scale implementations is harder. They specifically tend to sell to the more technical teams of the client, as convincing the more business-oriented roles of the value of blockchain can be very difficult, as it is still hard to substantiate claims with numbers.

Case #6: Machine learning, business model centered

Value proposition

Case #6 is building a machine-learning based medical imaging viewer which is currently focusing on automating mammography diagnostics.

Clients

Current clients are radiology firms.

Revenue model

Case #6 is planning to use a pay-per-read model, meaning that clients pay for every diagnosis which is done by the algorithm. Normally, licensing models are used in the healthcare industry.

Most notable points made during the interview

Case #6 is very use-case specific. In their view, the use-case is technologically feasible and economically viable, thus we do not see the usual broader definition of use-cases. Interestingly, they see the field of medical imaging with AI/ML as more business challenge than a technological challenge, as most barriers come from regulation, competition, and a potential unwillingness of the medical community to adapt to such a radical technology. They put much emphasis on a fast go-to-market strategy – which makes sense, as such an AI-driven medical viewer profits from new data coming from clients (i.e. for training the algorithms) and thus exhibits network effects.

Case#7: Machine learning, technology centered

Value proposition

Case #7 provides a machine learning toolbox for corporates to build machine learning models based on their own data. They want to provide a "cognitive engine" but are still working out the scope of what that will eventually entail.

Clients

They are currently working with many larger clients with different levels of technological capabilities. They are still in the process of defining who their eventual target customers should be.

Revenue model

Currently they are creating revenue through consulting-oriented pilot projects. The eventual revenue model, as soon as their cognitive engine is used as a standalone product, is still to be discussed.

Most notable points made during the interview

Case #7 are not quite sure whether they see themselves as business model centered or technology centered. As they have no or minimal assumptions about the use-case as well as a vast ground-up technological development, they qualify as technology centered within our framework.

As they are working on a product which is still in the future in terms of technological feasibility, their current envisioned cognitive engine is not yet a finished product. As such, they still have to adapt it for each specific project. These (consulting) projects are their current interim business model, as they sustain the company until the eventual value proposition is feasible. Also, they use these projects to understand the eventual product specifications better.

4.3.3 Data structure & overview

As discussed in Chapter 4.3.1 "Methodology", we used our interviewee-oriented 1st-order concepts (quotes from the interview) to derive our analysis-oriented 2nd-order themes (findings). Ultimately, we derived **14 findings** from **290 1st-order concepts**. The findings are separated into the three aggregate dimensions of **business model**, **technology,** and **environment**, which correspond to our RSQ #3-5. Furthermore, each of the findings within these aggregate dimensions is split into "common" findings, which can be observed in both approaches, "BMC" which can be observed for the business model centered approach, and "TC", which can be observed in the technology centered approach. After the initial overview of findings, we will briefly discuss them in detail. Also, an exemplary data structure will be provided so that the reader can see how we derived them. The entire data structure is available in the appendix of this thesis. We recommend going into it and reading all the respective 1st-order concepts to better understand the findings. Together with the short profile of the company and the detailed explanation of the finding, this will help to provide a clearer picture.

Aggregate Dimension: Business Model Design
2nd Order Themes
1.1 Common - Hype leads firms to easily get a "foot in the door" (cooperations, pilot projects). Nevertheless, value propositions are harder to find.
1.2 Common - Often an "interim business model" is used to sustain the company until the envisioned value proposition can be monetized.
1.3 BMC - Often use-cases are defined broadly in an area, because exact use-cases are still to be figured out. Companies are open to pivot within a use-case range.
1.4 BMC - A fast time-to-market along with eventual network effects are a frequent competitive strategy.
1.5 BMC - BMC startups often use industry experts for their specific value proposition.
1.6 TC - They are mostly agnostic about the use-cases, partly because they often don't believe successful use-cases are clear.
1.7 TC - TC startups are more explorative when it comes to monetizing their value proposition compared to BMC startups.
1.8 TC - Usually they have little to no business development personnel.
Aggregate Dimension: Technology
2nd Order Themes
2.1 Common - Showing clear value of the technology to corporate clients is often difficult, because no prior use-cases exist.
2.2 BMC - Figuring out how to link the technology with the use-case is done in cooperation with corporations.
2.3 BMC - Even though business model centered development approaches focus on a use-case, they also focus on using or adapting inadequate existing technology.
Aggregate Dimension: Environment
2nd Order Themes
3.1 Common - Clients tend to not understand the technology well but are hyped to use them.
3.2 Common - It is hard to assess the competitors or their capabilities, as everything moves so fast. Often claims of their capabilities are strongly overstated.
3.3 Common - Hype cycles may affect how companies should build their business-models, as partnerships and client-relationships are easy to build during high-hype stages.

Table 8: Overview of findings

Each of the findings will be discussed in detail. An exemplary **data structure** is shown for finding **1.1 Common - Hype leads firms to easily get a "foot in the door" (cooperation, pilot projects). Nevertheless, use-cases/value propositions are harder to find.**

2nd Order Themes	Connected 1st Order Concepts
Common – Hype leads firms to easily get a "foot in the door" (cooperations, pilot projects). Nevertheless, use-cases and actual value propositions are harder to find.	Case #5: "I think it's fairly easy to find a client, it's fairly easy to tell them something like "let's collaborate", "let's run this". What is more challenging to have large-scale implementation."
	Case #4: "Blockchain is a buzzword and we can see that from the traction we get, we have many companies that just come to us because they hear about blockchain because it's such a hype and they all want blockchain, without necessarily knowing what exactly it is."

	Case #4: "So today we are lucky enough to go for cold-calling or go reach for the clients. Our founders and managers of Case #4 are well connected in the blockchain sphere, so we constantly have customers and partners approaching us to work together."
	Case #4: "Then the challenge might be, as you said, finding the use-case, because in our business development team we don't have industry experts and sometimes we might find it difficult to find the specific use of blockchain for companies who want to use and implement blockchain technologies."
	Case #3: "In terms of our sales pipeline, business development, I don't think we, at the moment, are facing any challenges. It's actually fairly easy to get pilots up and running."
	Case #6: "Ich denke es ist easy mit denen zu [potentielle Kunden], oder zumindest Interesse zu wecken. Der Sprung zur eigentlichen Arbeit ist dann nicht so einfach, (...) ich würde schon sagen, es ist zum Großteil vom Hype getrieben."
	HypLed: Yes, it is easier to acquire members in the blockchain space, but that just comes from the fact that everyone is hyped about blockchain.
	Case #7: Overall, if I were to answer, the hype does not have positive implication for us because it open the doors for everyone
	Case #7: I mean, it is so frustrating, because the hype does two things. One, it creates a lot of noise within the corporate space, you know, all of a sudden, A, there is a lot of companies which promise to do things that are not feasible, and two, a lot of the corporate companies have a skewed perception of what is possible with the technology that is available today
	Case #9: "No, often it's the other way [they don't approach big corporates], Most of the things happen because somebody in that company approaches us because they have heard about something that we have done. They don't necessarily know what they want to do with us, but they say, "Hey, can you guys do something?"

Table 9: Sample data structure

As we can see, we have 10 connected 1st-order concepts for this 2nd-order theme. Each of the connected 1st-order concepts adds a little bit to the picture and gives the theme (finding) more detail and credibility.

In the following, we will briefly describe and discuss each of the findings.

4.3.4 Findings RSQ#3 "Which challenges do ventures face when it comes to designing their business model?"

1.1 Common - Hype leads firms to easily get a "foot in the door" (cooperation, pilot projects). Nevertheless, value propositions are harder to find.

This has been a common thread throughout the interviews. **Hype** is one of the three major characteristics startups face in underdeveloped general-purpose technologies, as defined within our framework (see Figure 4). It seems that the hype around these novel technologies does make it easier for companies to connect to potential corporate clients, yet this might not always be positive.

"Overall, if I were to answer the hype does not have positive implication for us because it opens the doors for everyone."
– Case #7

Because of **technological immaturity** and the lack of prior examples, actual value propositions or use-cases for clients are often hard to find. The fact that clients often do not even understand the technology (see Finding 1.2) does not help and might exacerbate the problem. In regard to the classical model of a hype cycle (e.g. Gartner Hype Cycle), a novel research question might be to analyze whether this affects how companies should (chronologically) build their business models (see finding 3.3) – creating valuable partnerships/clients-relationships during a period of "Inflated Expectations" might be more easily done and help firms get through a "trough of disillusionment".

1.2 Common - Often an "interim business model" is used to sustain the company until the envisioned value proposition can be monetized.

Because the envisioned use-case/value proposition mostly cannot be monetized yet, as there is a lack of technological capability to generate that value proposition or a lack of market demand, companies work with "interim business models".

"The primary objective of them [the pilot projects] is just to secure revenue, you know to pay the bills and secondary objective is to understand the space ...help us define the product." – Case #7

Case #7, for example, wants to provide a general cognitive engine based on which companies can easily build their own machine-learning models. This is technically not yet feasible, and their cognitive engine, "Cognitio", is limited to a certain range of use-cases. Thus, Case #7 is currently working on paid pilot projects. As can be seen in the quote, this "interim business model" is not a waste of time, as it helps companies better understand and define their value proposition – though we did hear that this interim business model can take valuable resources from developing the actual value proposition.

1.3 BMC - Often use-cases are defined broadly in an area because exact use-cases are still to be figured out. Companies are open to pivot within a use-case range.

As a central characteristic of underdeveloped technologies with great disruptive potential, eventual use-cases are not yet clear. Business model centered startups will thus often define a rather general use-case or have an industry focus and start working on pilot projects to determine what is feasible and where market-demand might exist.

"We are also having conversations with Airlines, government, public organizations, parking companies, companies that provide bike sharing, ride hailing, ride sharing so to be honest all our clients are all the businesses that provide any means of transportation." – Case #3

Case #3 is building a blockchain-based incentivization scheme for the transportation sector. Because exact use-cases are still unclear, they are not focusing on one use-case specifically. Rather, they are working with big corporations to better understand product-market fits.

1.4 BMC - A fast time-to-market along with eventual network effects are a frequent competitive strategy.

As discussed in Chapter 2.3, building a non-replicable business model is central to ensuring long-term profitability. Classical examples such as economies of scale, patents, know-how or brand reputation are often irrelevant or unreliable isolating mechanisms when looking at IT-based technologies such as machine learning or DLT. However, network effects can be a very reliable isolating mechanism. As more people use the product, the product becomes better and better. If this is the company's goal, a fast time-to-market and fast scaling can be a necessary strategy.

"Yeah definitely, I mean with us that has been 100% the approach that we are following [first mover advantage through reputation & client base]." – Case #3

For Case #3 this approach makes sense. The more people use the Case #3 token within their ecosystem, the more valuable their service will become, as the token can be exchanged for a wide variety of things. Case #3 is not the only startup we interviewed who sees such an approach as beneficial, others are Case #5, Case #2, and Case #6.

1.5 BMC - BMC startups often use industry experts for their specific value proposition.

Unlike technology centered startups, business model centered startups often use industry experts to better understand possible viable use-cases. This makes sense, as they need to iterate between what is technologically feasible and what is economically viable. In technology centered firms we have seen the opposite; they usually do not employ industry experts and only have a small number of business-development staff (see finding 1.8).

"(...) the unique value proposition of our deep expertise in food & pharmaceuticals is another differentiating factor that the companies really like (…) you're not just "oh we are building some kind of blockchain, please find the use-case for it" – Case #5

Case #5 uses blockchain technology together with sensor-based information in order to let people know about the history of the food and medicine they are consuming, in a way that it cannot be changed by any participant along the supply-chain. They need to understand the specific problems and needs of specific supply-chains in order to successfully adapt existing DLT to serve its purpose.

1.6 TC - They are mostly agnostic about the use-cases, partly because they often do not believe successful use-cases are clear.

As stated before, technology centered startups do not, or only to a small degree, think about use-cases of the technology. They usually have a technological vision in mind and believe that use-cases will pair with the technology once it becomes more mature or market demand increases (Schmueck et al., 2018). Moreover, some startups seem to believe that thinking about a use-case is not only not their strategy but downright impossible, as the disruptive potential of the technology has yet to definitively show viable use-cases.

"Das geht nicht. Unser Ansatz ist-. Das geht nicht [to define use-cases]. Es ist viel zu jung. Wir haben noch viel zu wenig Verständnis, wo diese Sachen wirklich nützlich werden."
[Translation: "That's impossible. That is our approach. It is impossible [to define use-cases]. It's much too early. We just don't yet understand where these things will become valuable." – Case #8

Case #8, for example, explicitly states that there is still too much uncertainty regarding viable use-cases, and that companies which are working on use-cases right now are at a strategical disadvantage. But this latter finding does not seem to be the case for all of the technology centered startups we interviewed (see finding 1.7)

1.7 TC - TC startups are more explorative when it comes to monetizing their value proposition compared to BMC startups.

Business model centered startups seem to more clearly define their use-case and revenue model. This use-case might be defined more broadly, and subsequently they use and adapt whichever technological basis is necessary. Technology centered startups, on the other hand, seem to be more explorative when it comes to monetizing their technology. This does not necessarily just concern the revenue model itself but might mean that they use their own technology for building use-cases in the future.

"Wie, was wir sein werden, das ist noch nicht klar. Wir wissen noch nicht klar, ob wir wirklich auf den Core-Bereich fokussiert bleiben. Oder ob wir, und das überlegen wir gerade, einen Product-Arm aufbauen" – Case #8

[Translation: "We're not sure yet what exactly we will be. We don't know if we will remain focused on the core-technology or if we will, and that's what we are currently deliberating about, build a product-arm."] – Case #8

Case #8 shows this explorative attitude well. Specifically, the question is whether they should monetize their product, for example through licensing to corporates or business model centered startups, or if they themselves should later get into a use-case. The latter strategy is what Schmueck et al. (2018) sees as the classic strategy for technology centered startups, as they would be the first who could match their technology with a profitable use-case. The question remains open which approach companies eventually choose.

1.8 TC - Usually they have little to no business development personnel.

Technology centered startups are usually solely focused on developing the underlying technology, and thus employ only a relatively small group of business development personnel.

"(...) for example for the Case #4 software division 90% of us are developers, for the business development team we are only 2. (…) So you can see how technological driven we are." – Case #4

The two business-developers at Case #4 are, among other things, concerned with finding a suitable revenue model, understanding in which industry vertical they could most add value and figuring out the competition.

4.3.5 Findings RSQ#4 "Which challenges do ventures face when it comes to the technology?"

2.1 Common - Showing clear value of the technology to corporate clients is often difficult because no prior use-cases exist.

As discussed in Finding 1.1, it might not be too hard to get into contact with corporate clients. Yet we have seen that proving clear value to those clients can be hard, as there are no numbers to substantiate claims made. Furthermore, it seems that, especially the non-technological staff of companies, is hard to convince of the technologies' value. The hype might be enough to implement pilot projects, but large-scale implementations still seem like a hard sell.

"(...) big companies always have a bunch of geeks who love playing around with cool technology and so on, but those guys will never be able to convince their CEO for example of the need to install the system in the company, because for that they need to demonstrate clear value (...)" - Case #5

2.2 BMC - Figuring out how to link the technology with the use-case is done in cooperation with corporates.

We have seen that business model centered startups combine a use-case with an existing technology stack, and then adapt the technology to fit the specified purpose. Both the use-case and "how" are mostly developed through pilot projects with larger corporate partners.

"Pretty much around 75% of the tier 1 car companies are currently our clients, if we can call them clients, because at the moment were on pilot stage with all of these businesses meaning that we are working on potential use-cases that we are exploring and seeing whether we could actually achieve the results that we are seeking to start with." – Case #3

For Case #3 this means that not only do they need to figure out which use-cases could be viable, which is also done with corporate partners, but if they can serve those use-cases with the current technological level, and if not, which technological adaptions can be made.

2.3 BMC - Even though business model centered development approaches focus on a use-case, they are also focused on using or adapting inadequate existing technology.

Whereas technology centered startups can virtually allow themselves to have no business-development functions, business model centered startups still need a strong technical background. In fact, the majority of their staff might still be technological. As has been evident throughout the interviews, business model centered startups start by asking "Where can we use this technology?" rather than "Which technology could solve this problem?". Thus, they mostly start out with a technical background.

"Because we are also building our own blockchain and we are basically designing the architecture, I wouldn't say from scratch necessarily but there are quite a few fundamental changes we are making, so we want to make sure the final design fits the purpose." – Case #5

Because these startups, such as Case #5, are the first to the game, the technology mostly does not fit the use-case satisfactorily. Thus, adaptions or work-arounds have to be made to solve the use-case with certain limitations. As the technology progresses and becomes better, the use-case can be solved as intended.

4.3.6 Findings RSQ#5 "Which challenges do ventures face when it comes to the business environment?"

3.1 Common - Clients tend to not understand the technology well but are hyped to use them.

Going back to our "Emerging-Technology Triangle" (see Figure 4) we can see that all three defining characteristics (hype, high (expected) disruptive potential and technological immaturity) together lead to ***"unspecified market demand"***. Our interviews show that this seems often to be the case. Due to the extreme hype around some of these technologies, corporates try to jump onto the bandwagon. The problem arises when, and this is often the case, they do not really understand the technology. Therefore, it is hard for them to find actual use-cases, see value in certain proposed implementations or even discern hype from reality when working with startups.

"Well, I definitely believe the market demand is there, and unfortunately as soon as businesses hear blockchain they go "Yeah, I want to do something with blockchain" because it is cool and trendy and hyped, and they want to use it nowadays, but it's not a great approach because they don't know what they are getting into really when it comes to the way the tech works." - Case #3

3.2 Common - It is hard to assess the competitors or their capabilities, as everything moves so fast. Often claims of their capabilities are strongly overstated.

One thing that seems to echo across all the interviews is that it is very hard to define or understand your competitors. Because the technology is so new, most of the time there are no established players. Furthermore, startups often oversell their capabilities or pivot frequently.

"So, from that perspective it's a pretty tricky competitive landscape, just in terms of capturing and processing all that information takes a lot of time and effort and secondly, of course, because many other companies in the blockchain space are also working in a hyper fast environment, information can change even on a weekly basis, but definitely on a monthly basis." - Case #5

3.3 Common - Hype cycles may affect how companies should build their business-models, as partnerships and client-relationships are easy to build during high-hype stages.

Gartner's famous "Hype Cycle Theory" states that emerging technologies go through cycles of hype and disillusionment (Panetta, 2017). As we have seen, hype is definitely a contributing factor for companies to get a foot in the door with potential clients and partners (see Finding 1.1). What we have also noticed during the interviews is the notion that this hype might not last forever.

"(…) du brauchst auch eine gute Finanzierungsstrategie, viel Geduld und einfach einen starken go-to market um eben das Risiko eines potentiellen Tals der Tränen sozusagen zu umgehen." – Case #6

[Translation: " (…) you also need a good financing strategy, lots of patience and a strong go-to market strategy to minimize the risk of a trough of disillusionment."] – Case #6

What does this mean for companies? Should they use the hype for building relationships early? What does this mean for their financing strategy? Hype cycles are a distinctive feature of such novel technologies, and it remains an open research question to better understand how startups can best use this.

4.4 Conclusion & Limitation

It should be noted that it is very hard to find definitive answers to the proposed research questions, given their lack of research in academia, absence of comprehensive frameworks and the scope of this thesis. Therefore, the findings of RSQ#3-5, as well as the other findings, should be understood as a starting point for further research, and not a definitive answer to a very broad question.

However, there were clear common themes among the interviews which we believe to be quite robust and should guide further research. Notably, ventures in these underdeveloped GPTs seem to have an easy time finding new potential clients – clients tend to be very hyped about these technologies, but often don't know how to use them. Getting the intended value proposition to work in a technological and economically viable way is very hard for startups of both business development approaches, as they are still working with often very underdeveloped technology. Although both approaches obviously have a value proposition, they differ in how they define it. Business model centered startups assume a broad use-case and often run pilot projects with corporates to narrow it down. Technology centered startups do not assume a use-case and work to improve certain metric of the underlying technology, often being very explorative in terms of how to monetize the technology down the line. Yet both approaches use "Interim Business Models" in order to keep the company financially viable until their intended value proposition becomes profitable.

Major limitations to the findings described in this chapter should be seen as the following.
First, we only interviewed seven startups. Therefore, the reader should question how representative this is for the more general GPT ecosystem. Furthermore, prior bias cannot be discarded as a potential limitation. The interpretation of the 1st-order quotes, which ultimately lead to the findings we have presented, is necessarily subjective. Although we tried to minimize such subjective bias and adhered strongly to the method set out by Gioia et al. (2013), interpretation will always play a significant role in an inductive case study design. We therefore recommend to the reader to go into the Appendix and read the 1st-order concepts for each of the findings. This helps put more context into our findings and will enable the reader to see how we interpreted the raw data.

5. SUMMARY & CONCLUSION

Our primary research question, and goal of this thesis, is to shed light onto the question:

"Which challenges do new ventures face when building a competitive business model in the context of underdeveloped general-purpose technologies?"

We answer this question by defining five research sub-questions (RSQ). In **RSQ #1** ***"Which emerging potential general-purpose technologies can we currently identify?"*** we utilize the GPT model set out by Lipsey et al. (2005) to quantifiably measure the *ex-ante* potential of current technologies to become a GPT. We find that artificial intelligence specifically, but also distributed ledger technologies seems to score highly on all dimensions set out in the framework. General classification frameworks have been discussed in academia, but to our knowledge this thesis is the first study to utilize these frameworks in a quantified manner.

RSQ #2 is ***"Which general approaches to creating a competitive business model can we identify?".*** In this chapter we base our findings on seven interviews, conducted with startups in the area of machine learning/AI and DLT. We find that, in line with research by Schmueck et al. (2018), general approaches can be split into a business model centered and a technology centered development approach. Furthermore, we propose the Emerging Technology Triangle (see Figure 4) to better understand why these approaches exist, and a Business Model Development Matrix (Figure 5) to classify startups into these two approaches. Schmueck et al. (2018) were the first to identify these two approaches and this thesis adds more clarity into their characteristics. Both the Emerging Technology Triangle and the Business Development Matrix are novel and add important insight.

RSQ #3-5 focus on the business-model development challenges these startups face, specifically in terms of designing the business model, the technology, and the environment.

For **RSQ #3** ***"Which challenges do ventures face when it comes to designing their business model?"*** we establish eight distinctive findings (see Table 8).

Most importantly, we find that for both types of approaches, i.e. business model centered and technology centered, it is very easy to get a foot in the door with potential clients. Yet the challenge seems to be to find a working value proposition (Finding 1.1). This fits the narrative of firms positioning themselves very early and is a key feature of underdeveloped GPTs. This seems to be a reason why we see these two distinct business model development approaches, as the intended value proposition can often not yet be monetized, either because it is technically not feasible, or market demand is lacking. Companies of both approaches use "Interim Business Models" to sustain their company until the technology matures far enough or market demand increases sufficiently (Finding

1.2). We notice that business model centered firms tend to define their use-case quite broadly (Finding 1.3), whereas technology centered firms seem to mostly be agnostic about the use-case, as they often believe it too early to tell (Finding 1.6). We find that technology centered firms tend to be more explorative when it comes to monetizing their value proposition (Finding 1.7), as licensing of the technology or building their own service, based on that technology, are both viable options. Business model centered firms tend to be clearer in this regard as they use any technology available and adapt it to fit their use-case. We also noticed that time-to-market seems to be important for many business model centered startups, as network effects seem to be a standard competitive advantage they strive for (Finding 1.4).

For **RSQ #4** ***"Which challenges do ventures face when it comes to the technology?"*** we have three distinct findings. First, it seems to be hard for startups of both development approaches to show clear value to potential clients, as no prior case-studies exist, and economical claims are hard to substantiate with numbers (Finding 2.1). Furthermore, business model centered startups tend to link technology with use-cases through pilot projects with corporates (Finding 2.2). This way they narrow down their initial broad assumption of a viable use-cases. Because the technology is still immature, and is being developed by technology centered startups, business model centered startups often have to adapt it to fit the intended use-case (Finding 2.3). It is for this reason that they need strong technical and business development teams, whereas technology centered startups often exclusively focus on the former (Finding 1.8).

For **RSQ #5** ***"Which challenges do ventures face when it comes to the business environment?"*** we also establish three distinct findings. First, clients often do not understand the technology but are hyped to use them (Finding 3.1). Interviews show that this can be both a blessing and a curse, as customer acquisition is often easier, but at the same time clients often cannot distinguish between ventures with real expertise and those with false claims. Moreover, providing actual value can become very difficult if the client does not sufficiently understand the scope and limitations of the technology. It also seems hard for ventures to assess the competitive landscape (Finding 3.2). Hype cycles may affect how ventures should plan to build relationships with potential clients and partners, as many ventures acknowledge that the hype may easily turn into disillusionment (Finding 3.3).

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Further research needs to be done. Specifically, empirically derived results are lacking in the area of business model development in general (Wirtz et al., 2016). Furthermore, as it pertains to the intersection between underdeveloped general-purpose technologies and business development, not much has been written or empirically studied. As such, research conducted by Schmueck et al. (2018) and this thesis lay some empirical ground work based on which further research should be conducted, especially as it relates to the two aforementioned approaches. The slope of technological advancement is ever increasing, and startups are forced to jump into the game earlier and earlier. As such, we need to establish frameworks for how companies can thrive in environment of both high technological risk and business risk. Many existing frameworks, such as the “Lean Startup”, focus on environments characterized predominantly by the latter (Ries, 2011). We see that hype, technological immaturity and high potential for disruption create a unique business environment around underdeveloped general-purpose technologies.

We believe that the results of this thesis are promising. We encourage our readers to delve into the Appendix and read the 1st-order concept based on which we derive our findings. These 1sts-order concepts are not subject to personal interpretation and also help put our findings into more context.

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