HALMSTAD UNIVERSITY

Master's Programme in Industrial Management and Innovation, 60 credits

MASTER THESIS

Commercializing Additive Manufacturing Technologies

A Business Model Innovation approach to shift from Traditional to Additive Manufacturing

Jonathan Hartmann & Matthias Lebherz

Master Thesis, 15 credits

Halmstad 2017-09-20

Acknowledgements

In the last part studying the Master of Science in Industrial Management and Innovation, we had the opportunity to investigate a very interesting topic. Through the study of Business Model Innovation for the shift from traditional to Additive Manufacturing, we could not only acquire new knowledge but also improve our ability to conduct a structured way of working. We hope that our thesis will be a handbook for businesses and people who are interested in the role of Business Model Innovation for the successful implementation of AM.

First of all, we want to say a big thank-you to our supervisors Mike Danilovic and Deycy Sanchez for their instructive feedback, competent support, and good-humoured meetings.

Moreover, we would like to thank HGF and Tylö for their willingness to participate in our study and the time they took to provide us profound information in the interviews.

In addition, we want to thank our opponents, fellow students, friends, and families for any kind of support during our studies.

Halmstad, September 2017

Jonathan Hartmann

Matthias Lebherz

Abstract

Additive Manufacturing is a fast-developing technology that is considered to be a game changer in the manufacturing industry. However, a technological innovation itself has no single objective value for a company. Indeed, it is widely acknowledged that the key aspect of a successful commercialization of a technological innovation is the linkage of the technology and the business model. Based on a qualitative study, which presents how companies have to develop their business model to commercialize AM, we conducted interviews with two Swedish small and medium-sized enterprises, which plan to invest in Additive Manufacturing. These two companies are HGF, a manufacturer of thermoplastic elastomers and rubber products, and Tylö, a manufacturer of heaters, steam generators, saunas, steam showers, and infrared saunas. In our analysis, we decided to analyse the cases successively, according to the nine building blocks of the Business Model Canvas. Firstly, we conducted a within-case analysis to analyse each case isolated from each other, and secondly a cross-case analysis to find possible nexuses, relations or, contrasts. The chapter conclusion provides an overall discussion of the most important findings emerging from the analysis with regard to the required changes within the current business model to capture value from the technology. We could find some disparities for two building blocks (channels and revenue streams). Thus, this implies that there is no universal approach to develop the business model to introduce Additive Manufacturing. Nevertheless, most of the required adjustments show accordance. While three building blocks turned out to remain largely the same (key partnerships, cost structure, and customer segments), four building blocks require important changes (key activities, key resources, value propositions, and customer relationships. The most important implications for those building blocks are presented in the following table:

Key activities	• Upgrade product development
Key resources	• Establish additional production facilities (3D-printers, etc.) • Gather new knowledge about AM
Value propositions	• Offer customized products
Customer relationships	• Closer relationship with the (end) customer • Enhance customer co-creation

Key Words: Business Model, Business Model Innovation, Additive Manufacturing

I Table of contents

Acknowledgements I

Abstract II

I Table of contents III

II List of Figures VI

III List of Tables VII

IV List of Abbreviations VIII

1 Introduction 1

1.1 Background 1

1.2 Problem Discussion 6

1.3 Purpose of the study 9

1.4 Thesis Layout 9

2 Framework of references 10

2.1 Manufacturing techniques 10

2.1.1 Traditional manufacturing 10

2.1.2 Additive Manufacturing 11

2.1.3 Additive Manufacturing as disruptive technology 15

2.2 Business Model 16

2.2.1 Business Model approaches 16

2.2.2 Business Model Concept 19

2.3 Business Model Innovation 25

2.3.1 Business Model Innovation Framework 29
3 Methodology 36
3.1 Research Approach 37
3.2 Research Strategy 38
3.2.1 Case selection 39
3.3 Research Methods 39
3.4 Data collection 40
3.4.1 Primary data 40
3.4.2 Secondary data 42
3.4.3 Obstacles in the data collection 42
3.5 Data analysis 42
3.6 Trustworthiness 44
3.6.1 Credibility 44
3.6.2 Transferability 45
3.6.3 Dependability 45
3.6.4 Confirmability 45
3.7 Research Ethics 46
4 Empirical Data 47
4.1 Introduction of the companies 47
4.1.1 HGF 47
4.1.2 Tylö 48

4.1.3 Review of our two case companies 49
4.2 Contemporary Business Model at case companies 50
4.2.1 HGF 50
4.2.2 Tylö 54
4.3 Changes in the Business Model 59
4.3.1 HGF 59
4.3.2 Tylö 62
5 Conclusion 81
5.1 Limitations and further research 84
References 85
Appendix 94

II List of Figures

Figure 1: Development of manufacturing value added of China and the EU .. 1

Figure 2: Manufacturing environment of the past and today 3

Figure 3: Market development of AM 4

Figure 4: Revenues and Net Income of Apple 8

Figure 5: Number of publications about AM from 1986 to 2017..... 11

Figure 6: Number of publications about BM from 1986 to 2017..... 20

Figure 7: Components of a business model 23

Figure 8: Components of a business model 24

Figure 9: Number of publications about BMI from 1998 to 2017 26

Figure 10: Different degrees of Business model change 28

Figure 11: Number of publications about BM, BMI & AM..... 30

Figure 12: Our Business Model Innovation Framework..... 31

Figure 13: Modified Model of 'The Research Onion' 36

Figure 14: Data Analysis procedure..... 44

III List of Tables

Table 1: Different AM technologies 13

Table 2: Definitions of business model 22

Table 3: Overview of the conducted interviews 41

Table 4: Findings Key Partnerships 68

Table 5: Findings Key Activites 69

Table 6: Findings Key Resources 70

Table 7: Findings Value Propositions 72

Table 8: Findings Customer Relationships 73

Table 9: Findings Channels 74

Table 10: Findings Customer Segments 76

Table 11: Findings Cost Structure 77

Table 12: Findings Revenue Streams 78

Table 13: Summary of Main Findings 79

Table 14: Most necessary changes to commercialize AM 82

IV List of Abbreviations

$	Dollar
%	Percent
€	Euro
3D	Three-dimensional
AM	Additive Manufacturing
B-to-B	Business to Business
B-to-C	Business to Consumer
BM	Business Model
BMI	Business Model Innovation
CAGR	Compound Annual Growth Rate
CEO	Chief Executive Officer
CFO	Chief Financial Officer
DDM	Direct Digital Manufacturing
DMRC	Direct Manufacturing Research Center
e.g.	exempli gratia
EU	European Union
FabLab	Fabrication Laboratory
HGF	Halmstads Gummifabrik
HPS	HGF Production System
R&D	Research and Development
RP	Rapid Prototyping
RT	Rapid Tooling
SME	Small and medium-sized enterprises

TPE	Thermoplastic elastomers
US	United States

1 Introduction

This chapter presents the current competitiveness and historical development of the western manufacturing industry. It furthermore describes the role of Additive Manufacturing within the industry and the challenge of commercializing new technologies, which leads us to the linkage between business model innovation and Additive Manufacturing.

1.1 Background

The competitiveness of manufacturing companies in developed countries is a major question when it comes to the future development of global competition. The shift of traditional mass production to developing countries led to the loss of manufacturing skills and capabilities in the western world. The emerging economies managed to benefit from the new know-how and increased their share of the world manufacturing output distinctly over the past decades (Jacques, 2012). The flagship of the economic rise of developing countries is China. The following line graph shows the development of manufacturing value added in US dollars of China and the European Union from 1991 to 2012.

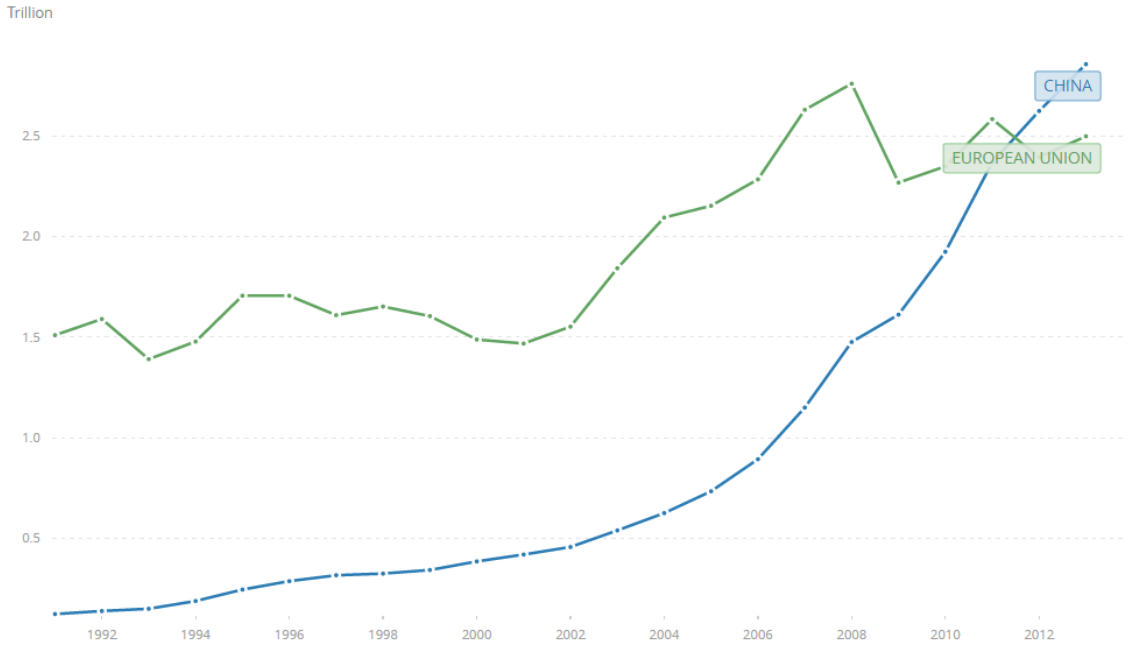

Figure 1: Development of manufacturing value added of China and the EU (Source: The World Bank, 2017)

It can be seen that China's manufacturing industry grew drastically in the last decades and overtook the manufacturing outcome of the European Union.

Today, China is the world's factory (Mees, 2016) and is expected to consolidate its position. In 2011, former US president Obama joined Silicon Valley's top luminaries and had the following question for Steve Jobs: "What would it take to make iPhones in the United States?". Job´s answer was unambiguous: "Those jobs aren´t coming back" (Duhigg & Bradsher, 2012). The reason why the outsourced manufacturing is non-reversible is not only cheap workforce but also flexibility, diligence, and industrial skills (Duhigg & Bradsher, 2012). Hence, the graph of the European value added in manufacturing indicates a volatile development, while the Chinese value added is constantly growing. As a consequence, the Chinese economy is said to be the biggest in the world with almost twice the size of the United States in 2050 (Jaques, 2012).

The western answer to this competitive situation and the reality that manufacturing is playing a steadily diminishing role in both employment and output (Uppenberg & Strauss, 2010) is a more innovative, customized and sustainable production (Mellor et al. 2014). Figure 2 shows the different phases of the historical development in manufacturing. Firstly, going from manual production with high product variety and low volume towards mass production, which peaked in the middle of the 20th century. After that, mass production got mainly outsourced and manufacturing shifted towards a more customized mass production with higher product variety and lower product volume per variant.

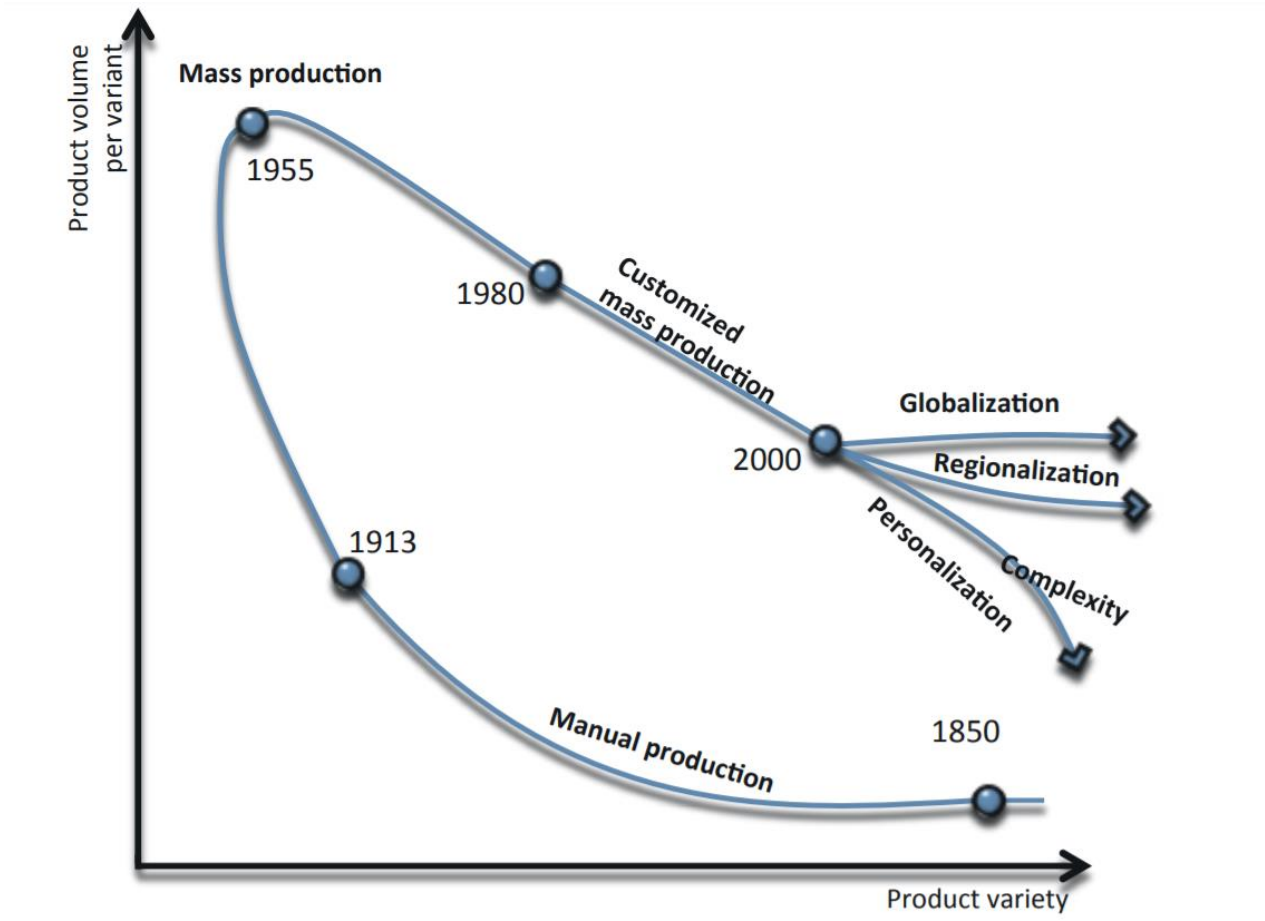

Figure 2: Manufacturing environment of the past and today (Source: IEC, 2015)

Today, in the next phase of development, manufacturing industries are undergoing rapid changes. Personalization, complexity, regionalization and also globalization are characterizing the manufacturing environment. The western strategy is to establish and integrate new enabling technologies for the manufacturing sector. These key enabling technologies should particularly strengthen the low volume competitiveness for a clean, highly performing, innovative, and socially sustainable factory of the future (European Commission, 2013). But the impact could get greater: Additive Manufacturing, one of those technologies, proved to have the potential for a mature series production technology, lately. It could change the logic of global competition and be a key technology for many companies.

AM, the process of joining materials to make products from three-dimensional (3D) model data, evolved quickly since the inception in the mid-1980s (Huang et al., 2013). When Charles Hull was developing the technology, his original purpose was the fast production of plastic prototypes (Hessman, 2013). Hull´s

technology, which is the basis of nowadays AM technologies, could create products in hours for which the traditional casting technique needed weeks (Kietzmann et al., 2015). In the meanwhile, after 30 years of development, AM already reached the stage of a disruptive technology (Berman, 2012; Rayna, T. & Striukova, L., 2016). In consequence of recent innovations, the main purpose of AM technologies is currently transforming from rapid prototyping to rapid manufacturing (Huang et al., 2013). Especially in industries with low volume and high complexity, such as the aerospace or dental industry, AM has become a mature series production technology (Roland Berger Ltd., 2016).

In 2015, the AM industry, which includes all AM products and services, expanded its compound annual growth rate (CAGR) by 25.9% to $5.165 billion. The CAGR of the three preceding year's accounts for 33.8% and the average CAGR of the AM industry for the last 27 years is 26.2% (Wohlers, 2016). The following figure is about different forecasts for the AM industry and shows that the ongoing development of the past seems to proceed.

RESEARCH FIRM	YEAR ($ Billions)						CAGR	CAGR Period
	2013	2014E	2015E	2017E	2018E	2020E		
AMR	$2.3					$8.6	20.6%	2013-2020
Canalys	$2.5	$3.8			$16.7		45.7%	2013-2018
CCS Insight	$1.2				$4.8		33.0%	2013-2018
Freedonia				$5.0				
Gartner			$1.6		$13.4		103.1%	2015-2018
IBISWorld *		$1.4					15.7%	2014-2019
IDC							29.0%	2012-2017
Wohler	$3.1				$12.8	$21.0	33.0%	2013-2018

* U.S. market only

Figure 3: Market development of AM (Source: Sophic Capital, 2015)

In figure 3 it can be seen that all different research firms predict diverging market developments, e.g. for 2018 Canalys predicts $16.7 billion and Gartner $13.4 billion. But out of all these diverging forecasts, you can draw one conclusion, which is that the market of AM will further grow in the future. Roland Berger Ltd. (2016) is stating a further growth in their study as well. They expect that the global AM market gets bigger significantly until 2020 with growth rates of up to 40% per year.

Within the original application area of rapid prototyping, process speed, costs, and process control have not been the focus of developer yet (Roland Berger Ltd., 2013). The transformation from rapid prototyping to rapid

manufacturing, however, affects more and more industries and thus will lead to further technology improvements throughout the whole AM value chain. In the study of Roland Berger Ltd. (2016), they forecast a further cost reduction of approximately 25-45% until 2020. According to a DMRC (Direct Manufacturing Research Center) survey of 75 AM experts, build speed will at least quadruple by 2018 (Roland Berger Ltd., 2013).

According to KPMG's Global Manufacturing Outlook (2016), 25% of companies, representing major industries[1], have already invested in AM technologies. In consequence of the assumed development, many firms will trail those companies and will also invest in the technology. In the survey, 31% of companies said that they definitely invest and 35% of companies announced that they possibly invest a significant amount in AM over the next 12 to 24 months (KPMG, 2016).

The two companies of our study, Tylö and HGF, can be assigned to the group of companies that possibly invest in the technology over the next 12 to 24 months. Tylö and HGF are small and medium-sized enterprises (around 130 employees each) located in Halmstad, Sweden. Until today, the company's haven´t worked with AM technologies in their production. Though, due to the recent development of AM technologies, both companies started to think about the possibility to integrate the technology in their production process. The CEOs stated that AM could help them not only as a prototyping technology but also as a manufacturing technology. The degree of integration mainly depends on the possibilities of the technology. Is the right material available? Is there a need of post-processing? Is the 3D-printer able to print an item within a given time? The possibilities of AM technologies, however, are enormous, as it is developing more and more towards a rapid manufacturing technology.

The potential of AM is recognized globally since countries like Brazil, India, China, and South Korea are also investing heavily in the development of the manufacturing sector (Mellor et al. 2014, Gates et al. 2016). China, for

[1] Aerospace & Defense, Automotive, Conglomerates, Medical Devices, Engineering and Industrial Products, and Metals

instance, is supporting the domestic AM industry development via several initiatives. When it comes to applying the technology to end-use production, Chinese and South Korean companies are even the most proactive of all (Müller, A. & Karevska S., 2016).

Hence, business opportunities related to AM are very competitive. The problem with new technologies is how to gain sustainable competitive advantage out of them. According to Wynett et al. (2002), the problem of product and technology innovation is that they often lead to relatively short-lived benefits, with the consequence to quick imitation and the loss of competitive advantage. Cliffe and McGrath (2011) are describing a similar issue, that due to the rapid technology imitation of competitor's, product and process innovation alone no longer offer the sustainable competitive advantage as it once did. Due to the worldwide adoption and development of AM, HGF and Tylö are aware of this problem.

Therefore, both companies know that the key to sustainable success is not the technology itself, but rather how they can integrate and commercialize AM through an appropriate business model.

1.2 Problem Discussion

"A mediocre technology pursued within a great business model may be more valuable that a great technology exploited via a mediocre business model" (Chesbrough, 2010, p.354).

This means that "technology by itself has no single objective value" (Chesbrough, 2010, p.354). It is widely acknowledged that the key aspect of capturing value and sustainable competitive advantage from technological innovations is the linkage of technology and the business model of a company (Baden-Fuller & Haefliger, 2013; Baden-Fuller & Morgan, 2010; Chesbrough & Rosenbloom, 2002; Chesbrough, 2010). A business model is "a conceptual tool that contains a set of elements and their relationship and allows expressing the business logic of a specific firm" (Osterwalder et al., 2005, p.10). The connection between the business model concept and technology is described by Baden-Fuller and Haefliger (2013) as a complex two-way linkage. First, business models can determine the way in which technology gets developed. Second, business model choice influences the way in which technology is monetized and if the relevant firm makes profit (Baden-Fuller & Haefliger, 2013). In our study, we are only focusing on the latter way of connection.

Business models, therefore, are also defined as a "heuristic logic that connects technical potential with the realization of economic value" (Chesbrough & Rosenbloom, 2002, p.529). The inherent value of a technology remains latent

until it is commercialized in some way. Thus, technology managers must expand their perspectives to find the right business model in order to capture value from it (Chesbrough & Rosenbloom, 2002). The choice of the business model determines the nature of complementarity between business model and technology and the way to monetization. Thus, a poor choice can lead to low profits, a good choice to superior profits (Baden-Fuller & Haefliger, 2013). What firms need to understand is that a business model has a cognitive and a mediating role in order to commercialize technology to capture economic value from technology investments (Chesbrough & Rosenbloom, 2002).

Following these statements, the development and investments in new technology must go hand in hand with the development of the business model. Many companies, however, seem to focus on the innovation of products and technology. Lindgren et al. (2010) state that we know much about innovation in general and particularly how to innovate products, but we know very little about business model innovation. Chesbrough (2010) also identified this imbalance: "While companies may have extensive investments and processes for exploring new ideas and technologies, they often have little if any ability to innovate the business models through which these inputs will pass." (Chesbrough, 2010, p.354).

Business model innovation is a process of designing either a modified or a new activity system (Amit and Zott, 2010) or "the search for new business logics of the firm and new ways to create and capture value for its stakeholder" (Casadesus-Masanell and Zhu, 2013, p.464). While the term of business model innovation was relatively unknown in the beginning of the 21st century, it started to get broad awareness in business and academia since a decade (Zott et al., 2011). One reason for that development are several success stories of companies, which conducted business model innovation, such as Apple (Markides, 2006). In October 2001, Apple introduced the iTunes/iPod business model and expanded their activities of innovation from a product level to a business model level. Figure 4 illustrates the change of revenues (left y-axis) and net income (right y-axis) of Apple after the introduction of the new business model.

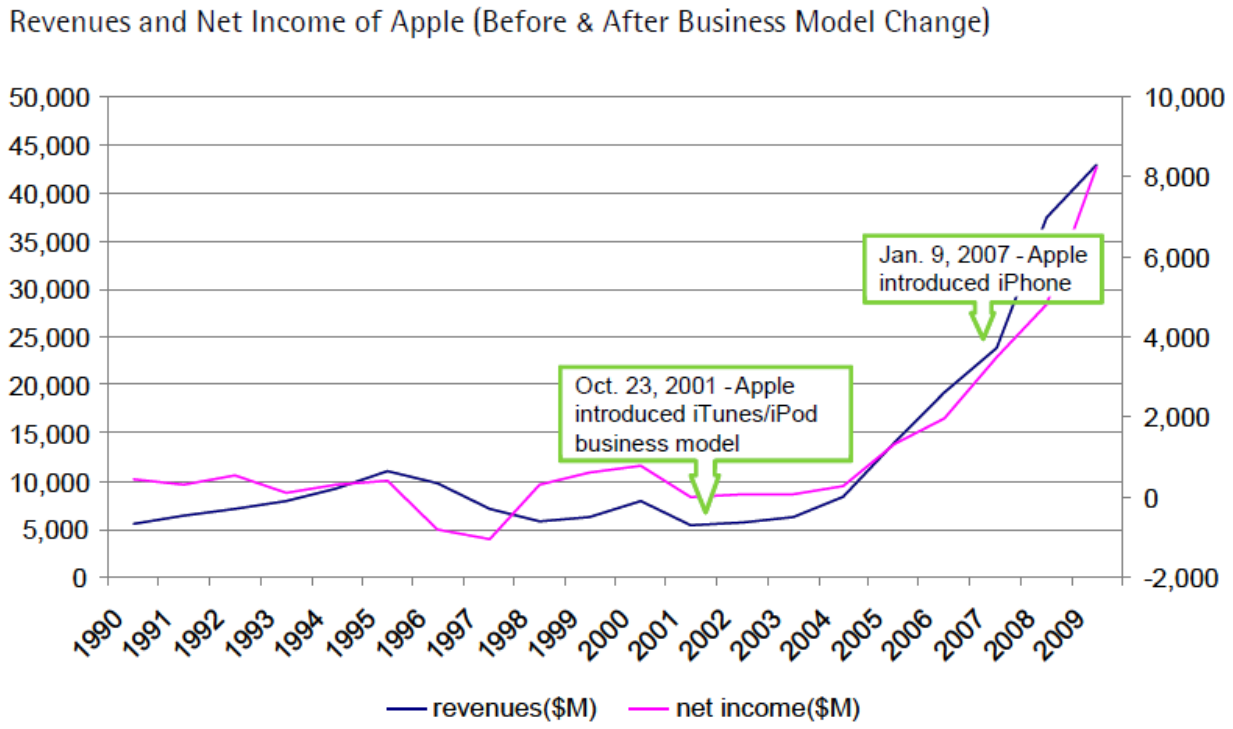

Figure 4: Revenues and Net Income of Apple (Source: Amit & Zott, 2010)

Another reason for the strong increase of business model innovation interest can be ascribed to the connection between technology and business model choice. This relationship is well-recognized but recently became more intense, dynamic and uncertain (Baden-Fuller & Haefliger, 2013). The reason for that are disruptive technologies, such as AM, which are leading to a specific type of technological change, following specific mechanisms and causing specific consequences (Danneels, 2004). Scholars, therefore, are talking about the need to take into account the influence of technology on business model innovation (Baden-Fuller & Haefliger, 2013). Chesbrough (2010) is stating that it will lead to different economic outcomes when you have the same technology taken to market through two different business models and that if there is a potential new technology, managers have to find an appropriate business model.

As a consequence, several studies address the need of business model changes in respect of AM (Afuah, 2014; Zott et al., 2011). Scholars claim that AM creates opportunities for business model innovation (Piller et al., 2015) and that business model innovation will play an important role for companies to implement AM (Rayana & Striukova, 2014). Khorram Niaki and Nonino (2017) state that technology managers must propose a new business model based on the technical characteristics of AM.

The literature field of AM management is still developing, which means that some aspects of the field have not been investigated or have been given limited attention so far (Khorram Niaki & Nonino, 2017). Although many scholars mention the need of business model innovation for the implementation of AM, we could not find any studies about this correlation.

1.3 Purpose of the study

Hence, the purpose of this study is to explore how companies have to develop their business model in order to commercialize AM.

With the help of our two case studies, we figure out how the companies should adjust the building blocks of their current business model to benefit economically from the implementation of AM.

1.4 Thesis Layout

Our thesis is structured into six chapters. The first chapter provides background information, describes the challenge of integrating a new technology, and presents the purpose of the study.

The second chapter gives a literature overview of traditional manufacturing and AM, the business model concept, and business model innovation. Furthermore, it presents the business model innovation framework of our study.

The subsequent section explains the methodology of our study, such as research strategy, research approach, and study design.

Our fourth chapter, which presents the empirical findings, contains three parts. Firstly, the introduction of the two companies. Secondly, the current business model of both companies according to the nine building blocks and the third part shows the required changes within the nine building blocks.

The empirical findings are followed by the analysis part, which sums up the findings of both cases and compares them in the form of a within-case and cross-case analysis.

The last chapter of our study is the conclusion, which presents the key findings and final implications of our study. Moreover, limitations connected to the study and suggestions for further research will be shown.

2 Framework of references

This section presents the literature overview of traditional and Additive Manufacturing, the disruptive character of AM, the business model concept, and business model innovation. Within the concept of business model innovation, we are focusing on its character of being a process "to capture value from that technology" (Chesbrough & Rosenbloom, 2002, p.530) in order to define potential adjustments for the current business model. The chapter gets completed with our business model innovation framework.

2.1 Manufacturing techniques

Since we are focusing on the shift from traditional manufacturing to Additive Manufacturing, this sector will present these two concepts more in detail and finally will elucidate the disruptive characteristics of AM.

2.1.1 Traditional manufacturing

Before the industrial revolution, products were fabricated by local craftsmen with the use of mainly local available materials. They also sold their products primarily to local customers (Petrick & Simpson, 2013). Furthermore, the term manufacturing comes from the French word for "made by hand". But this etymological origin doesn't fit anymore to today's modern way of manufacturing (Campbell et al., 2011).

Many innovations in production methods, mining methods and machine tools initialized a new age of traditional manufacturing, which is also called as the industrial revolution. The industrial revolution has enabled our world of today because it facilitated mass production and the replacement of labour with machines. Nonetheless, moulding, casting, forming and machining are complicated processes, which include tooling, machinery, computers, and robots (Campbell et al., 2011; Petrick & Simpson, 2013).

The process of most of the traditional manufacturing techniques is subtractive. A subtractive process is a process, where unwanted or gratuitous material is removed from a substance in order to get the desired product. For instance, a wooden lamp stand is created out of a wooden block with a lathe, which cuts the gratuitous wood to gain the desired shape. Other processes, which are subtractive are cutting, drilling, filling, turning, grinding or milling (Campbell et al., 2011; Kietzmann et al., 2015; Petrick & Simpson, 2013). But the traditional manufacturing techniques include also inherent limitations, which lead to the need for new approaches, such as AM (Campbell et al., 2011).

2.1.2 Additive Manufacturing

AM gained increasing attention from the industry and science in recent years. According to Guo & Leu (2013), considerable progress has been made in the development of AM and also in the applications of AM, such as automotive, aerospace, energy, biomedical and other fields, in the last years. The following figure underlines this statement as well. It shows the number of publications per year from 1987 until 2017. In 1987 there was only one paper published and in 2016 there were almost 700 papers about AM published. Currently, the Web of Science database contains more than 2000 papers in total (Web of Science AM, 2017).

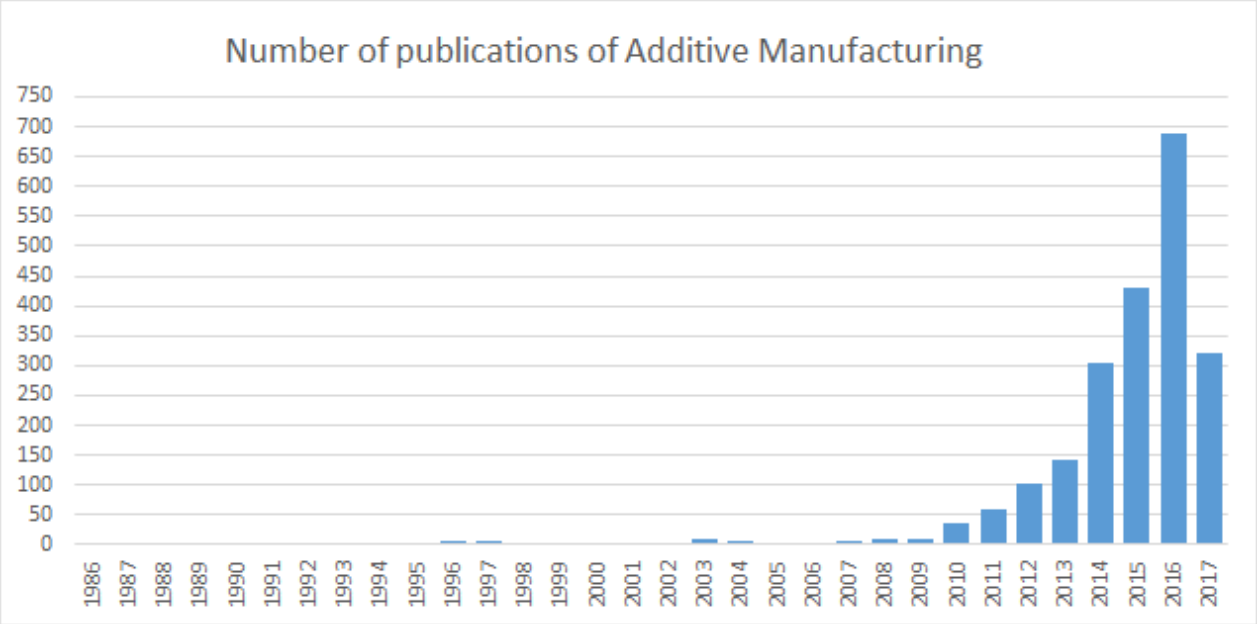

Figure 5: Number of publications about AM from 1986 to 2017 (Source: Web of Science AM, 2017)

AM is colloquially known as 3D printing and these two terms are used interchangeably in the literature (Petrick & Simpson, 2013). We are using in our thesis the term AM. AM technologies are an assemblage of manufacturing processes. These processes join materials to make physical 3D objects directly from virtual 3D computer models and produce parts layer-by-layer, in contrary to subtractive traditional manufacturing methods, which create 3D geometry by removing material in a sequential manner (Berman, 2012; Sandström, 2016; Connor et al., 2014). The materials, which can be used by AM to build objects, encompasses a variety of materials, such as plastic, metal, ceramics, glass, paper, and living cells. The form of these materials can be powder, filaments, liquids, or sheets (Manyika et al., 2013). Finally, after more than 20 years of confusing terminology, the ASTM International F42 Committee on

Additive Manufacturing Technologies defined Additive Manufacturing as the "process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies." (ASTM International, 2012).

The following table will show six different kinds of AM technologies, give a short description of them and also mentions the most common applications.

Technology	Description	Application
Selective laser sintering	A layer of powder is placed on the platform and then a laser portrays the first layer of the object into the powder. As a consequence, the power melts in the right shape together. This is repeated until the desired product is finished.	Prototypes, Manufacturing
Direct metal laser sintering	It works similar as the SLS but it just uses melted metal powder.	Rapid tooling, medical implants and aerospace parts
Fused deposition modelling	A heated nozzle exhales a filament of plastic resin, wax or another material layer-by-layer in the shape of the desired product.	Prototyping, low-volume manufacturing
Stereolithography	A laser portrays on the surface of a pool of photopolymer the first layer. After that, the build platform moves down and the next layer will be portrayed until the object is done.	Rapid prototyping, complicated shapes
Laminated Object Manufacturing	On the build platform, a sheet of material (paper, plastic, metal) is attached and the next layer sticks underneath to it because of a heated roller. A laser cuts the contour of the object layer-by-layer into the sheets.	Form/fit testing, rapid tooling patterns, less detailed parts
Inkjet-bioprinting	A nozzle places one tiny dot of ink at a time to generate	Health sector

	shapes. The object is created by spraying a mixture out of scaffolding material and living cells	

Table 1: Different AM technologies (Source: Manyika et al., 2013).

The evolution of AM can be divided into three stages. The first one started at the beginning of the 1980s, where AM was developed by Charles Hull. Charles Hull´s original purpose for the development of AM was the fast production of plastic prototypes (Hessman, 2013). Hull´s technology, which is the basis of nowadays AM technologies, could create products in hours for which the traditional manufacturing technique needed weeks (Kietzmann et al., 2015). As a consequence, AM started to find broad use for rapid prototyping (RP) (Gardan, 2016; Roland Berger Ltd., 2013). RP made it possible to create parts representative of mass produced parts in a faster and easier way (Bernard and Fischer, 2002). During the time the AM technology improved and found also new applications. The second stage begins in the second half of the 1990s. Traditional manufacturing processes need tools and moulds to manufacture products and these are very expensive and need a long time to be produced. AM facilitates to create these moulds in a fraction of the time and costs. This process is called rapid tooling (RT) (Hiemenz, 2013; Zonder and Sella, 2013). After further improvements of the technology, the third stage began in the late 2000s. It became possible and economical in some cases to produce end products with AM, which is called direct digital manufacturing (DDM) (Rayna & Striukova, 2016). As claimed by Gibson et al. (2014), "the speed, quality, accuracy, and material properties have all developed to the extent that parts can be made for final use and not just for prototyping." (Gibson et al., 2014, p. 37). According to Piller et al. (2015), AM is already used in many companies for RP but the larger opportunity of AM is to substitute traditional manufacturing for serial manufacturing of products.

Furthermore, AM offers several benefits compared to traditional manufacturing. First of all, AM facilitates flexible production of customized parts. To do that, it uses direct digital production. This means, it just needs the 3D model of the product to start manufacturing without any expensive and time-consuming moulds and tools. Therefore, any changes at the part can be easily implemented and this leads to a high degree of customization (Roland Berger Ltd., 2013; Berman, 2012; Mellor et al., 2014; Petrick & Simpson, 2013). Another benefit of the just mentioned advantage is the freedom of design. AM processes enable the production of products in any shape, which allows producing lightweight designs via topological optimization and it is also capable to add complexity to geometries with just a slight increase in production costs. Another consequence out of this is that AM reduces a number

of production steps, as even complex parts will be printed in one process (Campbell et al., 2011; Roland Berger Ltd., 2013). In addition, AM offers the possibility for part consolidation, which means that AM is able to consolidate parts of an assembly into one single part. As a result, there is no need for assembly. Hence, AM reduces the production time and cost (Campbell et al., 2011; Roland Berger Ltd., 2013).

But AM has not only effects on the manufacturing, it also has the potential to impact environmental concerns, the inventory management, and supply chain of companies. Since the AM process adds material layer-by-layer it reduces the waste compared to subtractive processes. It is even possible to recycle the waste material of AM processes (Manyika et al., 2013; Kietzmann et al., 2015; Campbell et al., 2011; Berman, 2012). Moreover, AM decreases the inventory risk to a minimum, because parts can be produced as needed rather than storing parts because of a possible future need. Thus, there is no unsold completed product in the inventory and companies save space and costs (Campbell et al., 2011; Kietzmann et al., 2015). Berman (2012, p.6) claims, AM is "an ideal technology for making replacement parts". Finally, AM has also the potential to simplify the supply chain of companies due to the ability to print on demand by reducing the lead times and inventories (Petrick and Simpson, 2013). Besides that, AM enables companies to move their production away from countries with low labour costs closer to the point of consumption and therefore the distribution can be simplified (Tassey, 2014; Kietzmann et al., 2015; Campbell et al., 2011). It's even possible, that the customers download the 3D-model of a product or design by themselves and then print it at home. This creates a lot of challenges and opportunities for established firms, newcomers and consumers as well (Rayna & Striukova, 2014). For instance, some online 3D object exchanges, like Thingiverse, Shapeways, Ponoko or MakerBot's have evolved, via which consumers can download 3D designs of all kind of products either for free or for a fee and then print it (Kietzmann et al., 2015).

However, even with all of these advantages of AM to traditional manufacturing techniques, there are also some barriers and limitations of AM. These limitations encompass according to Manyika et al. (2013) limited product size, high material cost, lack in accuracy of the end product, low printing speed, and limited object strength. For instance, the product size is limited to the size of the chamber of the 3D printer (Roland Berger Ltd., 2013). Due to the slow printing speed, AM is limited for mass production (Roland Berger Ltd., 2013; Campbell et al., 2011). According to Sherman (2009), materials, which are suitable for AM can cost 10 to 100 times more than typical materials. According to the article “Print me a Stradivarius: How a new manufacturing technology will change the world” in “The Economist”, nowadays AM

technology produces with a precision of about one-tenth of a millimetre and it can print with plastics, resins, and metals (‘‘Print Me,’’ 2011). But Rudd (2011) claims that the robot arm of a 3D printer requires 10 times better precision to be able to compete with industrial engineering processes (Rudd, 2011). Berman (2012, p.7) states, "A number of issues relating to cost, accuracy, and strength of 3-D products need to be overcome before this technology can achieve widespread adoption."

In summary, AM offers several advantages to manufacture specific kinds of products such as products, which are ordered in singular configurations and very small quantities (Berman, 2012). The technology is still mostly used for RP but due to significant improvements in quality, price and processing time, AM became a viable manufacturing technology (Bogers et al., 2016). Gibson et al. (2014, p. 56) claim, "certainly, we will continue to use this technology for prototyping for years to come, but we are already entering a time when it is commonplace to manufacture products in low volumes or unique products using AM". Nonetheless, it is improbable, that AM will make traditional manufacturing technologies obsolete (Huang et al., 2013). However, Bogers et al. (2016) state that AM already became a suitable manufacturing technology because of advancements in price, part quality and manufacturing speed.

2.1.3 Additive Manufacturing as disruptive technology

Rifkin (2012) states, there is an increasing consensus that AM, considered as disruptive or emerging technology, will enhance the productivity, generate more jobs and fuel the economic growth.

After 30 years of development, AM already reached the stage of a disruptive technology (Berman, 2012; Rayna & Striukova, 2016; Horn & Harrysson, 2012). A disruptive technology is a technology innovation, which changes market structures and value creation (Berman 2012; Vance, 2012). In addition, AM potentially has the ability to change the way products are designed, produced, distributed, and sold (Manyika et al., 2013). According to Campbell et al. (2011, p.2) “AM could prove to have as profound an impact on the manufacturing world as the PC and the Internet on the information world. It could also provide a step forward in environmental protection and resource productivity”.

Besides the immense potential of AM, it also entails relevant and required changes within a company's business model (Afuah, 2014; Zott et al., 2011). Since AM is a technology, which is flexible and manufactures extremely customized and personalized products, it also offers challenges and opportunities for developing new business models (Piller et al., 2015; Ponfoort

et al., 2014). Piller et al. (2015) also claim, that AM creates a vast number of opportunities for business model innovation. According to Rayna & Striukova (2014), business model innovation will play a vital role for companies to successfully implement AM. Looking from a general perspective on business models for AM, the technology alone doesn't add some value to a company if it isn't commercialized in a lucrative way (Chesbrough & Rosenbloom, 2002). Sometimes technologies can be implemented with an existing business model but AM is a disruptive technology, which requires rethinking and some adjustments to the business model to capture its value (Chesbrough, 2010; Johnson et al., 2008).

The former sections explained the technology AM, its advantages and limitations and its disruptive character on the manufacturing industry. The difficulty with new technologies is to gain sustainable competitive advantage out of them. Therefore the next paragraphs describe the term business model because the key aspect of capturing value from technological innovation is the linkage of technology and the adaption of the business model of a company.

2.2 Business Model

The term "business model" has been seen in many different ways due to the broad use of different authors (Osterwalder et al., 2005). Thus, there is confusion about what a business model is and how it can be used (Shafer et al., 2005). In the following section, recent literature will be used to give an overview of business model approaches, the business model concept, its components, and perspectives.

2.2.1 Business Model approaches

In order to use a business model to influence the way in which technology is monetized, a company, first of all, has to establish and define a business model framework for their firm. In recent history, a couple of different frameworks that help to describe, understand, apply, and also possibly innovate business models were introduced. Nielsen and Roslender (2014) have chosen six frameworks, which represent antecedent and more current business model concepts. These concepts will be presented briefly:

- Service-Profit Chain (1994)
- Strategic Systems Auditing (1997)
- Strategy Maps (2001)
- Intellectual Capital Statements (2003)
- Open Business Models (2006)
- Business Model Canvas (2008)

Service-Profit Chain (1994)

This approach mainly relates to the subject of marketing management and in particular service organizations and was elaborated and introduced by Heskett et al. (1994). The service-profit chain is representing a business model which is focusing on the direct and strong linkage between frontline employee satisfaction, customer loyalty and profitability. Engaged and satisfied employees lead to high levels of customer satisfaction and loyalty, which in turn leads to long-term profit and growth (Heskett et al., 1994). These linkages should be supported by a special kind of leadership and innovative measuring techniques (Heskett et al., 1994).

Strategic Systems Auditing Framework (1997)

This business model was elaborated by the consultancy KPMG and a team of experts and scholars and originally aimed to enhance audit quality in respect of changing environments (Peecher et al., 2007). The analysis approach of the model starts with the strategic analysis of the external factors influencing the markets, alliances, products and customers of the organization, followed by an analysis of the business processes (strategic management processes, core business processes and resource management processes). The framework is not focusing on the business elements itself but rather on the characteristics and analysis of the links between them (Nielsen & Roslender, 2014). External forces, markets, business processes, alliances, core products and services, and customers are the six components of the model (Nielsen & Roslender, 2014).

Strategy Maps (2001)

The approach of strategy maps is based on the Balanced Scorecard performance measurement and transforms it into a strategy-driven performance management tool (Kaplan & Norton, 2001). It is a combination of non-financial and financial performance goals and comprises four perspectives for analyzing the value-creation strategy: Financial (shareholder perspective), customer, internal business processes, and learning and growth (Kaplan & Norton, 2001). The process of the strategy map is aiming to operationalize ideas of the management and has three steps: "(1) Define the vision of the company (what will we be/achieve?), (2) Evaluate the mission of the company (why are we here?) and account for the core values (what do we believe in?), and (3) Work out the strategy of the company (how can we fulfill the vision?)" (Nielsen & Roslender, 2014).

Intellectual Capital Statements (2003)

The Intellectual Capital Statements model was developed by Danish researchers in consequence of criticisms of a mismatch between companies' market value and their financial statements (Nielsen & Roslender, 2014). The guideline for the model includes four main steps: (1) The knowledge narrative, which is a story about how the company uses knowledge resources to creates value for the customers, (2) the facing challenges of the value creation process, (3) the initiatives identified by the company, and (4) the resulting performance indicators (Nielsen & Roslender, 2014).

Open Business Model Framework (2006)

The approach from Chesbrough & Rosenbloom (2002) describes a business model that takes technological characteristics and potentials as inputs and converts them through customers and markets into economic outputs (Nielsen & Roslender, 2014). Thus, the business model has the task to capture value from commercializing technological inputs. This, according to Chesbrough and Rosenbloom (2002), requires six elements: (1) Value proposition, (2) market segment, (3) value chain, (4) cost and profit, (5) value network, and (6) competitive strategy.

Business Model Canvas (2008)

The recent contribution of Osterwalder and Pigneur (2010) is focusing on how a business creates, delivers, and captures value. Value proposition, therefore, is central in the model and links the infrastructure of the organization with the customer (Nielsen & Roslender, 2014). The purpose of the authors was to create a shared language and a business model that everybody understands (Osterwalder & Pigneur, 2010). The model contains nine building blocks, which are (1) key partnerships, (2) key activities, (3) key resources, (4) value propositions, (5) customer relationships, (6) channels, (7) customer segments, (8) cost structure, and (9) revenue streams (Osterwalder & Pigneur, 2010).

Review

When we compare the above-mentioned frameworks, we can identify different emphases. While the antecedent approaches have a more specific focus, the Business Model Canvas is a more generic model. The Service-Profit Chain (1994) for instance is focusing on the direct and strong linkage between frontline employee satisfaction, customer loyalty and profitability. The emphases of the Strategic Systems Auditing Framework (1997) are external forces, markets, and business processes. The Strategy Maps approach (2001)

is focusing on how to deliver a strategy and not how to create a strategy. The Intellectual Capital Statements model (2003) is very theoretical and relies on financial performance indicators. The first approach, which put the value proposition in the focus of the model was the Open Business Model framework (2006). Osterwalder and Pigneur (2010) refined this model and added three more elements to improve the coherence and the understanding of the "how´s" and "why´s" of business activities. The Canvas Model is easy to understand and can convince experts through the consistent and structural framework. Therefore, the model got adopted extensively in the practical as well as in the academic world. As a consequence, we will use the Business Model Canvas as analytical framework in our study. Hence, we will come back to a more detailed description of the Business Model Canvas in chapter 2.3.1. In order to understand the role of the Business Model Canvas, we will provide a general overview of the business model concept and its different components and perspectives hereafter.

2.2.2 Business Model Concept

The awareness and importance of the business model concept is grown significantly over the last years, especially as it is associated as a source of competitive advantage (Johnson et al., 2008; Markides & Charitou, 2004, Magretta, 2002). No matter if it is a new venture or an established firm, a good business model is considered to be essential for success (Magretta, 2002). According to a study of IBM in 2007, financially successful companies perceive consequential and sustainable business model management twice as much important as less financially successful companies (Giesen et al., 2007). The high significance of the business model concept is not only related to the practical application but also to the scientific research. The high amount of published paper within the last decade supports this statement. In the Database Web of Science, the number of papers including the term "business model" in their title and their topic rose up to 728 in 2016 compared to 126 in 2000 (Web of Science BM).

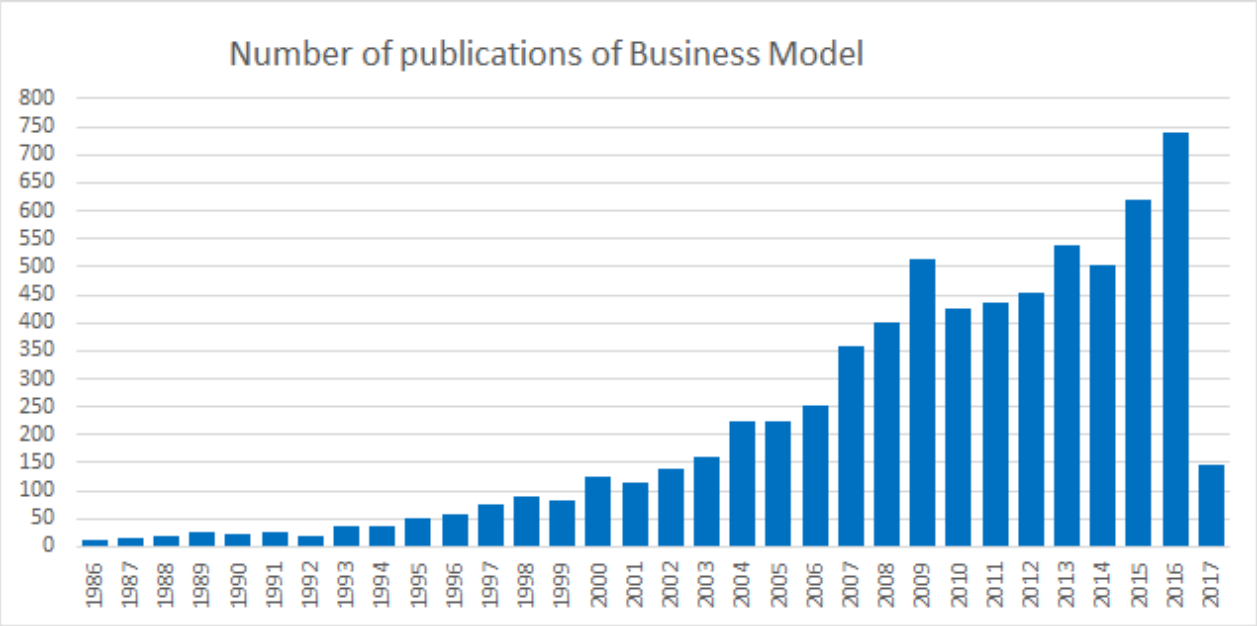

Figure 6: Number of publications about BM from 1986 to 2017 (Source: Web of Science BM, 2017)

The business model concept gained greater interest after the advent of the internet and the creation of electronic businesses at the end of the 20th century (Alt & Zimmermann, 2001). The figure shows the steady increase of interest since the beginning of the 21st century. Due to the high amount of published papers (more than 700 in 2016), the figure also indicates that the business model research contains different fields of interest. One main field of interest is the already mentioned linkage of business model and technology. Some scholars suggest to see the business model concept within the traditional strategy lexicon of competitive advantage intertwined with technology (Osterwalder et al., 2010; Demil and Lecocq, 2010; Zott & Amit, 2007). We, however, agree with Baden-Fuller and Haefliger (2013), Teece (2010), and Baden-Fuller and Morgan (2010) and treat business model as a standalone concept and potentially separable from technology and strategy (Baden-Fuller & Haefliger, 2013).

The first use of the term goes back more than fifty years. Although it was used in a very unspecific way, Bellman et al. (1957) and Jones (1960) were the first academic papers where the wording of business model appeared (Osterwalder et al. 2005). Then. the concept of business model gained greater prominence as a consequence of the advent of the internet and the creation of electronic businesses at the end of the 20th century (Alt & Zimmermann, 2001).

In the following years, more and more aspects of strategy influenced the understanding of the concept. The business model approach turned to a

concept of general management (Chesbrough & Rosenbloom, 2002), through which companies started to analyse the competitive structure and to make strategic innovation-decisions (Hamel & Ruben, 2000). Until today, scholars explored and discussed the concept of business model in articles, books, business press, and scientific journals, including the fields of e-business, information management, strategy, or management (Zott et al., 2011; Wirtz et al., 2016).

Although there was and is a great awareness for business model research, many basic questions are not clarified explicitly (Wirtz et al., 2016). The main challenge for the concept of business model is the fragmented and heterogeneous literature, which led to an inconsistent use of the term and the lack of definitional clarity (Wirtz et al. 2016; Zott et al., 2011; Chesbrough & Rosenbloom, 2002).

Due to that, several definitions of a business model are presented in Table 1.

Author(s), Year	**Definition of Business Model**
Chesbrough & Rosenbloom, 2002	A business model is "the heuristic logic that connects technical potential with the realization of economic value" (p.529).
Magretta, 2002	Business models are "stories that explain how enterprises work. A good business model answers Peter Drucker´s age old questions: Who is the customer? And what does the customer value? It also answers the fundamental questions every manager must ask: How do we make money in this business? What is the underlying economic logic that explains how we can deliver value to customers at an appropriate cost?" (p.4).
Osterwalder et al., 2005	A business model is "a conceptual tool that contains a set of elements and their relationship and allows expressing the business logic of a specific firm. It is a description of the value a company offers to one or several segments of customers and of the architecture of the firm and its network of partners for creating, marketing, and delivering this value and relationship capital to generate profitable and sustainable revenue streams" (p.10).
Johnson et al., 2008	Business models "consist of four interlocking elements, that, taken together, create and deliver value" (p.52).

	These are value proposition, profit formula, key resources and key processes.
Teece, 2010	A business model "articulates the logic, the data and other evidence that support a value proposition for the customer, and a viable structure of revenues and costs for the enterprise delivering that value" (p.179).
Wirtz et al., 2016	A business model is "a simplified and aggregated representation of the relevant activities of a company. It describes how marketable information, products and/or services are generated by means of a company's value-added component. In addition to the architecture of value creation, strategic as well as customer and market components are taken into consideration, in order to achieve the superordinate goal of generating, or rather, securing the competitive advantage. To fulfil this latter purpose, a current business model should always be critically regarded from a dynamic perspective, thus within the consciousness that there may be the need for business model evolution or business model innovation, due to internal or external changes over time" (p.41).

Table 2: Definitions of business model

This overview of several definitions shows the variations of business model definitions. As a consequence, different authors attempted to define the business model concept through identifying and categorizing components and perspectives of the business model concept. These authors state that several fields of interest of researchers led to a literature development in "silos" or "perspectives" (Zott et al., 2011, Wirtz et al., 2016). Consequently, the literature of business model concept entails several components as well as perspectives.

Components

There is no generally accepted definition of the term business model yet (Morris et al., 2005). Therefore, several scholars analysed business model literature to identify the major components of given approaches (Wirtz et al., 2016; Morris et al., 2005; Shafer et al., 2005; Zott et al., 2011). Shafer et al. (2005), using twelve definitions, and Wirtz et al. (2016), using sixteen definitions, made the most comprehensive analyses. Figure 7 (Shafer et al., 2005) and 8 (Wirtz et al., 2016) are presenting the overview of business model components.

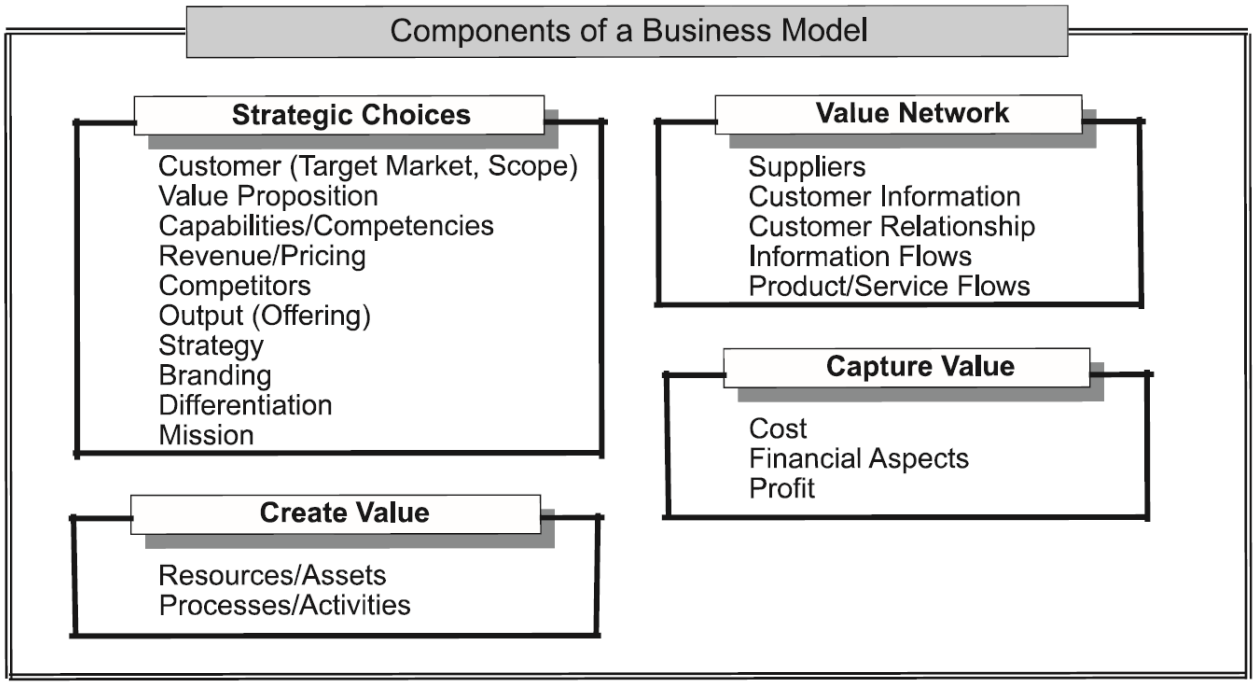

Figure 7: Components of a business model (Source: Shafer et al., 2005)

In their analysis, Shafer et al. (2005) identified 42 components within the literature of business model. The twenty components that are listed above were considered as the most relevant and contain all nine components of the Business Model Canvas. Wirtz et al. (2016) presented only nine different components of business model literature and compared the content of several authors.

Compo-nent / Author	Strategy	Resources	Network	Customers	Market offering (value proposition)	Revenues	Service provision	Procure-ment	Finances	Spectrum of the Components
Hamel (2000)	Core Strategy, Strategic Resources		Value Network	Customer Interface						◔
Mahadevan (2000)			Logistic Stream		Value Stream	Revenue Stream				◔
Wirtz (2000)	Combination of production factors for strategy implementation	Core competencies & Core assets		Market & customer segmentation	Service offer & Value proposition	Systematization of revenue forms	Combination & transformation of goods & services	Production factors & Suppliers	Financing & Refinancing	◕
Hedman/Kalling (2002)	Managerial and organizational, longitudinal process component	Resources		Customers	Competitors, Offering		Activities & Organization	Factor & Production Input Suppliers		◕
Bouwman (2003)		Technical architecture		Customer Value of Service					Financial arrangements	◔
Afuah (2004)	Positions	Resources			Industry Factors		Activities		Costs	◑
Mahadevan (2004)				Target Customers	Value Proposition	Revenue Model	Value Delivery			◔
Voelpel/Leibold/ Tekie (2004)		Leadership capabilities	Value Network (Re)Configuration for the Value Creation		Customer Value Proposition					◔
Yip (2004)	Scope, Differentiation	Organization		Nature of Customers, Channels	Value Proposition, Nature of Outputs		How to transform inputs (including technology)	Nature of inputs		◕
Lehmann-Ortega/Schoettl (2005)					Value Proposition, Value Architecture	Revenue Model				◔
Osterwalder/ Pigneur/Tucci (2005)		Core Competency	Partner Network	Target Customer, Distribution Channel, Relationship	Value Proposition	Revenue Model	Value Configuration		Cost Structure	◕
Tikkanen et al. (2005)	Strategy & Structure		Network				Operations		Finance & Accounting	◑
Al-Debei/El-Haddadeh/Avison (2008a)			Value Network		Value Proposition, Value Architecture				Value Finance	◔
Demil/Lecocq (2010)		Resources & Competences, Organization			Value Proposition	Volume & Structure of Revenue Streams			Volume & Structure of Revenue costs	◑
Johnson (2010)		Key Resources			Customer Value Proposition	Profit Formula	Key Processes			◑
Osterwalder/ Pigneur (2010)		Key Resources	Key Partners	Customer Relationships, Channels, Customers Segments	Value Proposition	Revenue Streams	Key Activities		Cost Structure	◕
Intensity of use	◑	◕	◑	◑	◕	◑	◑	◔	◑	

Figure 8: Components of a business model (Source: Wirtz et al., 2016)

The figures contain twenty (Shafer et al., 2005) and nine (Wirtz et al., 2016) components. Shafer et al. (2005), who are listing more than twice as much components as Wirtz et al. (2016), are comprising all nine components of the latter authors and therefore show consensus. The Business Model Canvas of Osterwalder and Pigneur (2010) is listed in the last row, showing also big accordance with the selected components of Wirtz et al. (2016). Thus, the nine building blocks of the Business Model Canvas cover the components of both analyses. This proves that the model is a very generic and comprehensible framework to describe, understand, and innovate business models.

Perspectives

Zott et al. (2011) for instance reveal three main interest areas. The first area of interest are the business models for e-Businesses. Doing the business

electronically was new in the end of the 20th century and therefore motivated researchers to describe and analyse the new business models (Alt & Zimmermann, 2001; Teece, 2010). The second stream is business model and strategy. Business strategists and scholars increased their attention towards firms' value creation, performance, and competitive advantage (Zott et al., 2011). The third perspective of business model research, according to Zott et al. (2011), is technology and innovation management. Business models help to commercialize innovative ideas and technologies and are also seen as a new subject of innovation themselves (Zott et al., 2011).

Wirtz et al. (2016) are also mentioning three perspectives of business model research, emphasizing on the recently grown importance of strategy-oriented articles. Technology-oriented publications have been released especially in the end of the 20th and the beginning of the 21st century. Organization-oriented contributions are representing the third perspective, although they have a subordinate role compared to the other two perspectives (Wirtz et al., 2016).

Review

Both scholars mention a technology-oriented business model perspective, which proves that the connection between business model and technology is well-known. As we described in the introduction, we are focusing on the perspective where business model choice influences the way in which technology is monetized (Baden-Fuller & Haefliger, 2013). The relationship will be described more in detail later in chapter 2.3.1.

2.3 Business Model Innovation

Deregulation and privatization, technological changes, and globalization are just some examples of forces that shape today's business environment of continuous and complex change (Voelpel et al., 2004). Business model innovation is seen as a vehicle for corporate transformation and renewal and therefore gained a lot of attention over the last decade (Zott et al., 2011). In this subchapter, the current understanding of what business model innovation is and its approach in the context of technical change will be presented. Furthermore, we will present our business model innovation framework and provide a more detailed explanation of the Business Model Canvas.

Definition of Business Model Innovation

While companies tend to have extensive investments and processes for exploring new ideas, technologies, and processes, they often have little if any attention and ability to innovate and develop business models (Chesbrough, 2010; Johnson, 2008). However, the attention for business model innovation

is increasing, as scholars and managers believe that business model innovation is a key source of sustainable competitive advantage (Voelpel et al., 2004). Numerous examples of organizations, such as Apple, Dell, Southwest, or Wal-Mart, showed that business model innovation can successfully reinvent companies and even change whole industries (Markides, 2006; Voelpel et al., 2004).

The Economist Intelligence Unit reported in a survey in 2005 that over 50% of executives believe business model innovation will become even more important for success than product or service innovation (Johnson et al., 2008). This survey gets particularly interesting when looking at the historical development of published paper about business model innovation in Web of Science. Figure 9 shows that there is a significant increase of published papers since 2006, which therefore supports the survey forecast from 2005.

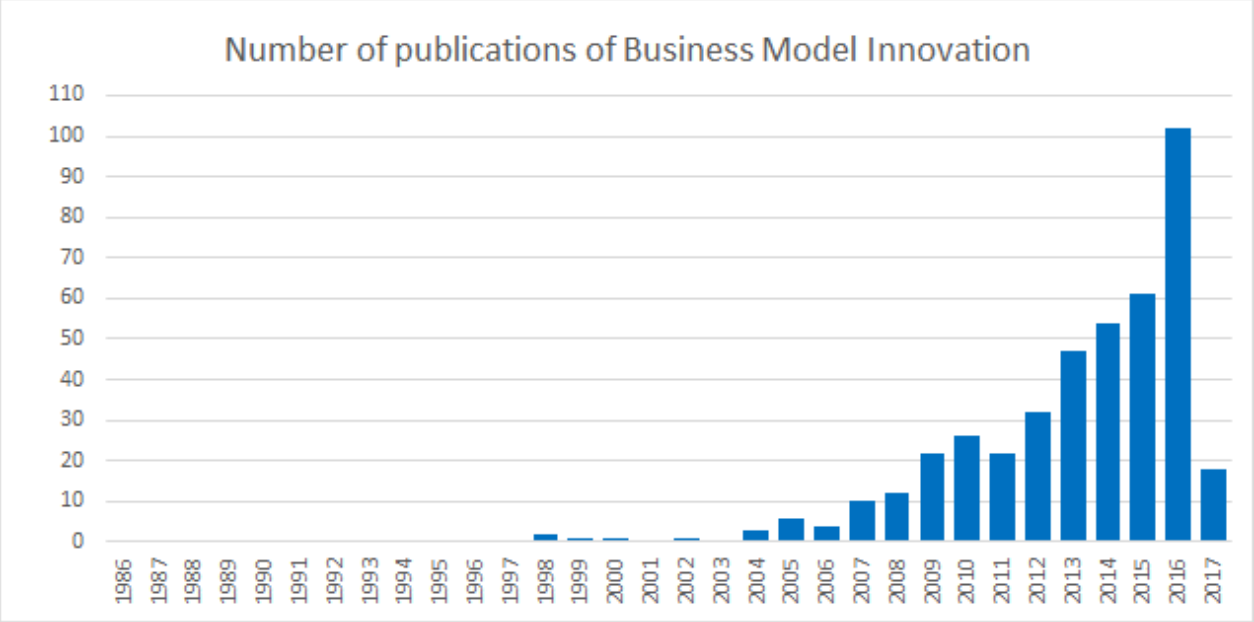

Figure 9: Number of publications about BMI from 1998 to 2017 (Source: Web of Science BM, 2017)

After the flourishing attention for the business model concept in the beginning of the 21st century, several areas of research were established. Business model innovation is one of these areas that has gained particular significance, therefore is seen as an independent self-contained concept in the literature (Wirtz et al., 2016). As this field of research is based on the inconsistencies of the business model concept, the literature of the business model innovation is also representing a slippery and fuzzy construct to study (Casadesus-Masanell & Zhu, 2013; Spieth et al., 2014).

Gambardella and McGahan (2010) state that "business model innovation occurs when a firm adopts a novel approach to commercializing its underlying assets" (p.263). Casadesus-Masanell and Zhu (2013) have a similar understanding and describe business model innovation as "the search for new business logics of the firm and new ways to create and capture value for its stakeholder" (p.464). Amit and Zott (2010) are explaining business model innovation as a process of designing either a modified or a new activity system. Johnson et al. (2008) is seeing the occurring change of a business model innovation more radical and describes it as the complete reinvention of the current business model. A similar definition is presented by Markides (2006), who is defining it as much more than the discovery of a radical new strategy, as a firm redefines what an existing product or service is and how it is provided to the customer.

This selection of definitions shows that the literature is presenting different understandings about business model innovation. Hence, the question is: When is a business model new? Voelpel et al. (2004) for instance are stating that organizations that reinvent themselves with systemic strategy approaches can still maintain the existing business model. To clarify this question, Linder and Cantrell (2000) created a framework of four different change models, which describe the degree to which the firm’s core logic is changing. According to their understanding, journey models are causing a business model change. Journey models move a company "deliberately and purposefully to a new operating model and never returns" (Linder & Cantrell, 2000, p.13). Examples for this is the shift of value propositions to go global or the change of the generic strategy (Linder & Cantrell, 2000). Extension models (e.g. Backward/forward/horizontal integration, externalizing an internal capability) and renewal models (e.g. new service offer, new brands, untouched markets, new retailing) can but don´t have to change the business model. Although these models can help to evaluate the occurring changes, the degree to which the logic finally changes can vary from firm to firm (Linder & Cantrell, 2000).

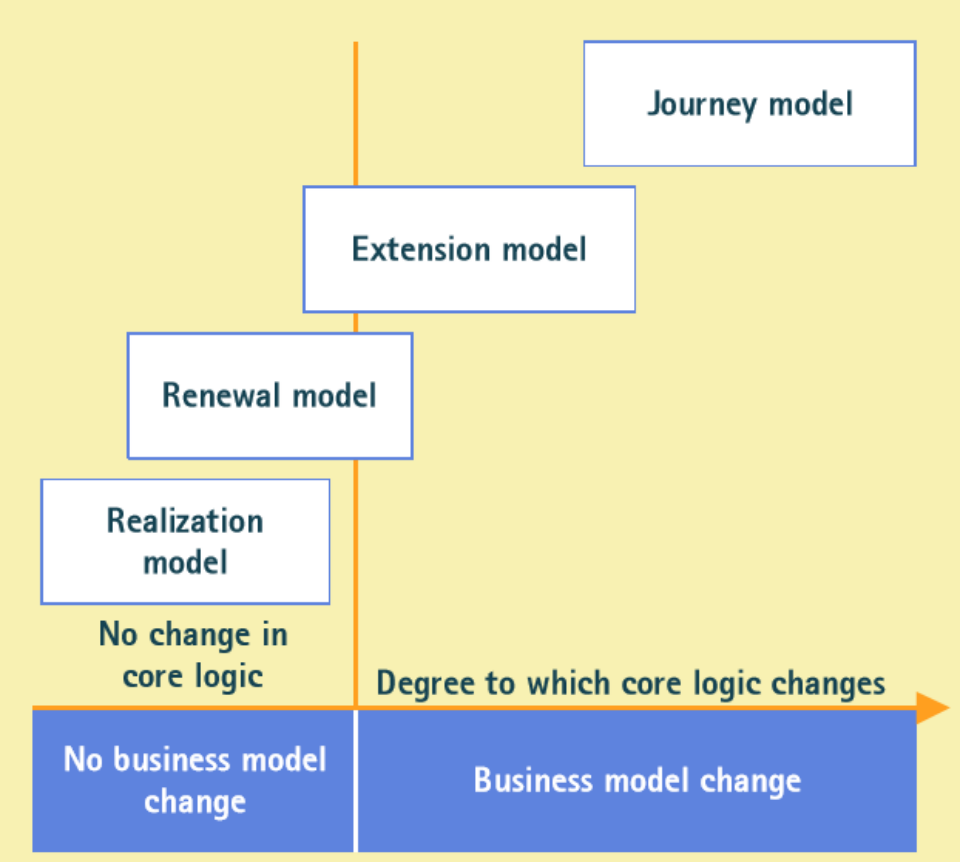

Figure 10: Different degrees of Business model change (Linder and Cantrell, 2000)

Other scholars are emphasizing on the importance of what is performed in order to complete transactions (Amit & Zott, 2001) and the form of organization structure and network relationship changes (Chesborough, 2007) when it comes to business model innovation. Magretta (2000) is describing business model innovation more generally, like writing a new story based on old ones. A BM, therefore, is new, if one of the generic value chain activities (building blocks) is new (Magretta, 2000).

Taking these different perspectives into consideration, we define business model innovation as a process of developing the business model, which can have both, little impact or huge impact on the existing business model and its core logic.

Dimensions of business model innovation

The fast and unpredictable changing business environment is shaping the reinvention of companies' business models. Therefore, the literature is describing different dimensions, which have the potential to initiate business model innovation. First, business models themselves represent a dimension of

innovation (Mitchell & Coles, 2003; Amit & Zott, 2010). This could happen for instance by introducing new methodologies, connecting previously unrelated parties, new linkages, new transaction mechanisms, or modifying internal operations (Trimi & Bergebal, 2012, Amit & Zott, 2010). The second dimension of innovation is technology. Business model innovation is often based on technological changes as they often have impacts on customer value and the business network (Voelpel et al., 2004). The third dimension of innovation is the customer and relates to the basic questions of Peter Drucker: "Who is the customer? And what does the customer value?" (Magretta, 2002, p.4). Hence, changes in customer/user behaviour force firms to rethink their customer value proposition and the overall business model (Voelpel et al., 2004).

Our study is based on the dimension of technology, which is described more in detail in the following section.

2.3.1 Business Model Innovation Framework

When we put together the development of publications from the topics business model, business model innovation, and Additive Manufacturing, we can see an agreeing increase of published papers in each topic. Figure 11 shows that the concept of business model is part of the literature since more than three decades, whereas business model innovation and Additive Manufacturing were growing almost parallel since the 21st century. This could imply that there is a connection between the rising interest of AM and business model innovation. Although they are not connected exclusively, AM and business model innovation are linked to each other.

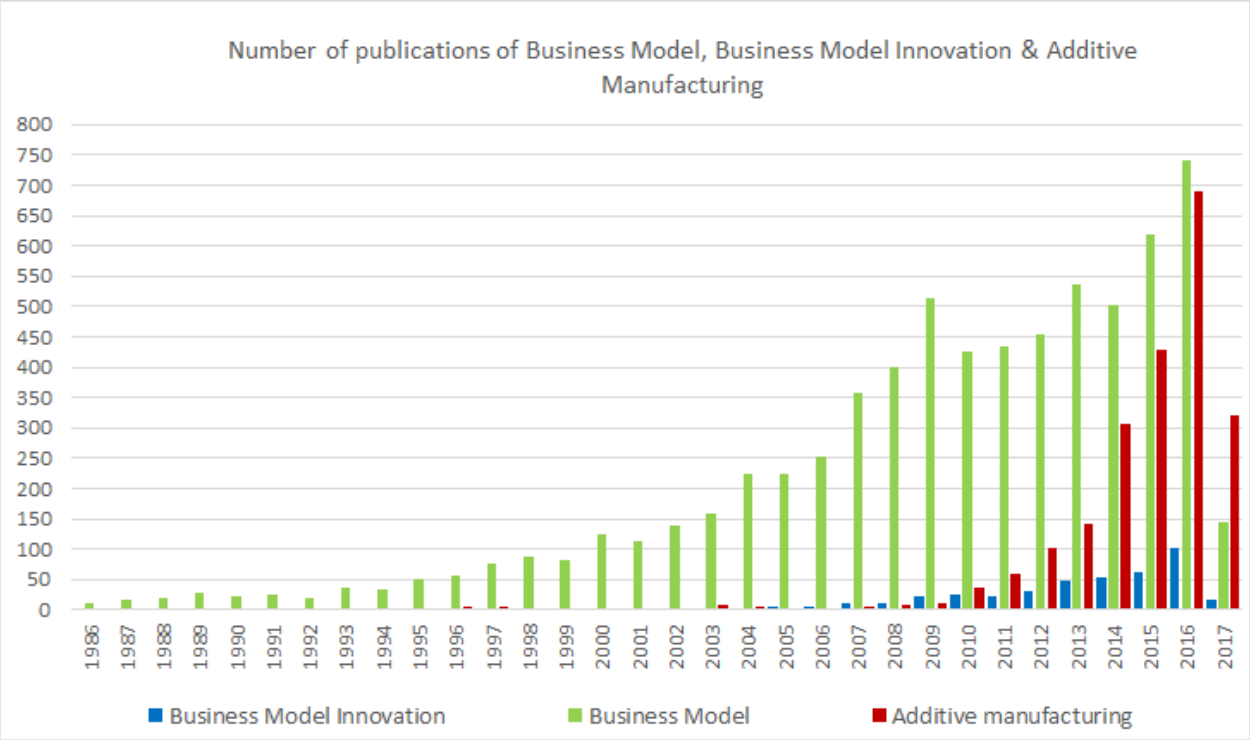

Figure 11: Number of publications about BM, BMI & AM (Source: Web of Science BM, BMI, AM, 2017)

The starting point for this linkage is the above mentioned technological dimension of innovation, in which technology development facilitates new business models (Baden-Fuller & Haefliger, 2013). Chesbrough and Rosenbloom (2002) explored the role of business models in capturing value from innovation. They state: "The inherent value of a technology remains latent until it is commercialized in some way" (Chesbrough & Rosenbloom, 2002, p.530). If a new technology arises, it can be both not affecting and affecting the business model innovation. If the new technology can successfully employ a business model, which is already familiar to the firm, business model innovation is redundant. If the new technology has a disruptive character and will not fit to the current implemented business model, Chesbrough and Rosenbloom (2002) are stating that "technology managers must expand their perspectives, to find the right business model, or 'the architecture of the revenue', in order to capture value from that technology" (p.530).

Additionally, Figure 12 shows the connection between the different concepts, which have been used in this study and in combination they form our business model innovation framework.

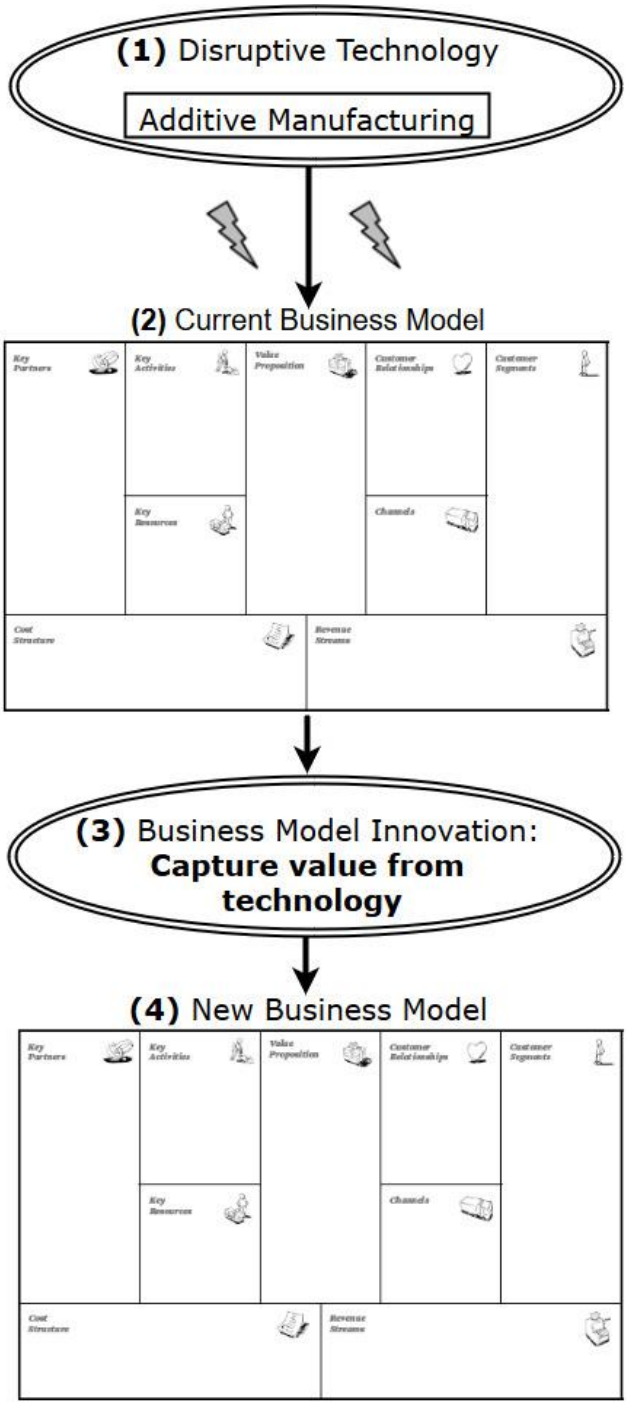

Figure 12: Our Business Model Innovation Framework (Source: Osterwalder & Pigneur, 2010)

In the following, a short description of the connection of the different concepts, which are illustrated in figure 12, is presented, using the example of a company, which wants to implement a new technology.

A company, which wants to implement a new technology has to check if the new technology fits to the current business model. In our case, the new technology is Additive Manufacturing. AM and its disruptive character were described above and build the first element in our Business Model Innovation Framework: **(1) Disruptive Technology AM.**

The business model of a company is describing the way, how the company is currently creating, delivering, and capturing value: **(2) Current Business Model.** The flashes between element (1) and (2) represent that AM doesn't fit to the current BM due to its disruptive character.

Therefore a new BM is needed to capture value from the technology. The business model innovation represents the third element and is the process, which develops the current business model in order get a new business model: **(3) Business Model Innovation.**

The last element in figure 12 is the result out of the process of the BMI. It is the adjusted and new BM to capture value from AM: **(4) New Business Model.**

Our analytical model

Our research purpose is to explore how companies have to develop their BM in order to commercialize AM. Figure 12 shows the process of BMI due to a technological innovation. Thus, the analysis of the above-mentioned literature allows us to apply the Business Model Canvas of Osterwalder and Pigneur (2010) in element (2) and (4) of figure 12 as our analytical model to analyse and compare the BMs of companies. Furthermore, it allows us to fulfil our research purpose.

The Business Model Canvas of Osterwalder and Pigneur (2010) entails nine building blocks. Each building block of the Business Model Canvas is characterized by attributes and questions and we will use them to collect and analyse our empirical data. The goal is to detect similarities and deviations in the required changes within the current BM of two companies, which want to implement AM.

Hence, in the following a more detailed description of the nine building blocks of the Business Model Canvas, which is our analytical tool in our framework, is presented. In the following, the references of the nine building blocks are all from the authors, Osterwalder and Pigneur (2010).

(1) Key Partnerships

This building block is representing different types of partnerships forming a network of suppliers and partners. Key partners can help to optimize the allocation of resources, to build economy of scale partnerships, to reduce risk and uncertainty, or to acquire particular resources and activities. Osterwalder & Pigneur (2010) distinguish between four different types of partnerships:

- Strategic alliances between non-competitors
- Coopetition: strategic partnerships between competitors
- Joint ventures to develop new businesses
- Buyer-supplier relationships to assure reliable supplies

(2) Key Activities

Key Activities are the most important actions a company must do to make its business model work successfully. They build the basis to create and offer a value proposition, reach markets, and maintain customer relationships. Dependent on the business model, key activities can be categorized in production (mainly manufacturing firms), problem solving (mainly service organizations) and platform/network (mainly platform as key resource).

(3) Key Resources

The Key Resources building block represents the most essential assets required to run the business. Similar to the Key Activities, Key Resources are the basis of business and differ from company to company. Those resources can be categorized as physical (e.g. facilities, buildings, and machines), intellectual (e.g. brands, knowledge, patents and copyrights), human, or financial assets.

(4) Value Propositions

The bundle of products and services that create value for the customer is described by the building block Value Propositions. A value proposition solves problems or satisfies needs for a specific customer segment. The benefits offered to the customers can be quantitative (e.g. price, speed) or qualitative (e.g. design, customer experience) and can be defined by elements such as newness, performance, design, price, brand, or customization.

(5) Customer Relationships

This building block explains the different types of relationships a company establishes with specific customer segments. In order to keep and acquire customers or to boost sales, companies can build several categories of

customer relationships, such as personal assistance, self-service, automated services, communities, or co-creation.

(6) Channels

Channels is the building block that describes how a company communicates with and reaches customers to deliver their value proposition. Channels can include several functions:

- Increase awareness among customers about a company´s products and services
- Supporting customers evaluate a company´s value proposition
- Allowing customers to buy specific products and services
- Value proposition delivery to customers
- After sales customer support

(7) Customer Segments

Customer segments describe the building block that defines the different groups of people or organizations a company attempts to reach and serve. A business model can comprise one or several small or larger customer segments, which are crucial for long-term survival. There are different types of customer segments, such as mass market, niche market, segmented market, or diversified market.

(8) Cost structure

The building block cost structure represents all costs necessary to operate the business model. All activities of a particular business model incur costs and can be identified throughout defining key resources, key activities, and key partnerships. The importance of cost structures varies from business to business and can be divided in two general classes (cost-driven and value driven business models). Characteristics of cost structures can be fixed costs, variable costs, economies of scale, and economies of scope.

(9) Revenue streams

The building block revenue streams describes the cash a company earns from each customer segment. Companies have to clarify for what value each customer segment is willing to pay and how to create revenue streams for each customer segment. There are different ways to generate revenue streams (e.g. asset sale, usage fee, licensing, subscription fees, and advertising). In general, it can be divided between two revenue streams:

- Revenue stream resulting from one-time payments

- Recurring revenue streams resulting from ongoing payments

Each revenue stream in turn can include different pricing mechanisms (e.g. fixed prices, auctioning, and volume dependent).

Review

These nine building blocks are describing all essential parts of every business. Every block will be a foundation for our interviews and analyses. Thereby, it will be possible to evaluate the impacts of AM on all parts of the business, including assets, services, channels, and others.

3 Methodology

This chapter presents the methodological choices used in this study and why they are relevant. Further, it contains a description of our entire process of research, including research approach, research strategy, research, design, data collection and data analysis.

The structure of the methodological choices is illustrated in the following figure. The model in this figure is based on the 'research onion' of Saunders, M., Lewis, P., and Thornhill, A. (2009).

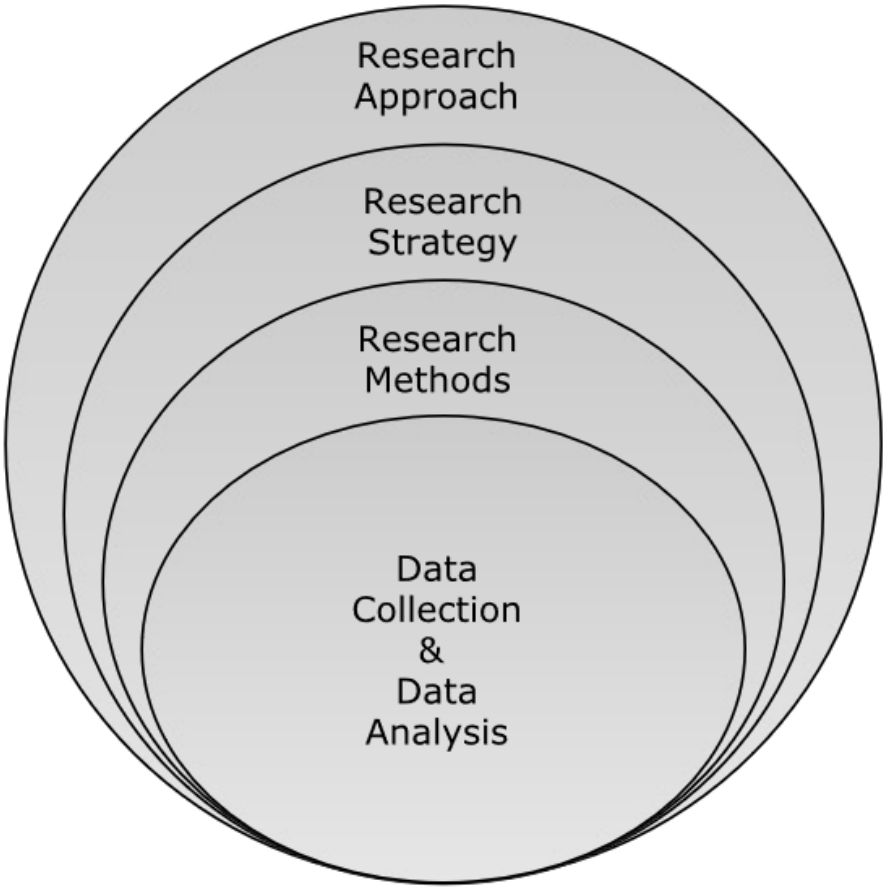

Figure 13: Modified Model of 'The Research Onion' (Source: Saunders et al., 2009)

The 'research onion' is a model, which helps to create and structure the methodological choices of a research process. Thus, we used this model to illustrate the structure of our methodological choices. In the following subchapters, we go through each layer of the model, starting with the research approach.

3.1 Research Approach

According to different business research literature, there are two main approaches to conduct business research. These are the deductive and inductive approach (Bryman & Bell, 2011; Saunders et al., 2009). A deductive approach is deducing a hypothesis, which is based on a set of known theories, and tests this hypothesis against the collected research data. An inductive approach is collecting data and developing theory out of the analysis of the empirical findings (Saunders et al., 2009). In addition, induction is about interpreting and analyzing what we see in direct examination of a phenomenon and drawing conclusions afterwards (Van de Ven, 2007). Therefore, this study is using an inductive approach, as we are collecting empirical data about the implementation of AM and developing theories how companies have to develop their BM afterwards.

The idea of this investigation area came up in a discussion about AM with one of our professors. New technologies develop in a rapid speed and AM has a high potential to vastly influence the manufacturing industry. Thus, as Europeans, we are interested in the future development of the European manufacturing industry. Based on this interest in current topics of the manufacturing industry as well as our affinity for new technologies and our background, we decided to make a study in this field. But implementing the technology itself is not enough, the companies have to take also the business side into consideration. Chesbrough and Rosenbloom (2002) formulated it as, "technology managers must expand their perspectives, to find the right business model, or ´the architecture of the revenue´, in order to capture value from that technology" (p.530). Hence, we discovered a broad scientific field in a meeting together with some members of the Centre for Innovation, Entrepreneurship and Learning Research from the School of Business, Engineering and Science at Halmstad University. During the further procedure, we aligned current issues of the department with current interests from the industry and our interests. Consequently, we derived the purpose of our study from these alignments.

Moreover, a research topic with a lot of existing literature, from which you can create a theoretical framework and deduce a hypothesis, leads to a deductive approach. While for a research topic with only little available literature it is more likely to use an inductive approach (Saunders et al., 2009). Considering the purpose of our study, to explore how companies have to develop their BM in order to commercialize AM, you can determine three individual fields. These fields are BM, BMI and AM. Regarding each field separately, there is enough existing literature for each of these fields, but in connection of these three fields in one topic together, there is only little existing literature available. Due

to that our decision for an inductive approach is also supported by the poor existing literature in our investigation area.

3.2 Research Strategy

According to Saunders et al. (2009), it is most important to choose a corresponding research strategy to fulfil your purpose. Furthermore, the research strategy is directly influenced by the research question or purpose. Thus, researchers have to conscientiously think about their choice. Yin (2013) proposes five different strategies, which are possible to use. These strategies are experiments, survey, history, archival analysis and case study. Yin (2013) also provides an approach to exclude strategies depending on how the research question is formulated. We don’t have a research question in specific but we are investigating 'how' a phenomenon happens. Yin (2013) states, that a "how" question instantly excludes an archival analysis and a survey strategy. Therefore, we can directly exclude these two strategies. An experiment strategy can also be excluded since we can't control the activities we are observing. A history strategy is only recommended when you are dealing with the past (Yin, 2013). Since our study is about a BMI approach to shift from traditional to AM without much available data in the past this research strategy can also be precluded. According to Saunders et al. (2009), “if you wish to gain a rich understanding of the context of the research and the processes being enacted” (p.146) case study is the right choice. Eisenhardt (1989) claimed that case studies are suitable when "little is known about a phenomenon, current perspectives seem inadequate because they have little empirical substantiation, or they conflict with each other" (p. 548). In line with that, we need deep insights into internal factors and since the topic of this study is lacking empirical substantiation a case study is appropriate. Moreover, Cohen et al. (2013) stated that case studies could help to transfer the research phenomenon to other, similar situations or contexts. Thus, our study could be beneficial for other companies, which are planning to implement AM.

Adding to the chosen research strategy, there are three different categories of case studies: explanatory, descriptive, and exploratory and we chose an exploratory case study. According to Saunders et al. (2009), the aim of an exploratory case study is to gain a profound understanding of the problem, the present situation and to acquire valuable knowledge. Hence, the focus of our exploratory case study is on how companies have to develop their BM in order to commercialize AM. More, the exploratory study enables us to change the direction and provides us with a certain degree of flexibility and leeway (Saunders et al., 2009).

Besides, a case study can also be conducted as single or multiple case strategy. The disadvantage of a single case strategy is, that the researcher depends on one single source. By contrast, the multiple case strategy facilitates the researcher to gain additional data to discover differences by comparing the cases (Bryman and Bell, 2011). Additionally, Yin (2013) states, that multiple cases might be better than a single case study because if you choose to conduct a single case study you have to justify this choice strongly. According to Saunders et al. (2009), the reason to choose a multiple case study is to check if the findings of the first case also occur in the second case and if the result is generalizable due to that. Hence, we applied a multiple case strategy to get a wider set of information with more robust and generalizable results.

3.2.1 Case selection

According to Eisenhardt (1989), the case selection is an important factor and that it is not advisable to choose the cases randomly. Hence, we chose our cases, HGF and Tylö, in accordance with our investigation area. We selected these two cases since both companies are in a similar situation. Both companies are before the implementation of AM as a manufacturing technology and consequently have to think about changes in their BM to capture value of the technology. Indeed, the companies are working in different business areas but this fact enables us to reach a broader audience and to present results on a wider basis of comparison.

3.3 Research Methods

In the business and management research, there are two widely used terms in respect of the way of collecting and analyzing data, which are quantitative and qualitative. A way to differentiate these two methods is the focus on different data types. Quantitative research is mainly using or generating numerical data, such as a questionnaire, in the data collection or data analysis, whereas qualitative research is using and creating predominantly non-numeric data, e.g. an interview (Saunders et al., 2009). Moreover, according to Bryman (2015) quantitative research is mostly linked with a deductive research approach and theory testing. Further, it usually creates theory in the front end by generating hypotheses which are tested against the empirical findings (Corley, 2012). In contrast, qualitative research is often combined with an inductive approach, which creates theory out of the empirical findings (Bryman, 2015) and Corley (2012) claimed the majority of qualitative papers enhance theory by creating it inductively. Another difference between the two methods is, that quantitative methods generalize characteristics due to the quantity of the sample and consequently neglects details of an individual case.

While a qualitative research method attempts to gather data of a small quantity of individuals and therefore concentrates on the exposition of the particular (Hyde, 2000). Additionally, to get a better comprehension qualitative research employs different methods to gather data (Bryman & Bell, 2011). In this thesis, we explore, how companies have to develop their business model in order to commercialize AM. To fulfil our purpose we have to figure out how the companies should adjust the current business model to benefit economically from the implementation of AM. Therefore we have to dive into these two companies to get a deeper understanding of the topic and draw our conclusions from our findings. Thus, we conducted a qualitative research study.

3.4 Data collection

A relevant part of a study is the data collection (Ghauri and Gronhaug, 2005). Without appropriate data, the purpose of the study cannot be fulfilled. Thus, in qualitative research, it is necessary to collect data from several sources to give evidence for the analyzed field (Polkinghorne, 2005). But there are different kinds of data, which is the primary and secondary data (Kothari, 2008). Bryman and Bell (2015) define primary data is a first-hand source. We collected our primary data through interviews. In contrast, secondary data is data, which is already collected by others (Ghauri and Gronhaug, 2005). In our study, we used primary and secondary data. Whereas the gathered primary data is the most valuable data, the secondary data was helpful to complement our findings from the interviews.

3.4.1 Primary data

Primary data can be considered as new data, which is gathered with a specific purpose (Saunders et al., 2009). The most common methods to collect primary data are observations, questionnaires, and interviews (Yin, 2013). We conducted interviews within our thesis. The advantage of interviews is, that they can be directly addressed to the purpose of the study (Yin, 2013). Further, there are three different types of interviews. This is the unstructured, the semi-structured, and the structured interview (Bryman & Bell, 2011). Since we set up an interview guide (Appendix A) and handed it out in advance, we conducted a semi-structured interview in our study. However, before we handed out the interview guide, we reviewed it together with a professor of Halmstad University, who is also into the topics of BMI and AM. After aligning the interview guide according to the feedback of this professor we distributed the interview guide to our interview partners.

Interview

Since both case companies are located in Halmstad, we were able to hold face-to-face interviews at the company offices to avoid any signs of confusion from the participants. The following table shows an overview of the conducted interviews.

Company	Date	Participant	Position of the participant	Setting & duration
HGF	27.04.2017	Christian Kiks	CEO	Face-to-face, at the company office, 55 minutes
Tylö	28.04.2017	Anders Dahl	CEO	Face-to-face, at the company office, 50 minutes
		Gunnar Nilsson	Product development	

Table 3: Overview of the conducted interviews

As you can see in Table 3 we conducted two interviews. One interview with Christian Kiks, the CEO of HGF and one interview with two participants from Tylö. These participants were Anders Dahl, the CEO, as well as Gunnar Nilsson from the product development. We chose these participants according to the statement of Van de Ven (2007) that it is vital to discover change processes, such as BMI, from the perspective of the managers, who are driving change efforts to catch the dynamics that confront the managers.

The interviews started with an introduction of us and our interview partner. In the following, we explained the purpose and intentions of the interview and gave our interview partners a brief picture of the background. The interviews took about one hour and we conducted them by using an interview guide. The interview guide was structured into three main parts. The first part was about general information and the history of the companies. Secondly, it was about AM and the last part was about BM. Within the last part, we had several specific questions for each of the nine building blocks of our framework. By using the interview guide, we worked through the different parts. At first, we clarified ethical issues to get permission to record the interview and to use the interview partners as a reference in our thesis. To avoid forgetting information (Bryman & Bell, 2011) and to ensure a higher level of correctness, we recorded the interview and transcribed it afterwards. To view the whole interview guide we refer to Appendix A.

3.4.2 Secondary data

Secondary data is data, which is gathered for other purposes than the current study (Saunders et al., 2009) and we have used it in order to complement our primary data. We have gathered our secondary data mainly via the company websites, product catalogues, and the published documents of the companies. Further, the theory and theoretical framework of this study are mainly based on books, articles, and journals from different databases. Especially the database Web of Science and Google Scholar has been used to find these sources.

3.4.3 Obstacles in the data collection

Based on our investigation area we firstly planned to conduct a retrospective study to present results, which are based on first-hand experience in the phenomena we are examining. Therefore, we decided to gather our empirical data through interviews with companies, which already implemented AM as a manufacturing technology and also adjusted their BM. Hence, we asked some of our professors for contacts of companies, which already implemented AM in their manufacturing and eventually contacted them via phone. Unfortunately, all of the contacted companies rejected a cooperation with us due to confidentiality and sensitivity of the data we needed. Because of these difficulties we had to find another way to generate data. Fortunately, during the conversations with our professors, we got also in contact with HGF and Tylö. These two companies were willing to cooperate but the problem was both were just in the beginning of the implementation of AM. Nevertheless, in consultation with our supervisor, a cooperation with them was still possible but we had to get away from our first idea to conduct a retrospective study.

Another obstacle in the data collection process was revealed during the interviews. Both companies had no elaborated contemporary BM and the participants during the interviews were unsure in their statements about the contemporary BM. Thus, we generated the contemporary BM according to our framework for both companies mainly based on secondary data.

3.5 Data analysis

Analyzing data is one of the last processed steps of a case study (Bryman & Bell, 2011). Moreover, it is the most important part to generate theory through case studies but it is also the most difficult as well as the least codified part (Eisenhardt, 1989). Yin (2013) states that the quality of the data strongly depends on the way how the data is analyzed and the capability to draw valuable conclusions out of the results of the analysis. According to Eisenhardt (1989), qualitative studies usually create a huge amount of data. Therefore it

is relevant to choose adequate analysis methods to understand and interpret the data. A method to master this vast volume of data is a within-case analysis, what contains a detailed written description of each case. The primary idea is to "become intimately familiar with each case as a stand-alone entity" (Eisenhardt, 1989, p.540). This procedure enables to develop patterns for each case individually before researchers generalize patterns via a cross-case analysis. Furthermore, it provides a deep understanding of each case, which facilitates the researcher to conduct a cross-case analysis faster. A cross-case analysis is a comparison of all within-case analyses to find common and generalizable patterns. A possibility to do this is to select or create categories and then search similarities within the categories (Eisenhardt, 1989).

Our first step in the analysis of the data was the transcription of the interviews. Then we selected the useful raw empirical data. After that, we categorized the collected data according to the nine building blocks of our framework for the contemporary BM. The included information here is mainly based on secondary data. Then, we conducted the same process for the new BM. The information here is primarily based on the primary data. After categorizing, we simplified the raw material data to emphasize on those elements, which are important to fulfil our research purpose and have a valuable contribution to our study. Since categorizing and selecting valuable and contributive data is the basis of our analysis, we regarded it as appropriate to conduct a within-case analysis to analyze each case isolated from each other, as well as a cross-case analysis to see possible nexuses, relations or, contrasts. In our analysis, we decided to analyze the cases successively, according to the nine building blocks of the Business Model Canvas, which we defined as our categories. That means, firstly we analyzed changes through the implementation of AM from the contemporary BM to the new BM in each category for both companies individually. After identifying the changes in each of the nine categories for both companies separately, we conducted a cross-case analysis to find common changes. At the end of our analysis, we present a table with our main findings of changes for both companies within each category. The following figure illustrates our procedure in the data analysis.

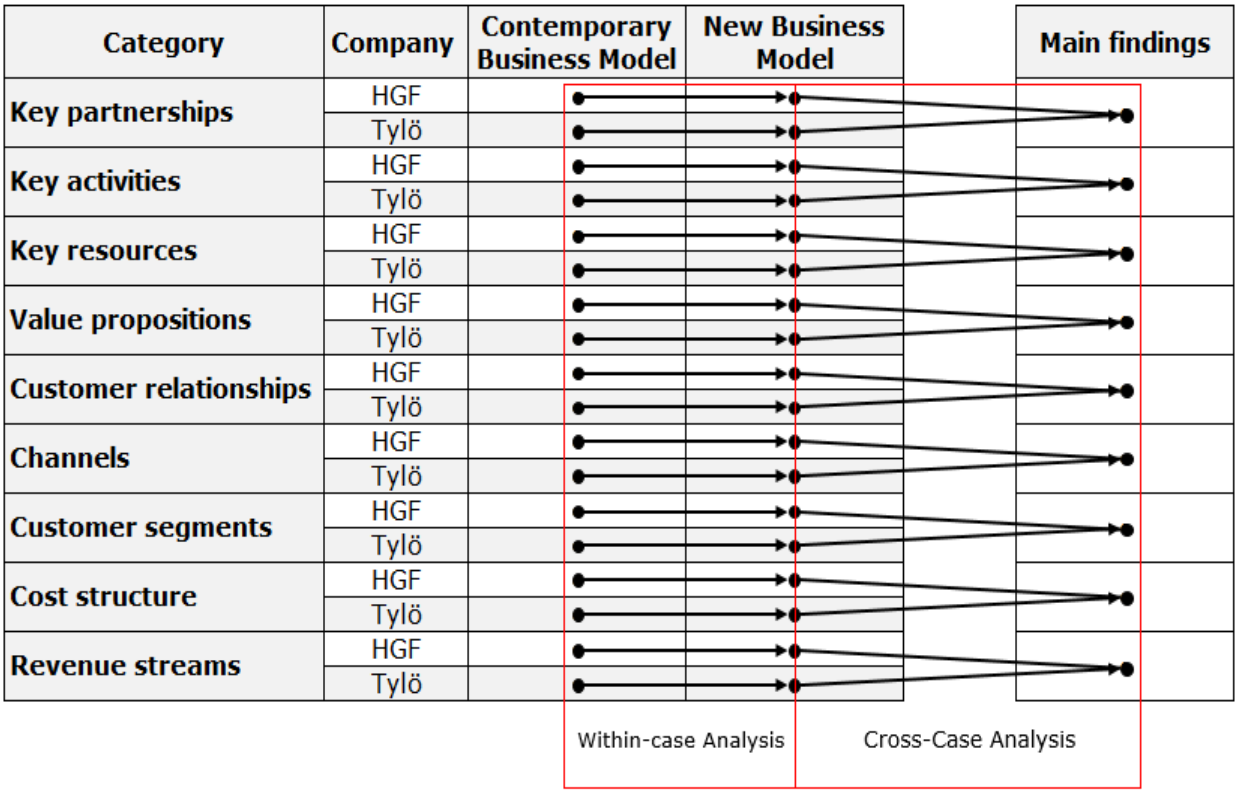

Figure 14: Data Analysis procedure (Source: Own Illustration)

This approach helped us to structure our analysis as well as the reader to understand the relations and coherences between the cases. We analyzed both cases according to the same elements to ensure consistency throughout our analysis.

3.6 Trustworthiness

For a high quality of qualitative research, it is necessary to generate trustworthiness and there are four criteria to consider to reach trustworthiness. These four criteria are credibility, transferability, dependability, and confirmability. In the next subchapters these four criteria are described more in detail (Bryman & Bell, 2011).

3.6.1 Credibility

Credibility is about "reducing the possibility of getting the answer wrong" (Saunders, et al. 2009, p. 156). Krefting (1991) names some techniques which influence the credibility such as the contact with informants, the interview technique, or unexplained inconsistencies. To raise our credibility we collected background information of our interview participants and created an

interpersonal relationship with our participants before we conducted the interviews. Because when informants feel comfortable with the researchers, the willingness to share information is higher (Krefting, 1991). Further, to increase our credibility, we created an interview guide before conducting the interviews. After we finished a draft version of the interview guide we reviewed it with other researchers, which are familiar with the field of the study, to ensure that we ask appropriate questions and finally made minor adjustments. Due to that, we had suitable questions to fulfil our purpose and our level of confidence for the actual interviews was higher. Additionally, we solved some inconsistencies and lacks of understanding through seminars and supervisions with other researchers.

3.6.2 Transferability

According to Krefting (1991), transferability is the applicability of the findings. Transferability deals with the issue if the findings of the study can be transferred into another situation or in the same situation at another time (Bryman & Bell, 2011). To ensure high transferability, qualitative researchers are asked to create a thick description, which provides others with enough knowledge about the possibility to transfer the findings (Bryman & Bell, 2011). Further, Kreftin (1991) states that "as long as the original researcher presents sufficient descriptive data to allow comparison, he or she has addressed the problem of applicability" (p. 216). Therefore, we collected a rich amount of data from different perspectives to provide the reader with a sufficient level of information about the cases that they can decide on their own whether the findings are helpful for them or not.

3.6.3 Dependability

Bryman & Bell (2011) state, that researchers should use an auditing approach. An auditing approach includes that the researchers have records of the complete research process. Hence, we tried to make our process of data collection and analysis as transparent as possible. Therefore, we kept all our records of the problem formulation, selection of participants, recordings and transcripts of interviews and so on.

3.6.4 Confirmability

Confirmability deals with neutrality (Krefting, 1991). Thus, it should be apparent that the researcher has not swayed the conduct of the research and its findings by personal values or theoretical inclinations (Bryman & Bell, 2011). Therefore, we recorded our interviews, what helps to counter accusations that we might have influenced the statements of our interview participants due to our values or biases. Another tool to increase confirmability

is according to Krefting (1991) reflexivity. We were able to reflect our work in casual as well as professional discussions as we worked in a team. Further, we had the possibility to get feedback and reflect our work in regular supervisions and seminars.

3.7 Research Ethics

It is essential for academic research to take ethical considerations such as harm to participants, lack of informed consent invasion of privacy and deception into account (Bryman & Bell, 2011). Thus, we consciously conducted our study with concern on ethical aspects that no participants would feel offended or mistreated. In order to prevent the above mentioned ethical issues, we have made particular considerations throughout our research. First, we have made explicit agreements concerning confidentiality and publication together with the case companies before the interviews. Secondly, all participants of the interviews were asked for permission before they were audio recorded and it was made clear that the recording could be turned off at any moment. Further, all data that has been collected is only open to members of the research team, including the host company, supervisors as well as examiners.

4 Empirical Data

This chapter presents our empirical findings, which we collected through our interviews and secondary data. We divided this chapter into three parts. In the first part, the two companies of our cases will be introduced. The second part contains the current business model according to the nine building blocks of the Business Model Canvas and the last part presents required changes within the nine building blocks due to the introduction of AM.

4.1 Introduction of the companies

Due to the recent development of Additive Manufacturing technologies, HGF and Tylö started to think about the possibility to integrate the technology into their production. Both companies know that AM has a high technical potential, which is represented by plenty of technologies and materials. But they also know that technological know-how alone is not enough for a successful implementation. Therefore, both companies are aware of the business part as well and consequently were willing to take part in our business model innovation study. The following two sections present general information of HGF and Tylö as well as some information about the historical development of the companies.

4.1.1 HGF

HGF is a successful and expanding manufacturer of thermoplastic elastomers (TPE) and rubber products. It is a Swedish small and medium-sized corporation, which is family owned and was founded in 1947. HGF means written-out Halmstads Gummifabrik and it celebrates its 70th anniversary this year in September (Interview HGF). In 2016 the company generated revenue of about 17 million Euros and has 136 employees (Allabolag, 2016). The headquarter of the company is located in Halmstad, which is between Malmö and Gothenburg on the west coast of Sweden (About HGF, 2017). Since 2000, the company also owns a second production unit in Latvia. This factory was a requirement of the company's automotive customers, as they wanted HGF to find a low-cost country to produce (Interview HGF).

During the development of the company from the foundation until now, some major changes within the company occurred. The first one was, as already mentioned, the new production facility in Latvia. According to the current CEO, Christian Kiks, the most substantial change within the company was around 2006 and 2007 and then going into the financial crisis in 2009. Before that time, HGF was always working as a subcontractor and mostly for the automotive industry. But as a subcontractor the company was very exposed

to the competition and especially in the automotive industry it becomes a very harsh competition with very low margins. Therefore, the company started to focus on lean manufacturing in 2006 and introduced the HGF Production System (HPS), which is based on lean production principles. HGF embraced the lean principles and adapted them to its activities, which has resulted in numerous awards, such as second place in the "Swedish Lean Prize" in 2011 or the "Honda Excellent Overall Performance" price in 2015. Moreover, around 3 years ago, HGF made a decision to change the direction of the company from a pure producer of rubber products, towards an innovative company. Due to that, HGF increased its technical know-how and product development capabilities within the company to provide its customers with a better service. From this point on, HGF was able to come up with some suggestions or new concepts for the products of their customers and even develop their own products. Currently, HGF has two own products. These products are a rubber horse shoe and a fender for industrial ports. HGF will start to market these two products this year (Interview HGF).

Today HGF operates in six business areas, which are Automotive, Industrial Products, Marine and Offshore, Mining and Construction, Sealing and Sports. The goal of the company is to pursue the growing profitability. The main approach to reach this goal is to create new business relationships and to intensify the already existing ones (About HGF, 2017).

During the last years, we could see a lot of movement within the company HGF. Moreover, with the approach to pursue the growing profitability and the new direction of the company towards a more innovative one, we see a high potential to implement AM. To have a more detailed look at HGFs current business activities related to their BM, we will use the Business Model Canvas. Therefore, we will collect data according to the nine categories which allow us to investigate each category individually and also to compare the same categories of our two cases to each other. This gives us the possibility to see relationships or nexuses between both companies.

4.1.2 Tylö

Tylö AB is a well-established manufacturer of heaters, steam generators, saunas, steam showers, and infrared saunas. The small and medium-sized company is located in Halmstad, Sweden. Apart from the main factory in Halmstad, the company is running a central warehouse and a showroom in Oslo (Norway), where the entire range of products is on display. Tylö´s vision is to be the premium choice for people looking for quality of life and their mission is to be the global leader in sauna and steam products for premium customers through innovative design, a clear customer focus and consistently superior quality (About Tylö, 2017). Tylö is owned by a private equity group

and together with sister companies within this group the company is a leading actor in the sauna business (Interview Tylö).

The history of the company was mainly influenced by the founder Sven-Olof Janson, who was made an honorary member of the Swedish Sauna Academy in May 2007 in Luleå. The electrician began to develop smaller and more efficient heaters in 1950. He was of the opinion that sauna heaters at this time are too expensive and complicated, so he started to do some more affordable and simple ones on his own. As Sven-Olof Janson was a very curious and innovative guy, he accepted a challenge from a local business guy in 1951, which was to build a cheaper but better sauna. The business started to grow under the strong leadership of Sven-Olof Janson and expanded from sauna heaters to steaming elements, steam cabins, and sauna rooms. Sven-Olof Janson was CEO until the early 2000s, when Tylö already managed to be a leader of the sauna heaters, especially in Sweden in Norway. His state of health then forced him to retire from his position and to let his family members run the business. Not long time after that change the company got sold to a private equity group in 2008. This acquisition was the major change in the history of Tylö. The company went from a "one men show" (Interview Tylö) to a company that is owned by professionals of the same business.

The main consequences of this change were the development of an international thinking and the outsourcing of certain activities. Today, the products of Tylö are sold in more than 90 countries. Moreover, the company recently is moving towards a lean production approach with single unit production. In respect of this development, the company identified the technology of AM as a new technology that could provide additional opportunities for the single unit production approach. Before we will illustrate the impact of AM on the business model, the following Business Model Canvas categories show us the current business activities of Tylö.

4.1.3 Review of our two case companies

Our two case companies are HGF and Tylö. Both of them are SMEs, which are located in Halmstad in Sweden. HGF is a manufacturer of thermoplastic elastomers and rubber products and Tylö a manufacturer of heaters, steam generators, saunas, steam showers, and infrared saunas. Both of them are in the same situation and plan to implement AM. When you compare the companies with regard on the volume of their products, HGF is producing high volumes and Tylö low volumes. Hence, both companies want to deploy AM in different ways. On the one hand, HGF plans to use AM for the manufacturing of low volumes of interior rubber mats and strengthen their product development. On the other hand, Tylö wants to use the opportunities of AM

for their single unit production approach. Since our two case companies work in different business areas our analysis and findings of our study are confirmed for a broader perspective.

4.2 Contemporary Business Model at case companies

In this subchapter, we will illustrate the current business model of our two cases according to our nine building blocks, which emerge from the Business Model Canvas.

4.2.1 HGF

1. Key partnerships

HGF esteems long-term relationships with its customers and suppliers to enhance the supply chain at every stage. For that reason, HGF follows the following slogan. "Together, we can build the strength that makes us competitive against other supply chains" (HGF Lean Academy, 2017). Thus, HGF works with most of its customers and suppliers already for more than 20 years together. Hence, the company has really close buyer-supplier relationships to assure reliable supplies. Furthermore, the company started the HGF Lean Academy to further strengthen the cooperation between its key partners because the company believes "that increased knowledge in all areas in the fields of materials, technologies and lean production can be a catalyst to reach new heights in the development of existing and new products and the way we work together." (HGF Lean Academy, 2017). Due to this, the HGF Lean Academy helps its key partners, when they decide to invest in lean production, to gain full support for the concept and to obtain expertise within the company.

In addition, HGF has also a strategic alliance with the University of Halmstad. For instance, the company and university combine their resources in projects to develop technologies together (Interview HGF).

2. Key activities

One key activity of HGF is the production of rubber products. On account of this, HGF is using several manufacturing technologies. Firstly, the company has a mixing department, where they mix their own compounds for their products. Secondly, the main production technology is in the press shop, where the moulding of the products via compression or injection presses takes place. Occasionally, there is also a step after the moulding, where an assembly or printing is conducted. In addition, HGF focuses within the whole process of production on lean production, to produce as efficiently as possible.

Another key activity of HGF is, since the decision to change the direction of the company from a pure producer of rubber products towards an innovative company, the product development. Therefore, HGF likes to say "lean on us" and enhanced the technical know-how within the company. The product development process goes from the first concept to the finished product and includes six steps. These steps are the design of the product, material selection, CAD engineering, tool manufacturing, lean production and logistic solutions. The aim of HGF is to become the prolonged R&D department of its customers and provide them quick feedback as well as new and improved solutions (Why HGF, 2017). Furthermore, it enables HGF to develop its own products. Currently, HGF developed two products. These products are a rubber horseshoe and a fender for industrial ports and they will start to market these products this year (Interview HGF).

3. Key resources

The physical key resources of HGF are the headquarter in Sweden with its office and production facilities and the production facilities in Latvia. Another key resource of HGF are the approximately 130 employees. Most of them work already for a long period for HGF, which leads to a high degree of experience and knowledge of these employees (About HGF, 2017). Not to neglect is also the intellectual knowledge of the company as a key resource. There is, for instance, the knowledge of creating materials according to the demands of their customers. Furthermore, there is also the HPS, which led to improved efficiency rates, lower scrap, improved delivery performance and to a motivated workforce. Moreover, the company won the Halländska Lean Award also due to the HPS and the jury formulated the success of the HPS as follows "With great determination and dedicated staff, the winner of this award is changing from being a conventional production company into a world-class Lean Enterprise. The winner is an example for all SMEs, not only in Halland but in all of Sweden." (HGF Lean Academy, 2017).

4. Value propositions

HGF delivers with modern machinery and continuous improvement a wide variety of moulded, high-quality rubber and TPE products in its six business areas. The key value proposition is set on selling perfect, high-quality rubber and TPE products, which are developed in close cooperation with the customer. This means HGF is supporting its customers from an idea to a serial product with the aim to provide them quick feedback as well as new and improved solutions for their products. So, HGF’s focus is on tailoring its products to the specific needs of its customers but is still taking advantage of economies of scale to be able to offer its value at a lower price. Furthermore, each customer can either choose a standard proven material from a wide portfolio or HGF

develops a material according to the specifications of the customer. These materials will withstand tough conditions and high demands (About HGF, 2017). Stefan Borg, Sales Manager at HGF, claimed "[…] With new materials, new technology and product development we create value for our customers [...]" (Borg, 2016).

Recently, HGF also started to develop their own products. Currently, there are two products, which are developed by HGF. These products are a rubber horseshoe and a fender for industrial ports and HGF will start to market these two products this year (Interview HGF). Moreover, the fender has already been nominated as one of the finalists of the design award of the magazine Plastforum, which wants to support innovation and better solutions in the plastic, rubber or composite sector (Borg, 2016).

5. Customer relationships

Good and close customer relationships are a key factor of HGF. Because of that, HGF provides on the company website contact information of the management and other employees of the area of finance, sales, research and development, purchasing and materials. Thus, customers can easily find the appropriate contact for any request they have and get personal and professional assistance directly.

HGF develops each product in cooperation with its customers. The company is mostly engaging its customers to assist them with the design of new products. In this way, HGF is going to create value in co-creation with its customers and therefore close customer relationships with personal assistance are very important for HGF. This is also underlined with the following quote of the Sales Manager of HGF: "It’s important for us to establish close relations. […] We want to meet current and potential customers and let them know how we can help them in their product development and in their value chain." (Borg, 2016). From this quote, you can see that the company really values close relations with its customers and tries to support them as good as possible. Furthermore, one guiding principle of the company is to work in close relationships with its suppliers and customers to improve the supply chain in every stage, because then they can create the power to be competitive against other supply chains together (HGF Lean Academy, 2017).

Moreover, to intensify the cooperation and contact with its customers, HGF established the HGF Lean Academy. The HGF Lean Academy has the goal to support its customers when they decide to invest in lean production, as the HPS of HGF has become a great success. In addition to that, Christian Kiks, the CEO of HGF, said in a lean workshop with Eleiko "Lean should not to be restricted to boundaries of your own company [...] It is important for us that

our customers understand our production system. We will be stronger when we act together." (Lean Workshop, 2016).

6. Channels

HGF is a business to business company (B-to-B), which is using a direct sales channel either via its website or personal consulting of its employees. The main tool to reach and communicate with customers is the website of HGF, as there are contact information of the CEO, CFO and other employees, who are responsible for areas such as sales, research and development, purchasing, or materials. In addition, HGF provides on the company website, which is available in five languages, information about the company and its competencies as well as references of long-term relationships with some customers. Furthermore, HGF presents on its website the six business areas the company is working in and products it already developed and produced in each business area to raise the awareness of the customers and to help them to evaluate HGF's value proposition. Therefore, customers can send an inquiry for an idea for a new or existing product in rubber or TPE to HGF on the website. Within the inquiry form they have to provide HGF their name, email, subject, brief message and drawing or specification of the product. After reviewing the inquiry, HGF contacts the customer to find an appropriate solution. So, the customer can either contact an employee of HGF directly via the contact information on the website or send an inquiry on the homepage, but in both cases HGF is developing or improving the product in close cooperation with the customer, to consider all requirements of them and provide them professional advice to receive a high degree of customer satisfaction. This also enables HGF to sell specific products and services to its customers. Moreover, this close and direct cooperation with the producer of the product, without any middleman, is really appreciated by the customers and leads to a high customer loyalty. The distribution channel of HGF is really simple, because the customers are responsible to collect their products from the factories of HGF (Interview HGF; About HGF, 2017).

7. Customer segments

HGF is a B-to-B company, which is operating in six different business areas. These business areas are Automotive, Industrial Products, Marine and Offshore, Mining and Construction, Sealing and Sports. These business areas are quite different and because of that the needs and problems of the customers can vary a lot. But there is one thing, which all customers of all business areas have in common and this is the demand for high-quality TPE and rubber products, what exactly complies with the value proposition of HGF. Therefore, HGF is serving a mass market with moulded, high-quality rubber

and TPE products according to its six business areas and different requirements (Business Areas HGF, 2017).

8. Cost structure

HGF produces high-quality rubber and TPE products and therefore hires skilled employees. Thus, HGFs biggest expenses are the costs for personnel and production facilities as well as the costs for raw materials. Therefore, HGF is characterized by a high proportion of fixed costs.

Moreover, the company follows the vision to become a world-class rubber company. To achieve this vision, HGF introduced the HPS, which is based on lean production principles and led to improved efficiency rates, lower scrap, improved delivery performance, and a motivated workforce (HGF Lean Academy, 2017). Hence, the business model of HGF is more cost-driven than value-driven. Nevertheless, there is also the aspiration of producing high-quality rubber and TPE products but the focus on cutting the fixed and variable costs prevails since the products of HGF have very low margins (Interview HGF).

9. Revenue streams

As a producer of high-quality rubber and TPE products and in relation to their value proposition, HGF creates its revenue by selling TPE and rubber products. In 2016 HGF generated an operating profit of 771 thousand Euros, which is a profit increase of about 0.7% compared to the year before (Largest companies, 2016). The revenue stream of HGF is resulting from one-time payments of its B-to-B customers. The prices that the customers pay are negotiated based on market conditions and negotiation skills (Interview HGF).

4.2.2 Tylö

1. Key partnerships

After the acquisition in late 2008, Tylö went from a totally integrated to a more outsourced business approach. Due to this strategic decision, the company started to establish more partnerships, especially a higher amount of buyer-supplier relationships. Another kind of partnership that was established through the acquisition is the so-called coopetition with the other companies of the private equity group. A coopetition is a strategic partnership between competitors. The management stated: "we are actually fighting towards our sister companies in the world" (Interview Tylö). Nevertheless, the company is owned and managed together with its competitors. "It could happen that we

are producing everything for the European group here" (Interview Tylö), said Managing Director Anders Dahl.

Moreover, Tylö is working occasionally in partnerships with external test laboratories, universities and institutions to keep up-to-date with the latest advances (About Tylö, 2017).

2. Key activities

Tylö is a manufacturing firm since the foundation in 1950. Until today, product development and production remained the key activities of the firm. Every sauna and steam room that bears the name of Tylö is developed, tested and manufactured under their own roof. This means that the company is in control of the whole process, from conceptual design through to the finished product. Tylö´s product developers keep a close eye on current trends in design, interior decoration and architecture and at the same time make full use of the collective experience and know-how in technology, electronics, and materials science. Thus, the development of the products at Tylö is an ongoing process, which has set a benchmark for quality in the industry. Tylö is particularly famous for developing and producing its own heating elements. The sauna heaters are developed and designed to be effective, energy-efficient and reliable in the most demanding situations. The reason for the claim of fame is that no other sauna company except Tylö develops and produces heating elements (Interview Tylö).

The production of the company is constantly in progress and got improved from time to time. Recently, the management decided to shift towards a lean approach with single unit production. Instead of producing according to forecasts and laying the products in stock they are producing for customer orders only. This change also means that they are assembling more than producing. However, they are still doing sheet metal bending and also some welding in-house (Interview Tylö).

3. Key resources

Tylö´s essential assets for the business are physical, human, and intellectual resources. The company has been extended their factory floor in Halmstad more than a dozen times since 1950, most recently to give an area of 20,000 square meters. The factory floor is equipped with sophisticated machines for manufacturing and testing. The headquarter in Halmstad is also providing a modern office area and a showroom, which is not accessible for the public. The showroom in Norway´s capital Oslo, in contrast, is open daily during business hours for tradespeople and homeowners. Additionally, to the showroom, they also have a central warehouse in Oslo (About Tylö, 2017).

Other important resources are the human and intellectual resources. The company employs around 130 people, many of them since decades. Tylö, therefore, benefits from a loyal and highly skilled staff. Moreover, the company is accumulating intellectual know-how since 1950, mainly in the fields of technology, electronics, and material science (Tylö Professional, 2017).

4. Value propositions

The bundle of products and services that create value for the customer are high-quality products, such as heaters, steam generators, saunas, steam showers, and infrared saunas. These products can be found in luxury health spas and hotels, in award-winning homes, even on a super yacht and in a Buddhist monastery (About Tylö Life, 2017). Consequently, the benefits offered to the customers are qualitative in every aspect, particularly in design and customer experience. The company´s commitment to quality is reflected in every part of their operations and is an integral part of their design and product development activities, choice of materials, manufacturing process, service, and support. Hence, Tylö is offering a five-year material warranty for the entire product range, except for accessories (Tylö Support, 2017). As Tylö places high importance on their quality, their standards and claims for quality constitute the heart of their business strategy (About Tylö, 2017). Quality therefore also plays a central role in the mission and vision of the company (4.1.2).

Another value for the customers of Tylö is their active commitment to the long-term protection of the environment. The company is not taking timber from the rainforests. Instead, they use timber from traditional forestry in Sweden, the Baltic countries and North America. All plastic components are manufactured from environmentally certified raw materials. Timber waste is used to make briquettes, plastic waste is ground into granules and every scrap of metal is recycled. These measures reveal that they keep their manufacturing processes completely clean and give high priority to the environment in order to ensure the quality of life we want in the future (About Tylö, 2017).

5. Customer relationships

The company always aims to look after and to focus on the customer. The main tool for a good relationship with the customer is the website, which is available in several languages. On the websites, customers can find everything they need to solve minor problems, such as an extensive FAQ section and a download section with assembly instructions, instructions for use, exploded-view drawings, and design documents. They can also find plenty of helpful information about all products and the sauna experience on the website and the online blog. Another feature that Tylö has installed recently is an online

configuration tool. The ready-made Harmony sauna is a solution for people who want a quick and easy sauna enjoyment, as the sauna gets delivered as prefabricated components that are simple to assemble. This service is based on an easy-to-use online tool and a fully automated system (Tylö Support, 2017).

In addition to automated online services, the customers have the possibility to get in touch through personal assistance. This can be achieved through an international grid of dealers. Over the years, Tylö has provided product training courses for many dealers to ensure that customers receive the very best quality of service. Nevertheless, it is also possible to contact Tylö directly. "Should our clients so require, we can, of course, modify our products to supply different designs, different colours or more exclusive materials than those in our standard offer. In instances where something truly unrivalled is required, we can also develop unique products and solutions exclusively for the project in question" (Tylö Professional, 2017). This personal assistance in the form of a dealer service centre is located in Halmstad and is also managing technical issues, questions about products, or general topics of dealers.

6. Channels

Tylö has different channels to communicate and reach the customers. On the one hand side, there is the internet. The website of Tylö provides extensive information about the product portfolio and general information about the science of sauna. For Swedish customers, it is even possible to shop online on the website. The automated configuration tool is also available for other countries. Customers have the possibility to configure the design, layout, sauna heater, control, and other options for the harmony sauna. Moreover, the company is operating an online blog, a Facebook account, and a YouTube account to provide general inspirations about the world of sauna.

On the other hand side, there is the network of retailers. Tylö is selling to the private consumer only via the website in Sweden, everything else is distributed via retailers or distributors. In Norway and Sweden, products can be purchased from specialist stores and major electrical, construction and hardware retailers (About Tylö, 2017). For the international market, Tylö is listing 124 distributors. There are exceptions: "If the customer is a professional spa, we talk to them directly" (Interview Tylö). In such cases, Tylö designs and manufactures unique products and solutions exclusively for the project in question.

7. Customer segment

Tylö has different kinds of customers, as it is not only practising business-to-business transactions. In Sweden, the company sells directly to the end consumer via the internet shop. The websites of other countries don´t offer the possibility to order directly, but the possibility to get informed about the products. Furthermore, customers are able to create a personalized harmony sauna. The targeted customers are premium customers, people looking for quality of life (About Tylö, 2017). "It could be a spa in Tylösand or a German family in Munich", said Managing Director Anders Dahl (Interview Tylö). High-quality hotels and spas are particularly important customers. Tylö is in control of the whole process, from design to finished product, and therefore describes itself as an ideal partner for such relaxation facilities (Tylö Professional, 2017). Thus, the customer segment can be described as a niche market.

The main group of customers, however, are retailers and distributors. Dependent on the country, Tylö's products can be purchased from distributors, specialist stores, major electrical, construction, and hardware retailers. In Sweden, the company is listing 86 retailers. In Norway, they have 16 retailers who sell to the end consumer. The sauna manufacturer is represented internationally and has established partnerships with distributors in more than 60 countries.

8. Cost structure

The business model of Tylö is neither cost- nor value-driven. Value-driven business models are less concerned with costs and focus more on the value of their products and services (Osterwalder & Pigneur, 2010). Although the sauna company is committed to high quality and value products, the company is still concerned about their costs. In order to stay competitive, fixed and variable costs are tried to keep down. About 130 skilled employees in a high-wage country, facilities in Halmstad and Norway, and advanced equipment are contributing to challenging fixed costs. Variable costs, such as high-quality materials and expensive tooling come in addition to the fixed costs and lead to a cost structure that demands high attention.

9. Revenue streams

There are different ways how a company can generate revenue streams. Tylö´s revenue streams result from one-time payments of retailers or end customers. These revenue streams all include the same pricing mechanism, which is fixed price.

4.3 Changes in the Business Model

Additive Manufacturing is nowadays offering a plenty of opportunities and is still developing. The technology alone, however, doesn't add some value to a company if it isn't commercialized in a lucrative way (Chesbrough & Rosenbloom, 2002). Hence, technology managers must expand their perspectives to find the right business model in order to capture value from it (Chesbrough & Rosenbloom, 2002). The following subchapters show the possible changes of the nine business model categories of HGF and Tylö due to an implementation of AM.

4.3.1 HGF

HGF came up with the idea to implement AM due to requests of customers of the automotive industry. These customers wanted to have a low volume of interior rubber mats with different colours for a special edition car but such products are very expensive to produce with traditional manufacturing as you need a separate mould for every colour. Therefore, HGF was looking for a possibility to fulfil also this demand of its customers and consequently bumped into AM. With AM, these low volumes of special edition interior rubber mats become economically viable as you don’t have to make a mould. Further, according to the CEO of HGF, the trend in the automotive industry is that customers want more and more customization in their cars and AM would enable HGF to produce customized mats. In addition, AM would be very useful for prototyping as well, which is another advantage of the technology (Interview HGF).

Consequently, HGF plans to implement AM only for low volumes of interior rubber mats for the automotive industry but in case of success, there might be opportunities for other products as well. In the following, we are presenting our findings, how the BM of HGF could change, in accordance with an interview with Christian Kiks, the CEO of HGF.

1. Key partnerships

The introduction of AM requires a variety of different interfaces with partners from various areas. It would mainly influence the buyer-supplier relationship since HGF needs to buy the 3D-printers and the material to print. Hence, some of the current suppliers of HGF would become dispensable but there would appear also new material and technology suppliers. The challenge for HGF is to find a supplier, who supplies a material, that complies with the requirements of the customers such as smell or tear resistance and is also printable.

Moreover, the introduction of AM would affect also the cooperation with the university. Due to the rapid development of the technology the purchase of a 3D-printer wouldn´t be a singular occurrence. Thus, HGF has to update the technology constantly, which will create the need for a lot of projects in cooperation with the university to stay pioneer in terms of AM (Interview HGF).

2. Key activities

Through the introduction of AM, the key activities would still be production and product development but it would change the way how these activities are performed in some cases. In terms of producing the interior rubber mats, HGF plans to implement a completely automatic production with AM for the low volumes but the high-volume mats would still be manufactured with traditional manufacturing. Therefore, the company plans to install a 3D-printer and a small robot next to it, which takes out the finished product and the printer could start printing the next one. This would enable HGF firstly to produce interior rubber mats at all times, for instance during the whole night and secondly to produce in Sweden and not in Latvia. Further, it would affect the ability to satisfy the customer, when it comes to these customized low volume interior rubber mats.

Besides that, AM would make the company a lot more competitive regarding product development, since the technology of AM offers HGF much more possibilities of making different designs of the interior rubber mats with different colours. It also makes the step of tool manufacturing of the current product development process superfluous and enables HGF to create prototypes rapidly (Interview HGF).

3. Key resources

The key resources of HGF would be influenced by the introduction of AM as well. It would add 3D-printers and small robots for the automatic production to the physical key resources. Possibly, the number of employees could decrease a little as the low volumes of the interior rubber mats are produced automatically. Furthermore, the intellectual knowledge has to be increased with the knowledge about AM (Interview HGF).

4. Value propositions

Whereas AM is just planned for interior rubber mats, only the value proposition of the business area automotive would be affected. Low volumes of interior rubber mats weren’t feasible for HGF because they are too costly to produce but with AM also these low volumes are economically viable. In addition, with AM there is no limit in customization because everything you can draw is

possible to print. Due to that, AM decreases the restrictions of design and it could integrate the ideas of the customer as well as HGF's own ideas. Consequently, AM permits HGF to offer low volumes of customized interior rubber mats to an appropriate price.

Furthermore, with AM the lead times of the low volumes of the interior rubber mats could be improved very much because you don't need to make a mould and to develop the material. So, usually HGF received a request for a new mat about one and a half years before the launch of the product but with AM you could produce a mat until the next day, respectively you have the material. Hence, in terms of service, that would be a big step ahead. In terms of improving the product it will give HGF flexibility but regarding the product quality, it would be the same (Interview HGF).

5. Customer relationships

The customer relationships would be slightly influenced by implementing AM. HGF develops its products already in close cooperation with its customers but with the help of AM, it could be even more intense. For instance, if the customer design team has an idea, HGF could print a prototype of this idea directly and the customers could see it, feel it and have it in their hands. So, the design loops with the customers would change to the current situation and the value creation via co-creation would be enhanced (Interview HGF).

6. Channels

The channels of HGF wouldn't be affected by the introduction of AM. HGF would remain a B-to-B company with a direct sales channel via its website or personal consulting of its employees and the major tool to reach and communicate with customers would still be the website of HGF. Only the offer of specific and customized products can be improved through AM. Equally to the sales channel, the distribution channel would stay the same as well (Interview HGF).

7. Customer segments

The only business area of HGF, which could be affected by the implementation of AM is the automotive business area, as HGF only plans to implement AM for interior rubber mats. According to Christian Kiks, the customer segments would remain the same. However, AM enables HGF to economically produce low volumes of interior rubber mats and it also facilitates the company to produce customized mats. Hence, with AM the firm would still serve the mass market but it also allows HGF to serve a niche market because it is able to satisfy specific requirements through tailored products (Interview HGF).

8. Cost structure

In consequence of the implementation of AM, there would be some small changes in the cost structure. On the one hand, the investment in new production facilities like 3D-printers and robots would increase the costs. On the other hand, not as much personnel would be needed anymore due to the automatic process and therefore the fixed costs would decrease. In addition, the costs for raw material would be slightly higher since the material for AM is more expensive than for traditional manufacturing. All in all, the costs would be somewhat higher but the customized interior rubber mats have also a higher margin. So, the BM of HGF stays more cost than value-driven but still with a high aspiration of producing high-quality products (Interview HGF).

9. Revenue streams

The revenue streams of HGF wouldn't be affected by the implementation of AM. It would stay exactly the same, except that AM offers the possibility to economically produce low-volume customized interior rubber mats, which have a higher margin (Interview HGF).

4.3.2 Tylö

Due to the recent development of AM, the technology became an interesting opportunity for Tylö. "We are going towards single unit production and we are seeing a possibility in it since room buildings are very unique" (Interview Tylö). Primarily, AM could increase the flexibility that is needed for a customized production. Moreover, the company could benefit from being able to build sophisticated prototypes in plastic for steam generators or the grill (Interview Tylö). Metal printing, which is growing with higher rates than plastic AM, is also a possibility for Tylö (Roland Berger, 2013). Altogether, it could affect the whole product range, from plastic corner nuts that improve production flexibility to the metal top grill of the sauna heater (Interview Tylö).

In an interview with the managing director and a product developer of Tylö, we discussed about AM and how their business model categories have to change in order to capture value from that technology.

1. Key partnerships

The implementation of AM would primarily affect the buyer-supplier relationships. Investments in the technology would require new suppliers not only for materials, such as metal powder but also for technological equipment. The reverse consequence is that some suppliers could get redundant. A

supplier of injection-moulded parts, for instance, could get superfluous, as Tylö is from now on able to 3D-print those parts itself (Interview Tylö).

Another consequence could be a stronger collaboration with the university. The fabrication laboratory (FabLab) of the university is a workshop with modern production technologies, including several 3D-printers. The FabLab employs experts and also provides its equipment to students, who could be potential participants of 3D-printing projects. Both parties already collaborate to produce 3D-prototypes and could intensify their partnership. Tylö could benefit from prospective projects, especially as they lack know-how regarding technological questions, such as: "what materials are available? Is there a need for post-processing? Is the 3D-printer able to print an item at a given time?" (Interview Tylö).

2. Key activities

Product development and production would remain the key activities of the company. AM, however, requires the firm to change the way how these activities are conducted. The possibility of producing complex parts with 3D-printing is shifting the boundaries of product development. Design, interior decoration and architecture can be performed on a much more sophisticated level than before. Hence, product development has to gain in significance for the company.

Tylö is famous for having control over the whole production process, from conceptual design through to the finished product. AM would change the way how some parts are produced, but it won´t change the company´s control over their activities. Quite the opposite would happen. The technology, for instance, could make it redundant to purchase corner nuts, which means that it will promote a more vertically integrated approach. "The reason to do outsourcing is that someone else is better to do that on a large scale" (Interview Tylö). Going towards a customized single unit production with the implementation of AM, therefore, would imply to have a more vertical integrated production in the future (Interview Tylö).

3. Key resources

The implementation of AM will require important changes for the key resources. A quite obvious change is the investment in 3D-printing facilities and materials, which will enlarge the production equipment. Apart from that, physical resources don´t have to be modified. As well as the production equipment, the intellectual know-how has to be enlarged. So far, Tylö has just collaborated with the FabLab to produce some prototypes and therefore has no know-how in 3D-printing. The implementation, however, requires

comprehensive knowledge, as there are plenty of different technologies and materials available.

4. Value propositions

Several parts of the sauna, such as the corner nuts, are made with injection moulding. This way of production is very expensive and is only economically advantageous if you have high volumes. This, in turn, leads to a limited flexibility in room building, as special corner nuts would be needed for unique room concepts. Since there is no expensive tooling required for producing different kinds of corner nuts with AM, this problem could get solved. Thus, the main benefit of AM has to be increased flexibility in both, room building and smaller parts such as the grill of a heater. Through that, the company should be able to offer more variations and customized solutions, potentially for the whole product range (Interview Tylö).

Apart from the flexibility, AM can influence the quality of the products. Not only because they can choose from different materials to produce for instance corner nuts, but also because they produce it in-house (Tylö Interview). This will increase the degree of vertical integration and the control over the quality. Furthermore, AM supports Tylös commitment to the environment. Due to the layer-by-layer process, it reduces the waste compared to subtractive processes. Moreover, the waste material of AM processes is easily recyclable and therefore facilitates Tylö´s recycling efforts (Manyika et al., 2013). The company can only benefit from these aspects when they manage to integrate it in their value propositions and communicate it to the customer.

5. Customer relationships

The majority of products are sold to distributors and retailers. Therefore, Tylö barely has direct contact with the end consumer. Only in exceptional cases, such as the internet shop for the Swedish market or relaxation facilities, Tylö is in touch with the end consumer. The possibility of producing customized parts and rooms will require a closer relationship with the private end customers and spas. The online configuration tool, which is a fully automated system, was the first step to get closer to the customer. "If that customer would like to have something unique in the product, then we have to speak with that customer in some way", was Anders Dahl´s argumentation (Interview Tylö). A good communication with the customer to understand what he needs will be crucial. This is a quite big change for the chain to the end user. The automated online tool for the Harmony sauna, however, is one solution that could get a broader application in the future. This change also brings along the possibility of customer co-creation. According to AM´s mantra

"if you can draw it, you can make it" it could be an option to include the customer in the design process of products.

6. Channels

The need to get closer to the end consumer is also influencing the channels. In order to communicate and to reach the end consumer to deliver their value proposition, Tylö has to get away from their distributor and retailer focused channel network. The managing director stated: "I think if we want to have the effect of unique production we need to communicate with the end user …" (Interview Tylö). This change, however, is not easy, as he is adding: "… but we are working in 90 countries, which is a challenging thing" (Interview Tylö). The best way to meet this challenge could be the internet. Tylö is already using the internet to communicate and partly distribute its products. In order to get closer to the end user globally, the internet could not only help with communication (online marketing) but also with online distribution.

7. Customer segments

When Tylö wants to get closer to the end user, distributors and retailers will sooner or later become redundant. This is a big change, which will not happen overnight, but it can be assumed that there is a correlated development between B-to-B and B-to-C distribution. Tylö would have to strengthen the distribution to the end consumer, through which the importance of the distributor and retailer network will decrease (Interview Tylö).

The segment of the end customer itself will be affected only slightly. Tylö is serving a niche market, which is mainly represented by middle-aged or older people who look for quality in life and professional relaxation facilities. This segment would largely remain the same. Nevertheless, more flexibility and possibilities for customization could address new customers (Interview Tylö).

8. Cost structure

The cost structure, which is neither cost- nor value-driven would largely remain the same. Producing customized saunas will increase the value of the products, but at the same time, the concern about costs wouldn´t cease. "We will check if it's more cost effective to use 3D printing than order the tool", stated managing director Anders Dahl (Interview Tylö). The company assumes that the production of parts with low volume will be economically sensible in the near future. The decision makers, however, will include several factors in their cost-benefit analysis, such as investment costs, operating costs, or saving potential.

9. Revenue streams

The implementation of AM would spawn some minor changes for the revenue streams. The income would still stem from one-time payments from retailers or private customers, but the way of pricing would change. As customization could offer plenty of variations, prices have to derive from the customer's choices. Hence, prices would go away from fixed prices to a variable pricing mechanism.

5 Analysis

This chapter displays our analyses of how the companies have to develop their BM in order to commercialize AM based on our empirical findings and our theoretical framework. According to Skarzynski and Gibson (2008), each segment of a BM has to be opened to see and understand the correlation and interaction between each category. Therefore, we firstly present a theoretical quotation regarding each of our nine categories and then we execute a within-case analysis as well as a cross-case analysis to get a basis for our final conclusion.

1. Key partnerships

Partnerships can help to optimize the allocation of resources, to build economy of scale partnerships, to reduce risk and uncertainty, or to acquire particular resources and activities (Osterwalder & Pigneur, 2010).

HGF

Partnerships are very important for HGF as the company values long-term relationships with its customers and suppliers to improve the supply chain at every stage. Therefore, the implementation of AM wouldn't affect current buyer-supplier relations, as the company is still doing its usual business but is adding AM for low volumes of customized interior mats. However, HGF would need new suppliers of technology and raw materials. Furthermore, the rapid development of the technology forces to constantly update the technology, what creates more room for projects with the university to intensify this cooperation.

Tylö

The introduction of AM would require new suppliers not only for materials, such as metal powder but also for technological equipment. The reverse consequence is that some suppliers could get redundant. Another consequence could be a stronger collaboration with the university. As the company has developed the idea of implementing AM quite recently, they have no know-how yet. The technology of AM is not only a broad and complex subject but is also changing quickly. An intensified collaboration with the university, therefore, could help to clarify contingencies and to spot opportunities.

Cross-case

	Current Business Model (Traditional Manufacturing)	New Business Model (Additive Manufacturing)
HGF	• Good buyer-supplier relations • Cooperation with the university	• New technology and material suppliers • Intensifying the cooperation with the university
Tylö	• Coopetition • Buyer-supplier relations • Collaborations with the university and other institutions	• New technology and material suppliers • Intensifying the cooperation with the university

Table 4: Findings Key Partnerships

Whether buyer-supplier relationships or the cooperation with the university, it can be seen that both companies are maintaining good partnership relations in their business. The implementation of AM could cause changes in two aspects. Firstly, both companies would have to establish new buyer-supplier partnerships for technology (e.g. 3D-printer) and materials (e.g. metal powder, rubber). Secondly, HGF and Tylö could intensify their cooperation with the University of Halmstad. SME´s usually don´t have proper R&D departments or technology teams that can focus on the possibilities of new emerging technologies. Therefore, both companies could benefit from projects with the university, in which questions about the technology can be clarified.

2. Key activities

Key Activities are the most important actions a company must do to make its business model work successfully. They build the basis to create and offer a value proposition, reach markets, and maintain customer relationships.

HGF

With the implementation of AM, the key activities of HGF would remain production and product development. But with AM the firm would have a new and automatic manufacturing technology to produce its interior rubber mats and the technology offers HGF much more possibilities of making different designs with different colours. In addition, it enables HGF to rapidly produce a prototype of any product.

Tylö

Like at HGF, product development and production would remain the key activities of Tylö. Both activities even will gain in significance, as the way how these activities are conducted will change. 3D-printing is shifting the boundaries of product development and creates new possibilities and significance for prototyping, product design, interior decoration and architecture. Moreover, AM would increase the possibilities to produce in-house instead of purchasing certain parts from the supplier. This would increase the importance of production and the control over the whole process.

Cross-case

	Current Business Model (Traditional Manufacturing)	New Business Model (Additive Manufacturing)
HGF	• Production • Product development	• Additional and automatic manufacturing technology • Upgrade product development • Rapid prototyping
Tylö	• Production • Product development	• Upgrade product development • More vertical integrated production • Rapid Prototyping

Table 5: Findings Key Activites

Both companies are manufacturing firms, which focus on product development and production. These key activities got developed and improved over a long period of time. Even AM is not changing this development of key activities, quite the opposite is the case: The implementation of AM requires to modernize the manufacturing technology and to strengthen the activities of product development. While HGF could imagine implementing an entirely new automatic manufacturing process for customized rubber mats, Tylö is firstly planning to use AM for corner nuts or other parts of the sauna. In both cases, it can be said that the production facilities will be modernized and improved. Both companies also see the benefit of rapid prototyping, as the additive "layer-by-layer" technology is providing new possibilities for product design and development. In order to benefit from the technology, product development has to play an even more important role for HGF and Tylö. The study of Roland Berger (2016) supports this implication as they identified that advanced product designs will be a key factor for success in AM production.

3. Key resources

Key resources represent the essential assets required to run the business. They are the basis of business because they enable a company to offer a value proposition, sustain relationships with customer segments, reach markets and earn revenues. (Osterwalder & Pigneur, 2010).

HGF

HGF plans to implement a completely automatic production with AM for low volumes of interior rubber mats. Consequently, the implementation of AM would slightly influence the key resources as new machines, more precisely 3D-printers and small robots would be added to the production facilities. Moreover, fewer employees are needed due to the automatic production and the knowledge about AM has to be gathered.

Tylö

The implementation of AM will bring along important changes for the key resources. Apart from the new 3D-printing machines, which will enlarge the production equipment, physical resources will be not affected. The intellectual know-how will be and has to be enlarged, as Tylö has so far just collaborated with the FabLab to produce prototypes and therefore has no know-how in 3D-printing.

Cross-case

	Current Business Model (Traditional Manufacturing)	**New Business Model (Additive Manufacturing)**
HGF	• Production facilities • Employees • Current knowledge	• Additional production facilities • Gather new knowledge about AM
Tylö	• Buildings (production area, showrooms) • Production facilities • Employees and knowledge	• Additional production facilities • Gather new knowledge about AM

Table 6: Findings Key Resources

HGF and Tylö have similar key resources that are the basis for today's business. Both within-case analyses show similar changes, which have to be done to implement AM successfully. First of all, new production facilities are required. Investments in appropriate equipment will be crucial for an effective

implementation of AM and therefore have to be well-conceived. A precondition for that is a profound knowledge about AM, which represents the second change. Both firms lack knowledge about AM and have to gather it before any decision regarding the technology is done. Complex and technology-intensive business environments lead to a more and more knowledge-focused approach (IEC, 2015), which underlines the importance of this change.

4. Value propositions

A value proposition is a product or service that creates value for the customer. Principally, it solves problems or satisfies needs for a specific customer segment. The benefits offered to the customers can be quantitative (e.g. price, speed) or qualitative (e.g. design, customer experience) and can be defined by elements such as newness, performance, design, price, brand, or customization (Osterwalder & Pigneur, 2010).

HGF

Without AM low volumes of interior rubber mats aren't feasible for HGF because they are too costly to produce. But with AM also these low volumes are economically viable, as you don't have to make a mould and develop the material. Adding to that, the lead times for these low volumes could be improved very much. Moreover, AM decreases the restrictions in design. So, there would be no limit in customization and HGF could produce special edition mats for its customers. Conclusively, regarding the product, it would give HGF flexibility and in terms of service, it would be a step ahead but the product quality would still be the same.

Tylö

The main benefit and change through AM has to be increased flexibility in both, room building and smaller parts such as the grill of a heater. Through that, the company would be able to improve its qualitative offer with more variations and customized solutions, potentially for the whole product range. The control over the quality will increase, as AM generates the possibility to go back to a more integrated business approach. Furthermore, AM supports Tylös commitment to the environment and brings sustainability efforts to the next level. The company can only benefit from these two aspects when they manage to integrate it in their value propositions and communicate it to the customer.

Cross-case

	Current Business Model (Traditional Manufacturing)	New Business Model (Additive Manufacturing)
HGF	• Perfect, high-quality rubber and TPE products	• Low volumes of customized interior rubber mats • Improved lead times
Tylö	• High-quality sauna products	• Customized products • Communicate higher quality control and environment benefits

Table 7: Findings Value Propositions

The value propositions of both companies are high-quality products. The production of those products is based on traditional technologies, which require expensive tooling and casting moulds. Thus, only high volumes are economically feasible at the moment. The implementation of AM would change the structure of manufacturing costs and would make it cheaper to produce low volumes. As a consequence, HGF and Tylö would be able to offer more customized products to create new value for their customers. Apart from the higher flexibility in production, both firms can offer additional values through the integration of AM. HGF, for instance, has the chance to improve their lead times and also to integrate an automated production line with AM. Tylö, by contrast, can get higher control over the quality as parts like corner nuts can be produced instead of purchased. The key to success will be the companies' ability to integrate these improvements into their value propositions for the customers.

5. Customer relationships

Customer relationships explain the different types of relationships a company establishes with specific customer segments. In order to keep and acquire customers or to boost sales, companies can build several categories of customer relationships (Osterwalder & Pigneur, 2010).

HGF

As HGF already develops its products in close cooperation with its customers e.g. the customers are involved in designing the products, HGF could intensify this cooperation even more with the implementation of AM. Because AM facilitates HGF to print a prototype of an idea of a product directly and then customers are able to see it, feel it and have it in their hands. Consequently,

the loops of designing the products with the customers would change to the current situation and the value creation via customer co-creation would be improved.

Tylö

Today, the majority of products are sold to distributors and retailers. The possibility of producing customized parts and rooms, however, will require a closer relationship with the private end user and spas. The online configuration tool was a first step to "speak" directly to the customer. This change also brings along the possibility of customer co-creation. According to AM's mantra "if you can draw it, you can make it" it could be an option to include the customer in the design process of products.

Cross-case

	Current Business Model (Traditional Manufacturing)	New Business Model (Additive Manufacturing)
HGF	• Close cooperation with its customers with personal assistance • Customer co-creation	• Closer relationship with its customers • Enhanced customer co-creation
Tylö	• Mainly distributors and retailers • Internet shop for Swedish customers	• Closer relationship with the end customer • Customization through customer co-creation

Table 8: Findings Customer Relationships

It can be seen that both companies, HGF and Tylö, value its customer relationships. But with the implementation of AM, both companies would have to intensify these close customer relationships due to the possibility of manufacturing customized products. For instance, HGF would be able to print a prototype of a customer idea directly and Tylö has to focus more on private end-users. Further, with AM both companies have the ability to involve the customer in the design process to co-create the product according to the requirements of the customers.

6. Channels

Channels describe how a company communicates with and reaches customers to deliver their value proposition (Osterwalder & Pigneur, 2010).

HGF

The channels of HGF won't be affected by the implementation of AM. The company would continue as a B-to-B company with a direct sales channel via its website or personal consulting of its employees. Further, the website would stay the main tool to reach and communicate with its customers. Just the offer of specific and customized interior rubber mats would be extended and the customers would still be responsible to collect their products at HGF.

Tylö

If Tylö wants to get closer to the end user, they have to establish a communication network to reach the end user directly. Thus, the network of distributors and retailers would lose in significance, which is a challenging change. The best way to meet this challenge could be the internet. Tylö is already using the internet to communicate and partly distribute its products. In order to get closer to the end user globally, the internet could not only help with communication (online marketing) but also with online distribution.

Cross-case

	Current Business Model (Traditional Manufacturing)	New Business Model (Additive Manufacturing)
HGF	• Direct sales channel via the company website or personal consulting • Customers are responsible to collect their products	• No significant changes
Tylö	• Distributors and retailers • Internet (online shop, social media)	• Direct end-user communication and distribution • Use Internet as global communication and distribution tool

Table 9: Findings Channels

For the building block Channels, the within-case analyses show different results. The main reason for that are the differences in the current business model. While HGF is a B-to-B company and is only making business directly with its customers, Tylö´s business is mainly based on a network of distributors and retailers. With the introduction of AM, Tylö would have to come closer and communicate straight to the end-user. This is a big change, which could be accomplished with a stronger use of the internet. HGF, in contrast,

only has to adapt their offer for customized products. Although the cases show different implications, it can be said that the distribution of more customized products require a direct communication and distribution to the end-user. The way towards a closer communication and distribution with the end-user could be achieved with the help of the internet, especially for international businesses like Tylö.

7. Customer segments

Customer segments define the different groups of people or organizations a company attempts to reach and serve. These different segments are grouped by a company due to identical needs, behaviours or other attributes. Profitable customers are crucial for long-term survival and thus represent the heart of any business model (Osterwalder & Pigneur, 2010).

HGF

AM would slightly influence the customer segments of HGF. The focus of the firm would remain on B-to-B and the mass market but AM offers new opportunities for HGF. By the use of AM, HGF is able to produce tailored interior rubber mats with special designs and different colours in low volumes. Therefore, AM facilitates HGF to serve also a niche market with customized products e.g. for special edition cars but the customer segment would mainly remain the same.

Tylö

When Tylö wants to get closer to the end user, distributors and retailers will sooner or later become redundant. If Tylö strengthens the distribution to the end consumer gradually, the importance of the distributor and retailer network will decrease (Interview Tylö).

The segment of the end customer itself will be not affected significantly. Tylö is serving a niche market, which is mainly represented by middle-aged or older people who look for quality in life and professional relaxation facilities. This segment would largely remain the same. Nevertheless, more flexibility and possibilities for customization could address new customers (Interview Tylö).

Cross-case

	Current Business Model (Traditional Manufacturing)	New Business Model (Additive Manufacturing)
HGF	• Only B-to-B • Mass market	• Serve a niche market with tailored products
Tylö	• Mainly B-to-B • People who look for quality in life	• Focus on B-to-C

Table 10: Findings Customer Segments

The analyses of the two cases show that only minor changes are required for the customer segments. The main impact of AM is an increased flexibility in production and the possibility of customized products. The kind of products, however, wouldn´t get influenced, which means that the people both companies attempt to reach doesn´t has to change. Nevertheless, possibilities regarding customized low-volume solutions could address some new customers. Thus, both firms should consider the chance to identify new customers, especially HGF within other business areas with lower volumes. Tylö has to get closer to the end-user and therefore has to shift its focus from B-to-B to B-to-C.

8. Cost structure

Cost structure represents all costs necessary to operate the BM. The importance of cost structures varies from business to business and can be generally divided in cost- and value-driven BMs (Osterwalder & Pigneur, 2010).

HGF

There would be some small changes in the cost structure. Additional costs for the investment of the new production facilities and the raw material would occur. However, less personnel would be needed due to the automatic process and therefore the fixed costs would decrease. To sum up, the costs would be a little higher but the customized interior rubber mats have also a higher margin. So, the BM of HGF would remain more cost than value-driven but still with a high aspiration of producing high-quality products.

Tylö

The cost structure, which is neither cost- nor value-driven, would largely remain the same. Producing customized saunas will increase the value of the products, but at the same time, the concern about costs wouldn´t cease. Decisions regarding AM will include several factors in their cost-benefit analysis, such as investment costs, operating costs, or saving potential.

Cross-case

	Current Business Model (Traditional Manufacturing)	New Business Model (Additive Manufacturing)
HGF	• More cost-driven with high aspiration of producing high-quality products	• Slightly higher costs
Tylö	• Neither cost- nor value-driven	• Cost-benefit analysis for decisions

Table 11: Findings Cost Structure

The cost structure of both cases would only be influenced marginally through the implementation of AM. In both cases, it has to be carefully considered if the implementation economically makes sense. The saving potential or higher margins should at least be in balance with the investment and operating costs. However, in the case of HGF, the saving potential of less needed personnel and the higher margin of customized interior rubber mats should benefit an implementation of AM. Tylö has to consider more thoroughly if the higher value of the customized products defrays the costs for AM.

9. Revenue streams

Revenue Streams describes the cash a company earns from each customer segment. Companies have to clarify what value each customer segment is willing to pay and how to create revenue streams for each customer segment. In general, it can be divided into revenue stream resulting from one-time payments or recurring revenue streams resulting from ongoing payments.

HGF

The revenue streams of HGF wouldn't be affected by the implementation of AM. AM only offers HGF the possibility to economically produce low-volume customized interior rubber mats with a higher margin.

Tylö

The implementation of AM would spawn some minor changes for the revenue streams. The income would still stem from one-time payments from retailers or private customers, but the way of pricing would change. As customization could offer plenty of variations, prices would derive from the customer's choices. Hence, prices would rather go away from fixed prices to a variable pricing mechanism.

Cross-case

	Current Business Model (Traditional Manufacturing)	New Business Model (Additive Manufacturing)
HGF	• One-time payments • Dynamic prices based on market conditions and negotiation skills	• No significant changes
Tylö	• One-time payments • Fixed prices	• Variable pricing mechanism for customized products

Table 12: Findings Revenue Streams

The impact of AM on the building block revenue streams is irreducibly. For HGF nothing except the ability to manufacture customized interior rubber mats with a higher margin would change. But the income would still come from one-time payments with dynamic prices. Tylö would retain also the one-time payments of its customers but because of the customization of the products, the firm would change its pricing mechanism from fixed to variable prices.

Summary of main findings:

The following table shows a summary of our main findings. As main findings, we define the necessary changes in the BM for both of our cases.

Category	Company	New Business Model (Additive Manufacturing)
Key partnerships	HGF, Tylö	• New technology and material suppliers • Intensifying the cooperation with the university
Key activities	HGF, Tylö	• Upgrade product development
Key resources	HGF, Tylö	• Establish additional production facilities (3D-printers, etc.) • Gather new knowledge about AM
Value propositions	HGF, Tylö	• Offer customized products
Customer relationships	HGF, Tylö	• Closer relationship with the (end) customer • Enhance customer co-creation
Channels	HGF	• No significant changes
	Tylö	• Direct end customer communication and distribution via internet
Customer segments	HGF, Tylö	• No significant changes
Cost structure	HGF, Tylö	• No significant changes
Revenue streams	HGF	• No significant changes
	Tylö	• Variable pricing mechanism for customized products

Table 13: Summary of Main Findings

The table presents all required implications for the integration of AM. All nine building blocks of the Business Model Canvas were taken into account for HGF and Tylö. In the following chapter, the results of the main findings are discussed.

5 Conclusion

This chapter presents the key findings and final conclusions of our study. We will refer to the purpose of our study presented in the first chapter. Furthermore, limitations connected to the study and suggestions for further research will be shown.

The purpose of our study was to explore how companies have to develop their business model in order to commercialize Additive Manufacturing. First of all, our study confirms scholars like Piller et al. (2015) or Rayna & Striukova (2014), who stated the need for business model innovation for the implementation of AM. When we conducted the within-case analyses we could reveal plenty of changes, which are required to commercialize the technology. The changes, however, distinguish themselves in respect of importance. We could, for instance, identify only minor adjustments for the within-case analyses of the building block cost structure. Both cost structures would largely remain in between cost- and value-driven. HGF would expect to have slightly higher costs, Tylö stated that every decision regarding AM will be based on a cost-benefit analysis. We evaluated these implications to be not significant and therefore didn´t include them in our main findings. The same is true of the building block customer segments. The kind of products wouldn´t get influenced by AM, which means that the people both companies attempt to reach don't have to change significantly.

The cross-case analysis resulted in an accordance of 7 building blocks. The main findings only showed differences within the building blocks channels and revenue streams. While there are no significant changes needed in the two building blocks of HGF, Tylö´s business model would have to develop both of them. As the existing channels were created for the communication and distribution to distributors and retailers, Tylö has to establish a direct end customer communication and distribution via the internet. The direct and customized distribution, in turn, would require a variable pricing mechanism for the revenue streams of Tylö. The differences in these two building blocks imply that it can be not generalized how to develop a business model for the implementation of AM. The reason for that are the disparities of the businesses and its existing business models. Moreover, the degree of implementation of AM depends on the products and devices of the company.

Nevertheless, we could identify many accordances in our cross-case analysis. Seven building blocks, including key partnerships, key activities, key resources, value propositions, customer relationships, customer segments, and cost structure reveal similar main findings. The two latter ones were mentioned in the first paragraph of the conclusion, as they turned out to take

no significant changes. The building block key partnerships presents the same changes but is estimated less important than the other four blocks. If the companies decide to invest in AM, new buyer-supplier relationships are required but this is also a logic consequence. Apart from that, the collaboration with the university or in general with academia should be intensified.

Thus, we define the following four building blocks and the corresponding changes, which are illustrated in table 14, as the most important ones to commercialize AM.

Category	Company	New Business Model (Additive Manufacturing)
Key activities	HGF, Tylö	• Upgrade product development
Key resources	HGF, Tylö	• Establish additional production facilities (3D-printers, etc.) • Gather new knowledge about AM
Value propositions	HGF, Tylö	• Offer customized products
Customer relationships	HGF, Tylö	• Closer relationship with the (end) customer • Enhance customer co-creation

Table 14: Most necessary changes to commercialize AM

Key activities

The implementation of AM would require to upgrade the product development skills and capabilities. The technology of AM is shifting the limitations of design, as the processes enable the production of products in almost any shape and complexity. "If you can draw it, you can make it" is a famous idiom about AM, which already implies the increasing importance of drawing/designing. It is obvious that required changes always depend on the existing skills and capabilities. Nevertheless, it can be claimed that AM decreases the added value of the production and raises the added value of product development.

Key resources

Another important change has to occur in the building block key resources. Both companies came up with the idea to implement AM recently and have so far no or just very limited knowledge about AM. A profound know-how though is a precondition for a successful implementation, as every decision regarding

AM is based on the knowledge of the firm. In order to acquire crucial know-how, both firms could benefit from the already mentioned collaboration with the university. Another change for the key resources, which is more obvious, is the investment in appropriate production facilities.

Value propositions

The integration of AM makes it economically sensible to produce lower volumes of parts or products. While HGF plans to produce the whole product (rubber mat) with AM, Tylö has only ambitions to use the technology for parts (e.g. corner nuts). Still, both firms can benefit from the integration in respect of higher flexibility and customized designs. The crucial point is that the companies have to integrate those benefits in their value propositions in order to provide a higher customer value.

Customer relationships

The fourth building block that is expected to undergo important changes is customer relationships. Due to the possibility of producing customized products, customer opinions and requests have to get more attention from the firms. HGF has already established close relationships with its customers but should use the technology to improve their service, for instance through rapid prototyping. Tylö has recently introduced an automated configuration tool for a ready-made sauna and could extend this online service. This is also a first step towards customer co-creation, which is an interesting opportunity for both companies. These changes are particularly important for Tylö, as the company is primarily doing business with distributors and retailers so far and therefore, first of all, has to establish relationships with its end customers.

Systematic step-by-step approach

These changes are enormous and challenging and cannot be done overnight. Business model innovation is a process, which has to be thought out well and executed over a longer period. HGF and Tylö are at the beginning of the process to commercialize AM and can be assigned to the group of companies that possibly invest in AM over the next 12 to 24 months. It will be important for the companies to follow a systematic step-by-step approach, in which the acquisition of AM know-how has to be step one. Key partnerships or external experts/consultants could be helpful right from the beginning, as early decisions will determine further success.

5.1 Limitations and further research

Our findings are based on two case studies where we had the opportunity to investigate how companies have to develop their business model to commercialize AM. Our empirical data is based on interviews with HGF and Tylö, who recognized the possibilities of AM recently. Thus, both firms neither have experience with AM nor a profound knowledge about the technology. As a consequence, all our data is based on assumptions of the management. An interesting alternative, therefore, would be to conduct a retrospective study with a company or companies that have already implemented AM. This type of study would make it possible to investigate the process of business model innovation in a context of time to explore patterns of a methodical step-by-step approach.

Another limitation that leads to a possibility of further research is the restricted scope of AM at HGF and Tylö. At HGF, AM would initially only affect a small part (low volume rubber mats) of one business area (six areas in total). At Tylö, AM could only produce parts of the portfolio, such as corner nuts or the grill of a sauna heater. During our study following question arose: "How would the business model have to be developed for a pure AM production". Assumed, that a company is producing a specific type of toys, which could be completely produced with AM. A study about the business model innovation study of a manufacturing firm that has this characteristic would be needed to understand such implications.

References

About HGF (2017). Link: http://www.hgf.se/en-GB/about-hgf-29706512 [Access: 08.07.2017]

About Tylö (2017). Link: http://www.tylo.com/about-tylo [Access: 08.07.2017]

About Tylö Life (2017). Link: https://www.tylolife.co.uk/about/ [Access: 22.06.2017]

Afuah, A. (2014). Business model innovation: concepts, analysis, and cases. Routledge.

Alt, R., & Zimmermann, H. D. (2001). Preface: introduction to special section–business models. Electronic markets, 11(1), 3-9.

Allabolag (2016). Link: http://www.allabolag.se/5560516188/aktiebolaget-halmstads-gummifabrik [Access: 27.06.2017]

Amit, R., & Zott, C. (2010). Business model innovation: Creating value in times of change.

ASTM International. (2012). ASTM F2792—12a: Standard Terminology for Additive Manufacturing Technologies. ASTM International. Retrieved from www.astm.org/Standards/F2792.htm [Access: 23.02.2017]

Baden-Fuller, C., & Haefliger, S. (2013). Business models and technological innovation. Long range planning, 46(6), 419-426.

Baden-Fuller, C., & Morgan, M. S. (2010). Business models as models. Long range planning, 43(2), 156-171.

Bellman, R., Clark, C. E., Malcolm, D. G., Craft, C. J., & Ricciardi, F. M. (1957). On the construction of a multi-stage, multi-person business game. Operations Research, 5(4), 469-503.

Bernard, A., & Fischer, A. (2002). New trends in rapid product development. CIRP Annals-Manufacturing Technology, 51(2), 635-652.

Berman, B. (2012). 3-D printing: The new industrial revolution. Business horizons, 55(2), 155-162.

Bogers, M., Hadar, R., & Bilberg, A. (2016). Additive manufacturing for consumer-centric business models: Implications for supply chains in

consumer goods manufacturing. Technological forecasting and social change, 102, 225-239.

Borg (2016) Link: http://www.hgf.se/2016/10/31/en-GB/hgf%E2%80%99s-fender-looking-to-bring-home-design-award-at-the-elmia-subcontractor-fair-33966399 [Access: 28.07.2017]

Bryman, A. (2015). Social research methods. Oxford university press.

Bryman, A., & Bell, E. (2011). Business research methods.

Business Areas HGF (2017). Link: http://www.hgf.se/en-GB/business-areas-29706441 [Access: 20.07.2017]

Campbell, T., Williams, C., Ivanova, O., & Garrett, B. (2011). Could 3D printing change the world. Technologies, Potential, and Implications of Additive Manufacturing, Atlantic Council, Washington, DC.

Casadesus-Masanell, R., & Zhu, F. (2013). Business model innovation and competitive imitation: The case of sponsor-based business models. Strategic management journal, 34(4), 464-482.

Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. Industrial and corporate change, 11(3), 529-555.

Cliffe, S., & McGrath, R. G. (2011). When your business model is in trouble.

Cohen, L., Manion, L., & Morrison, K. (2013). Research methods in education. Routledge.

Conner, B. P., Manogharan, G. P., Martof, A. N., Rodomsky, L. M., Rodomsky, C. M., Jordan, D. C., & Limperos, J. W. (2014). Making sense of 3-D printing: Creating a map of additive manufacturing products and services. Additive Manufacturing, 1, 64-76.

Corley, K. (2012). Publishing in AMJ—Part 7: What's different about qualitative research?. Academy of management Journal, 55(3), 509-513.

Cua, F. and Theivananthampillai, P., (2009) Understanding Quality in Qualitative Research in IS: A Practitioners Road Map, [Online] 18, 1-16. Available from: otago.ourarchive.ac.nz/bitstream/handle/10523/1557/18_Paul_Understanding_qualititative_research_in_IS__A.pdf [Access: 24.05.2017].

Danneels, E. (2004). Disruptive technology reconsidered: A critique and research agenda. Journal of product innovation management, 21(4), 246-258.

Duhigg, C. and Bradsher K. (2012). How the U.S. Lost Out on iPhone Work. The New York Times. Link: http://www.nytimes.com/2012/01/22/business/apple-america-and-a-squeezed-middle-class.html [Access: 18.08.2017]

Eisenhardt, K. M. (1989). Building theories from case study research. Academy of management review, 14(4), 532-550.

European Commission (2013) - Factories of the Future. Link: http://www.effra.eu/attachments/article/129/Factories%20of%20the%20Future%202020%20Roadmap.pdf [Access: 10.04.2017]

Gambardella, A., & McGahan, A. M. (2010). Business-model innovation: General purpose technologies and their implications for industry structure. Long range planning, 43(2), 262-271.

Gardan, J. (2016). Additive manufacturing technologies: State of the art and trends. International Journal of Production Research, 54(10), 3118-3132.

Ghauri, P. N., & Grønhaug, K. (2005). Research methods in business studies: A practical guide. Pearson Education.

Gibson, I., Rosen, D., & Stucker, B. (2014). Additive manufacturing technologies: 3D printing, rapid prototyping, and direct digital manufacturing. Springer.

Giesen, E., Berman, S. J., Bell, R., & Blitz, A. (2007). Three ways to successfully innovate your business model. Strategy & leadership, 35(6), 27-33.

Gross, B. C., Erkal, J. L., Lockwood, S. Y., Chen, C., & Spence, D. M. (2014). Evaluation of 3D printing and its potential impact on biotechnology and the chemical sciences.

Guo, N., & Leu, M. C. (2013). Additive manufacturing: technology, applications and research needs. Frontiers of Mechanical Engineering, 8(3), 215-243.

Hamel, G., & Ruben, P. (2000). Leading the revolution (Vol. 286). Boston, MA: Harvard Business School Press.

Heskett, J. L., & Schlesinger, L. A. (1994). Putting the service-profit chain to work. Harvard business review, 72(2), 164-174.

Hessman, T. (2013). The dawn of the smart factory. Industry Week, 14, 14-19.

HGF Lean Academy (2017). Link: http://www.hgf.se/en-GB/hgf-lean-academy-29706600 [Access: 16.07.2017]

Hiemenz, J. (2014). Additive manufacturing trends in aerospace. White Paper, Stratasys, USA, 1-11.

Horn, T. J., & Harrysson, O. L. (2012). Overview of current additive manufacturing technologies and selected applications. Science progress, 95(3), 255-282.

Huang, S. H., Liu, P., Mokasdar, A., & Hou, L. (2013). Additive manufacturing and its societal impact: a literature review. The International Journal of Advanced Manufacturing Technology, 1-13.

Hyde, K. F. (2000). Recognising deductive processes in qualitative research. Qualitative market research: An international journal, 3(2), 82-90.

IEC (2015). Factory of the future. Link: http://www.iec.ch/whitepaper/pdf/iecWP-futurefactory-LR-en.pdf [Access: 16.04.2017]

Jacques, M. (2012). When China rules the world: The rise of the middle kingdom and the end of the western world. Penguin UK.

Johnson, M. W., Christensen, C. M., & Kagermann, H. (2008). Reinventing your business model. Harvard business review, 86(12), 57-68.

Jones, G. M. (1960). Educators, electrons, and business models: a problem in synthesis. The Accounting Review, 35(4), 619-626.

Kaplan, R. S., & Norton, D. P. (2001). The strategy-focused organization. Strategy and Leadership, 29(3), 41-42.

Khorram Niaki, M., & Nonino, F. (2017). Additive manufacturing management: a review and future research agenda. International Journal of Production Research, 55(5), 1419-1439.

Kietzmann, J., Pitt, L., & Berthon, P. (2015). Disruptions, decisions, and destinations: Enter the age of 3-D printing and additive manufacturing. Business Horizons, 58(2), 209-215.

Kothari, C. R. (2008). Research Methodology: Methods and Techniques. Delhi: New Age International Publishers.

KPMG (2016) - Global Manufacturing Outlook. Link: https://assets.kpmg.com/content/dam/kpmg/pdf/2016/05/global-manufacturing-outlook-competing-for-growth.pdf [Access: 02.05.2017]

Krefting, L. (1991). Rigor in qualitative research: The assessment of trustworthiness. American journal of occupational therapy, 45(3), 214-222.

Largest companies (2016) Link: http://www.largestcompanies.com/company/Halmstads-Gummifabrik-AB-4705/closing-figures-and-key-ratios?currency=EUR [Access: 03.08.2017]

Lean Workshop (2016) Link: http://www.hgf.se/2016/10/05/en-GB/eleiko-and-hgf-run-a-lean-workshop-together-33641686 [Access: 30.07.2017]

Linder, J. and Cantrell, S. (2000) Changing Business Models: Surveying the Landscape, Accenture Institute for Strategic Change, Cambridge.

Lindgren, P., Taran, Y., & Boer, H. (2010). From single firm to network-based business model innovation. International Journal of Entrepreneurship and Innovation Management, 12(2), 122-137.

Magretta, J. (2002). Why business models matter.

Manyika, J., Chui, M., Bughin, J., Dobbs, R., Bisson, P., & Marrs, A. (2013). Disruptive technologies: Advances that will transform life, business, and the global economy (Vol. 180). San Francisco, CA: McKinsey Global Institute.

Markides, C., & Charitou, C. D. (2004). Competing with dual business models: A contingency approach. The academy of Management executive, 18(3), 22-36.

Markides, C. (2006). Disruptive innovation: In need of better theory. Journal of product innovation management, 23(1), 19-25.

Mees, H. (2016). China as the World's Factory. In The Chinese Birdcage (pp. 21-32). Palgrave Macmillan US.

Mellor, S., Hao, L., & Zhang, D. (2014). Additive manufacturing: A framework for implementation. International Journal of Production Economics, 149, 194-201.

Mitchell, D., & Coles, C. (2003). The ultimate competitive advantage of continuing business model innovation. Journal of Business Strategy, 24(5), 15-21.

Müller, A. & Karevska S. (2016) - EY´s Global 3D printing report 2016. Link: http://www.ey.com/Publication/vwLUAssets/ey-global-3d-printing-report-2016-full-report/$FILE/ey-global-3d-printing-report-2016-full-report.pdf [Access: 20.07.2017]

Nielsen, C., & Roslender, R. (2014). Frameworks for understanding and describing business models. In The Basics of Business Models (Chapter 4, pp. 55-74). Ventus.

Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying business models: Origins, present, and future of the concept. Communications of the association for Information Systems, 16(1), 1.

Osterwalder, A. and Pigneur, Y., (2010) Business model generation, Amsterdam: Alexander Osterwalder & Yves Pigneur.

Peecher, M. E., Schwartz, R., & Solomon, I. (2007). It's all about audit quality: Perspectives on strategic-systems auditing. Accounting, Organizations and Society, 32(4), 463-485.

Petrick, I. J., & Simpson, T. W. (2013). 3D printing disrupts manufacturing: how economies of one create new rules of competition. Research-Technology Management, 56(6), 12-16.

Piller, F. T., Weller, C., & Kleer, R. (2015). Business models with additive manufacturing—opportunities and challenges from the perspective of economics and management. In Advances in Production Technology (pp. 39-48). Springer International Publishing.

Polkinghorne, D. E. (2005). Language and meaning: Data collection in qualitative research. Journal of counseling psychology, 52(2), 137.

Ponfoort, O., Ambrosius, W., Barten, L., Duivenvoorde, G., van den Hurk, L., Sabirovic, A., Teunissen, E., 2014. Successful Business Models for 3D Printing: Seizing Opportunities with a Game Changing Technology. Berenschot, Utrecht.

Teunissen, E., 2014. Successful Business Models for 3D Printing: Seizing Opportunities with a Game Changing Technology. Berenschot, Utrecht.

Print me a Stradivarius: How a new manufacturing technology will change the world. (2011, February 17). The Economist, p. 7.

Rayna, T., & Striukova, L. (2014). The impact of 3D printing technologies on business model innovation. In Digital enterprise design & management (pp. 119-132). Springer International Publishing.

Rayna, T., & Striukova, L. (2016). From rapid prototyping to home fabrication: How 3D printing is changing business model innovation. Technological Forecasting and Social Change, 102, 214-224.

Roland Berger Ltd. (2013). Additive manufacturing - A game changer for the manufacturing industry?, Link: https://www.rolandberger.com/publications/publication_pdf/roland_berger_additive_manufacturing_next_generation_amnx_study_20160412.pdf [Access: 13.02.2017].

Roland Berger Ltd. (2016). Additive manufacturing – next generation AMnx, Link: https://www.rolandberger.com/publications/publication_pdf/roland_berger_additive_manufacturing_next_generation_amnx_study_20160412.pdf [Access: 24.03.2017].

Rifkin, J. (2012). "The third industrial revolution", available at: www.economist.com/node/21552901 [Access: 27.04.2017].

Rudd, M. (2011, January 16). Next, we'll print out a curly iPhone. The Sunday Times Review, p. 7.

Sandström, C. G. (2016). The non-disruptive emergence of an ecosystem for 3D Printing—Insights from the hearing aid industry's transition 1989–2008. Technological Forecasting and Social Change, 102, 160-168.

Saunders, M., Lewis, P., & Thornhill, A. (2009). Research methods for business students.

Shafer, S. M., Smith, H. J., & Linder, J. C. (2005). The power of business models. Business horizons, 48(3), 199-207.

Sherman, L. M. (2009). Additive manufacturing: New capabilities for rapid prototypes and production parts. Plastics Technology, 55(3), 35—45.

Skarzynski, P. and Gibson, R., (2008) Innovation to the Core, Harvard Business School Publishing, Boston.

Sophic Capital (2015). Link: http://sophiccapital.com/3d-printing-the-education-sector-is-on-the-cusp-of-adoption/
[Access: 28.03.2017]

Tassey, G. (2014). Competing in advanced manufacturing: The need for improved growth models and policies. The Journal of Economic Perspectives, 28(1), 27-48.

Teece, D. J. (2010). Business models, business strategy and innovation. Long range planning, 43(2), 172-194.

The World Bank (2017). Manufacturing, value added (current $). Link: http://data.worldbank.org/indicator/NV.IND.MANF.CD?locations=CN-EU
[Access: 17.04.2017]

Tillväxtverket (2011a). Growth opportunities and growth barriers for Swedish small- and medium sized enterprises, Report 0359, Swedish Agency for Economic and Regional Growth, Stockholm.

Tylö Professional (2017). Link: http://www.tylo.com/professional/tylo-partner/ideal-partner.html [Access: 12.07.2017]

Tylö Support (2017). Link: http://www.tylo.com/support-page [Access: 20.07.2017]

Uppenberg, K., & Strauss, H. (2010). Innovation and productivity growth in the EU services sector. Luxembourg: European Investment Bank.

Vance, A. (2012). 3D Printers: Make Whatever You Want. BusinessWeek: Technology April 26, 2012.

Van de Ven, A. H. (2007). Engaged scholarship: A guide for organizational and social research. Oxford University Press on Demand.

Voelpel, S. C., Leibold, M., & Tekie, E. B. (2004). The wheel of business model reinvention: how to reshape your business model to leapfrog competitors. Journal of change management, 4(3), 259-276.

Web of Science BM (2017). Link:
http://wcs.webofknowledge.com.ezproxy.bib.hh.se/RA/analyze.do
[Access: 11.04.2017]

Web of Science AM. (2017) Link: http://apps.webofknowledge.com.ezproxy.bib.hh.se/CitationReport.do?product=WOS&search_mode=CitationReport&SID=Y16ZyfZrr7jQFbgRadA&page=1&cr_pqid=1&viewType=summary&colName=WOS [Access: 26.04.2017]

Why HGF (2017). Link: http://www.hgf.se/en-GB/about-hgf/why-hgf--29706518 [Access: 16.04.2017]

Wirtz, B. W., Pistoia, A., Ullrich, S., & Göttel, V. (2016). Business models: Origin, development and future research perspectives. Long Range Planning, 49(1), 36-54.

Wohlers, T. (2016). Wohlers report 2016. Wohlers Associates, Inc. Caffrey, T., & Wohlers, T. (2014). 3D printing builds up its manufacturing resume. Manufacturing Engineering, 152(6), 61-+.

Wynett, C., Fogarty, T., Kadish, R. T., Dell, M., Tovin, H., Keeley, L., & Talley, J. (2002). Inspiring innovation. Harvard Business Review, 80(8), 39-+.

Yin, R. K. (2013). Case study research: Design and methods. Sage publications.

Zonder, L., & Sella, N. (2013). Precision Prototyping, The role of 3D printed molds in the injection molding industry. White Paper by Stratasys Inc.

Zott, C., Amit, R., & Massa, L. (2011). The business model: recent developments and future research. Journal of management, 37(4), 1019-1042.

Appendix

A: Interview guide

Date:

Company:

Contact information:

Additive Manufacturing has the potential to change the way products are designed, produced, distributed and sold. Therefore, companies have to rethink their current Business Model, if they plan to implement Additive Manufacturing. The aim of this study is to figure out how companies have to innovate their Business Model to successfully shift from traditional to Additive Manufacturing.

General/History

1. Can you give us a brief introduction to the history of the company?
2. Have there been any major challenges in the past?
3. Have there been any major changes in the past?
4. Did you change your business model within the last 10 years?
    - If yes,
      - what were the triggers for the business model innovation (why did you change)?
      - what building blocks[2] changed?

Additive Manufacturing

5. What manufacturing technologies are you currently using?

[2]The business model Canvas has 9 building blocks: key partners, key activities, key resources, value proposition, customer relationships, channels, customer segments, cost structure, and revenue structure

6. Are you using the technology of Additive Manufacturing already? For instance for rapid prototyping?
7. Why are you implementing Additive Manufacturing/What are your short-term goals of implementing Additive Manufacturing?
   For what parts of the product will you use Additive Manufacturing? Is the use of Additive Manufacturing affecting the whole product range?

Business Model

8. Do you have an existing (written form) business model?

- If yes, what are your building blocks
- If not, what are your Key Partnerships, Key Activities, Key Resources, Value Propositions, Customer Relationships, Channels, Customer Segments, Cost structure, and Revenue structure?

Business Model Innovation

9. How is the implementation of Additive Manufacturing influencing the following building blocks?

10. Key Partnerships:

    - How is AM influencing your key partners?
    - How is AM influencing your key suppliers?
    - How is it influencing the collaboration with partners in respect of key resources and key activities?

11. Key Activities

    - How is AM influencing key activities (e.g. production)?

12. Key Resources (physical, financial, intellectual, human)

    - How is AM influencing the physical/intellectual/human/financial Key Resources?

13. Value Proposition

    - How is AM influencing the bundle of products and services (new offer)?
    - Can AM help you to serve new customer needs?
    - How is AM improving product/service performance?
    - How is AM influencing the concept of customization and the customer co-creation?

- How is AM influencing the design of the product/service?
- How is AM influencing the price of the product/service?

14. Customer Relationships

- How is AM influencing customer relationships of specific customer segments (co-creation)?

15. Channels

- How is AM influencing your communication channels?
- How is AM influencing your distribution channels?
- How is AM influencing your sales (delivery/after sales) channels?

16. Customer Segments

- How is AM influencing the group of people you want to serve?

17. Cost structure

- How is AM influencing your cost structure?

18. Revenue structure

- How is AM influencing the revenue streams (e.g. new pricing mechanisms)?

Matthias Lebherz
Bronnen, Germany
matthias.lebherz91@gmail.com

Matthias Lebherz received a Bachelor degree in Industrial Engineering in 2016 and is now graduating in the Industrial Management and Innovation Program.

Jonathan Hartmann
Simmerberg, Germany
jonathan-hartmann93@web.de

Jonathan Hartmann received a Bachelor degree in Industrial Engineering in 2016 and is now graduating in the Industrial Management and Innovation Program.

HALMSTAD UNIVERSITY

PO Box 823, SE-301 18 Halmstad
Phone: +35 46 16 71 00
E-mail: registrator@hh.se
www.hh.se