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**CUSTOMER-CENTRIC AND VALUE-BASED  
BUSINESS MODEL DESIGN**

**IMPACTS OF THE ADDITIVE MANUFACTURING  
TECHNOLOGY ON FIRM'S BUSINESS MODEL**



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Liiketoimintamalli on käsite, joka on yleistynyt viimeisen kahden vuosikymmenen aikana elektronisen liiketoiminnan kehittymisen myötä. Nykyisin liiketoimintamalli käsitettä käytetään myös muilla teollisuuden aloilla. Huolimatta siitä, että liiketoimintamalli käsitteenä on vakiintunut liiketalouden ammattilaisten keskuudessa, tieteellistä yhteisymmärrystä siitä mitä liiketoimintamallilla tarkasti tarkoitetaan ja mitä se pitää sisällään, ei ole saavutettu. Viimeaikaiset tieteelliset artikkelit liiketoimintamalleista painottavat kuitenkin arvon luomista, arvon lunastamista sekä asiakaskeskeisyyttä keskeisinä teemoina liiketoimintamallin suunnittelussa.

Pro gradu -tutkielman ensisijaisena tavoitteena on tutkia kirjallisuudesta niitä elementtejä, prosesseja ja toimintatapoja, joiden avulla liiketoiminnan arvonmuodostamisen mahdollisuuksia voidaan löytää ja tuoda esille. Lisäksi tavoitteena on luoda kirjallisuuden perusteella liiketoimintamallikehys, joka sisältää oleelliset tekijät asiakaskeskeisen ja arvoperusteisen liiketoimintamallin luomiseksi.

Materiaalia lisäävä valmistus tai paremmin tunnettu käsite 3D -tulostus on teknologia, jonka uskotaan mullistavan perinteisen teollisen valmistustavan. Pro gradu -tutkielmassa pyritään selvittämään kuinka materiaalia lisäävä valmistusmenetelmä vaikuttaa yrityksen nykyiseen liiketoimintamalliin ja arvon muodostamiseen.

Asiasanat: liiketoimintamalli, sidosryhmä, sidosryhmäteoria, arvo, arvon luominen, osallistava arvon luominen, 3D tulostaminen, materiaalia lisäävä valmistus

## ABSTRACT

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During the past two decades Business Model reached a status among business management and literature. Business models are often perceived as invented and implemented in electronic business companies only, however business model design is currently widely used also among other industrial fields. Nevertheless business models have rather long history, there still is much confusion what business models are and how they can be used in business development. In addition business models' scientific research and practical implementation have not fully found common understanding. Value, value creation, delivery and capture play central roles in business model creation and form a basic principle for business model design. The primary purpose of the Master Thesis is to explore the literature review and discover where and how value is created and which elements, process and methods are essential and most beneficial for creating a customer-centric and value-based business model. Intention is to compose a business model framework, which has a scientific foundation, but is practical enough to interest and benefit the business practitioners.

The development of additive manufacturing (AM) technology or three-dimensional (3D) printing is expected to transform manufacturing and company business models. Master Thesis's secondary purpose is to observe what impacts AM technology has for the company's business model and how the technology will change companies' business models.

Keywords: business model, stakeholder, stakeholder theory, value, value creation, value co-creation, 3D printing, additive manufacturing, rapid prototyping

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# 1 INTRODUCTION

So-called disruptive technologies like internet and additive manufacturing (AM) or better-known three-dimensional printing (3DP), are challenging the conventional business procedures. Internet and mobile technologies have revolutionized the way people communicate, buy and consume products and services as well as how people work. Because of the revolution of the internet and mobile technology, many traditional industries like news and media business have faced new business requirements and they have been forced to renew company strategies and business models to meet the changed business requirements in altered market environment.

The Economist -business magazine (2012) estimated that digitization of manufacturing transforms the way goods are made and called AM technology as the third industrial revolution. AM technology is a process, which enables producing a three-dimensional object basically of any shape from a digital model (Gridlogics, 2014). The effects of the AM technology will not only change the way products are manufactured, but it also impacts on product design, structures and materials used in AM process (The Economist, 2012). Some estimations predict AM accelerates the product development cycles and shift the profit structure of the companies (Cohen, Sargeant & Somers, 2014). It is also evaluated AM technology will reduce the environmental load (Gilpin, 2014) and reshape the future professions and jobs (The Economist, 2012). Even though AM technology has existed already two decades, it has not yet been a breakthrough technology. Ardilio and Seidenstricker (2013) indicate that the diffusion of a new technology into market is difficult and require many years before it is adopted. One reason for slow diffusion of the AM technology is considered to be the patents protecting the AM technology innovations. However, some of the critical patents have expired and are expiring during 2014 and it is estimated that the lapse of these critical patents will accelerate the diffusion of the AM technology. (Hornic & Roland, 2013.) The reports by the leading consulting companies support this assumption. Gartner's Hype Cycle for Emerging Technologies 2013 -report reveals the consumer 3D printing achieved its hype peak in 2013. The report estimates the trend in consumer printers will moderate

within 5-10 years, but within enterprises 3D printing hype peak is already passed and the report estimates plateau is reached in 2-5 years. (Gartner, 2013.) Wohlers Associates (2014) has been monitoring the markets of the metal printers for 14 years and their report reveals that the number of sold metal based AM machines increased by 75,8% in 2013 compared to 2012 (Wohlers Associates, 2014). In addition it is noticed during the research period that the number of AM technology related articles in national and international business magazines have increased and the discussions in national forums have been active.

As it looks obvious the AM technology will challenge and reshape the conventional way of designing and producing the products, it provides an interesting perspective and motivation to investigate the phenomenon from firm's value creation and business model viewpoint. Number of research articles of the AM technology has been published, but the majority of the studies cover the issue from the technical perspective and how AM technology is implemented in various industries. Less research is performed from firm's value creation, business development and business model perspective, even though it is predicted AM technology will occur as the third industrial revolution reshaping the product design and manufacturing (The Economist, 2012). Purpose of this study is to discover how AM technology impacts on company value creation and business model. It is vital for business managers to notice the changes AM technology creates in business ecosystem and react to change before it is too late. Ardilio and Seidenstricker (2013) emphasize business managers to reinvent the company business model when new technologies occur as it accelerates the adaption of the new technology within the industry.

It is apparent AM technology forces companies to re-evaluate their current business and revise the business models in a similar way as did the internet and mobile technologies. To investigate the impacts of the AM technology on firm's value creation and business model, it is important to understand what is meant by the business model and value creation. The recent literature indicates value creation, delivery and capture as the central elements in the modern business model design (Magretta, 2002; Osterwalder & Pigneur, 2010; Teece, 2010; Zott, Amit & Massa, 2010). In addition the importance of the customers and customer involvement in value creation process are emphasized (Nickerson, Silverman & Zenger, 2009; Saarijärvi, Kannan & Kuusela, 2013). The Master Thesis illuminates the value creation notion and observes where and how value is created in business relations. In addition business model concept is presented and the key elements of the value-based and customer-centric business model are illustrated. The study empirical part covers the impacts of the AM technology on company's value creation and business model.

## **1.1 The research objectives and structure**

Cohen, Sargeant and Somers (2014) indicated that AM technology is rapidly developing and the senior executives should be prepared for the disruptions

AM technology is causing in the near future. The business managers in various industries need comprehensive and practical business development tools and methods, so that the variable business requirements and objectives are identified and obtained. Business model design is an agile and flexible way to illustrate the business requirements and environment (Keen & Williams, 2013). Current business literature emphasizes stakeholder value and value creation as central elements in business activities (Freeman, Harrison, Wicks, Parmar & De Colle, 2010; Magretta, 2002; Osterwalder & Pigneur, 2010; Teece, 2010; Zott et al., 2010).

The first objective of the Master Thesis is to identify where value exists and how value is created in business relations (figure 1). The first study objective is observed through the stakeholder theory by Freeman et al. (2010). Stakeholder theory observes firms through an unstable market environment and through stakeholder groups, who have influence on the firm and who can be influenced by the firm. Stakeholder theory has been developed to reconceptualize or even solve specific problems. (Freeman et al., 2010.) The stakeholder theory's "The problem of value creation and trade" aspect is observed and considered in this study to provide solution to the first study objective. The second objective is to explore the elements, processes and methods relevant for a customer-centric and value-based business model design. The foundation for the second research objective is constituted by the stakeholder theory, value theories by Rescher (1969) and Schwartz (1992) and by recent academic business model literature. The third part observes how AM technology impacts on firms' business model and value creation. The purpose is to discover how new technology impacts on firm's value creation and capture. The third part is accomplished by interviewing Finnish large and small-medium size companies in machine industry, who utilize or consider utilizing additive manufacturing in a near future. The interviews were accomplished in eight companies in Pirkanmaa and Middle-Finland areas in Finland.

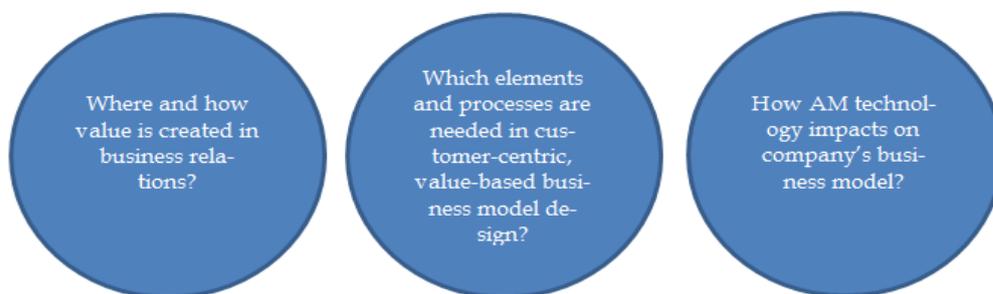


Figure 1 Master Thesis objectives

The research is qualitative in nature and data was collected by semi-structured interviews. Data was analysed by using content analysis method. The study results indicate that companies in Finnish machine industry utilize AM technology in prototype and miniature products. The cost and time efficiency was

mentioned as the most valuable factors of the AM technology usage. Cost and time efficiency were valued both by the company and the customer. AM technology has streamlined the R&D functions enabling to produce products similar to final products in forms, structure and colours. Only difference is the durability, which prohibits AM produced products to use in final consumption. Other valuable factors the study revealed were tailor-made products, marketing, product testing and environmental issues.

## **1.2 Thesis outline**

In the introduction the background and the basis of the subject are shortly presented. The research objectives and structure are followed and the purpose is to clarify the research questions and how research is accomplished. The second chapter illustrates the theoretical basis for the study. Stakeholder theory by Freeman et al. (2010) was chosen to provide insights to research questions. Stakeholder theory is complemented by other researchers on the field.

The third and the fourth chapter determines the value and business model concept. Value is described by Schwartz (1992, 2012) and Rescher (1969). Value is complemented and illustrated by the authors and researchers in the business and organizational context. Business model notion and the content of the business models are described based on the latest academic literature in the economics.

The fifth chapter represents the background information and the principles of the AM technology. The impacts of the AM technology on the value formation and business models are based on the latest literature. The summary of the literature review finalizes the fifth chapter. The chapter six and seven consist of research methods and research findings. In chapter eight the study findings are analysed and conclusions presented. The final chapter summarizes the study and further research proposals are presented.

## 2 THEORETICAL APPROACH TO CUSTOMER-CENTRIC AND VALUE BASED BUSINESS MODEL FRAME

R. Edward Freeman is regarded as the initiator of the stakeholder theory. He published in 1984 his first edition of the book "Strategic management: A Stakeholder approach", in which Freeman suggests that businesses should build their business strategy around relationships with key stakeholders. Year 2010 Freeman deepened the stakeholder approach and published a book "Stakeholder theory: The state of Art" with his colleagues (Freeman et al., 2010). Ever since Freeman published his stakeholder theory, it has inspired other researchers to investigate and evaluate the theory's accuracy and adequacy in strategic business management. In the following chapter the stakeholder theory is described according to Freeman et al. (2010) following insights from other researchers in the field.

### 2.1 Stakeholder theory

Stakeholder perspective and approach entered to business management literature few decades ago. The purpose of the stakeholder approach was to improve the understanding of the environment in which the firm is operating. There was also a need to broaden the management's roles and responsibilities to concern the other stakeholders' requirements in addition to the shareholders' interests. (Mitchell, Agle & Wood, 1997.) The critical questions from the management's perspective were; which groups or individuals are stakeholders and which are not (Mitchell et al., 1997).

Freeman (1984) defines stakeholder as "any group or individual who can affect or is affected by the achievement of an organization's purpose." (Freeman, 1984, 53). Clarkson (1995) identified stakeholders as individuals or groups that

have ownership, rights or interest towards organization's activities in the past, present or in a future. Friedman and Miles (2006) consider the organization itself as a group of stakeholders and the purpose of the organization should be to manage the stakeholder interests, needs and viewpoints. By indicating a certain focal stakeholder group like top-management inside the organization, it is capable to manage other stakeholder groups (Friedman & Miles, 2006).

Fundamentally the stakeholder theory is a theory about how business works and it could work at its best in a global turbulent business environment. Its purpose is to show how business can be described through stakeholder relationships and how value is created for the stakeholders in an effective way. (Freeman et al., 2010.) Jensen (2001) emphasises the importance of the interests of all the stakeholders in a firm when making decisions. All in all stakeholder theory's aim is to reconceptualise or even solve specific problem areas. The first problem area is the problem of value creation and trade, the second area is the problem of the ethics of capitalism and the third the problem of managerial mindset. (Freeman et al., 2010.)

The shareholders, customers, suppliers, distributors, employees and local communities are considered to be the most common stakeholder groups of the organization (Friedman & Miles, 2006). However, Freeman et al. (2010) determine the customers, employees, financiers, communities and suppliers as the primary stakeholder groups of the company (figure 2). For Clarkson (1995) the primary stakeholders are the individuals or groups, whose contribution to the organization is so important that without them the corporation is not possible to survive.



Figure 2 Primary stakeholder groups (Freeman et al., 2010)

Secondary stakeholders are defined to consist of the individuals or groups that affect or have the possibility to affect the company operations and business, but are not essential for organization's survival. Secondary stakeholders are for example media, government, competitors and special interest groups like environmental protection organisations. (Clarkson, 1995; Freeman et al., 2010.)

To facilitate the stakeholder identification and mapping Freeman (1984) suggests implementing the following questions:

1. Who are our current and potential stakeholders?
2. How does each stakeholder affect us (challenges and opportunities)?
3. How do we affect each stakeholder?
4. What assumptions does our current strategy make about each important stakeholder?
5. What are the current “environmental variables” that affect us and our stakeholders?
6. How do we measure each these variables and their impact on us and our stakeholders?
7. How do we keep score with our stakeholders?

The stakeholder theory is determined as descriptive, prescriptive and instrumental (Donaldson & Preston, 1995; Freeman et al., 2010). As descriptive stakeholder theory describes what the corporation is. Corporation is like “a constellation of co-operative and competitive interests possessing intrinsic value.” (Donaldson & Preston, 1995, 66.) Instrumental means the stakeholder theory establishes a framework for examining the connections between the stakeholder management implementation and the achievement of various corporate performance goals. The primary interest of executing stakeholder management within organisation has been the successful outcome of the conventional key performance indicators like profitability, growth and market share. (Donaldson & Preston, 1995.)

Prescriptive or normative attribute describe stakeholders as persons or groups with legitimate interests. Stakeholders are identified according to their interests and interest level in the corporation. The interests of all stakeholders are of intrinsic value. It is assumed that each group of stakeholders enhance value consideration only for its own sake. (Donaldson & Preston, 1995; Freeman et al., 2010.) For Donaldson and Preston (1995) the stakeholder theory is also managerial. Stakeholder theory not only describes existing position and relationships, but also recommends attitudes, structures and practices forming the basis for the stakeholder management (Donaldson & Preston, 1995).

The value creation for stakeholders forms a central element in the stakeholder theory. The importance of the value creation to all stakeholders is constructed by the assumption that people engaged in value creation are more responsible to those individuals or groups they think they can affect or be affected. In addition value must be created to the all stakeholders in an effective way. Effective means creating as much value as possible for the stakeholders without resorting trade-offs. Resorting trade-offs in turn means that sometimes creating value to one stakeholder implies reduced value creation to other stakeholders. (Freeman et al., 2010.) However Jensen (2001) argues that stakeholder theory should not be the only nominee for value maximization as it does not provide a complete definition of the corporate purpose or function and leaves managers to serve too many masters. The firms adopting stakeholder theory will be vul-

nerable in competition as “the stakeholder theory politicizes the corporation and leaves its managers empowered to exercise their own preferences in spending the firm’s resources.” (Jensen, 2001, 10.) As a solution Jensen (2001) proposes firm’s objective should be to maximize the firm’s market value in the long-run by fulfilling the demands of all the essential and important stakeholders and executing the requisite trade-offs among firm’s stakeholders.

Stakeholders in the business ecosystem form dynamic relationships between each other. Stakeholder theory’s focus is on the jointness of the stakeholders interests. The initial question of stakeholder theory *The problem of value creation and trade* is solved by answering how to redefine, re-describe or reinterpret stakeholder interest so that the both are satisfied and value is created to both. (Freeman et al., 2010.) Jensen (2001) argues that social welfare is maximized when each business organization is capable of maximizing its total market value. However, it is argued that the ability to maximize profit occurs when the firm is able to offer products and services the customers want, build solid relationships with its suppliers, inspire employees to give their best and have supportive community, which allows firm to flourish. Maximized profit is an outcome of the functional and sustainable stakeholder relations, where value is created to all parties. Maximizing profit at the cost of the stakeholders is counterproductive as it damages firm’s fundamental value driver, the stakeholder relationships. (Freeman et al., 2010.)

The stakeholder groups are multifaceted and form cross connections to each other. The Stakeholders form interfaces (figure 2) where value potential exists. The value potential actualizes when certain business activities occur between the stakeholders. By examining firm’s ecosystem and stakeholder activities in the value creation process, it is possible to see where and how value is created and gained. (Freeman et al. 2010.)

Summarizing the stakeholder theory the stakeholder theory is architecture, revealing firm’s true valuable relationships and the activities between the firm and the stakeholders. Stakeholder theory also reveals where value potential exists and how value is created in the stakeholder relations. By serving all the stakeholders in a best possible way and avoiding trade-offs between essential stakeholders, it is possible to create long-term value for all stakeholders, which results to profitable and successful outcome of the firm.

## 2.2 Stakeholder theory and practical implementations

Stakeholder theory has recently reached popularity among the business and society literature (Donaldson & Preston, 1995; Jamali, 2008). Stakeholder theory has been exploited in organizational and strategic stakeholder management development (Johansson, 2008; Verbeke & Tung, 2013) as well as in corporate social responsibility design (CSR) (Clarkson, 1995; Jamali, 2008) in public and private organisations. Alsos, Hytti and Ljungren (2011) utilized the stakeholder theory when analysing the national technology business incubator organiza-

tions in two Nordic countries, Finland and Norway. The purpose of the Alsos et al. (2011) study was to investigate by means of the stakeholder theory which external factors influence incubators' development and activities. The primary stakeholders of the technology business incubators are client companies, venture capitalists, large companies, universities and other governmental institutions. The challenge of the business incubator is to manage its stakeholders and endeavour to serve each stakeholder's goals. Balancing between each stakeholder's goals is challenging. (Alsos et al., 2011.)

The stakeholder theory's practical implementations in private organizations occur both in micro-enterprises and large companies. Johansson (2008) implemented stakeholder theory and stakeholder system model by Simmons and Lovegrove (2005) in his case study at a micro-enterprise. The study results indicated that due to stakeholder theory and Simmons and Lovegrove's stakeholder system model, the case company was able to identify its primary stakeholders and their interests. By implementing the stakeholder theory and the system model the company management received information of the stakeholder's contributions and performance allowing management to improve the evaluation of the stakeholder relations. (Johansson, 2008.) Jamali (2008) yielded similar kind of results by applying stakeholder theory and ethical performance scores (EPS) to investigate and measure the stakeholders' influence on the CSR. The study indicated that stakeholder theory steers management to collect and analyze CSR data and allows managers easily to understand and define the obligations and responsibilities of the firm vis-à-vis to the stakeholders (Jamali, 2008). Both Johansson's (2008) and Jamali's (2008) findings support Clarksson's (1995) proposal that corporate social performance can be effectively analysed and evaluated by corporate management if a framework for organizations stakeholder relations is described and constituted.

### 3 VALUE

Value, value creation, value delivery and value capture are concepts that are strongly linked to business relations and business model design. In the following chapter value is first defined by value theorists and later the value is examined in economic and business context.

#### 3.1 Value concept and definitions

Axiology is one of the earliest philosophical theories of value. Britannica encyclopedia (2006) determines axiology as a study of value or goodness in the deepest essence. John Ruskin pondered in 1894 the value concept in his political economy book *Munera Pulveris*. He defined value as signifying the strength or availing of anything towards the sustaining of life. Ruskin sees value as a life-giving power to everything. (Ruskin, 1894.) Value originates from an assumption that human is a goal-oriented organism seeking to achieve satisfactions and avoid dissatisfactions. Values are seen as qualitative or fact of being excellent, useful or desirable. Values are also regarded as things of the mind that have to do with the vision people have of the “good life” for themselves and their fellows. (Rescher, 1969.) Schwartz (2012) and Rescher (1969) mention commitment to values motivate person to action to achieve desirable goals. Commitment to values guides person in doing things he or she values and denying from doing others (Rescher, 1969). Schwartz (2012) emphasizes that values are believes that are activated when they are infused with feelings and forms thus importance for a person. De Ruyter, Wetzels, Lemmink and Mattson (1997) refer to Mattson (1991) identified three value dimensions for value perception. The first emotional dimension focuses on the feelings of a human. The second practical dimension has physical and functional aspect and the third logical dimension is focusing on the rational and abstract characters of the action. (De Ruyter et al., 1997.)

In addition to emotional, practical and logical dimensions, Rescher (1969) and Ruskin (1894) indicated that value has dual aspect. Value is manifested by verbal expression and behavioral action. Value gives reasons for motivating goal-oriented behavior that interest a human *in terms of benefits and costs*. (Rescher, 1969.) Ruskin (1894) determines values as intrinsic and effectual. Intrinsic values act as an absolute power of anything to support life. Ruskin's effectual value involves two needs; production of a thing essentially useful and the production of a capacity to use it. The effectual value does not exist if there is no intrinsic value or no acceptant capacity. (Ruskin, 1894.)

### 3.2 The value classification

The concept of the value is inherently complex and multifaceted. To attempt to increase the understanding of the values, they can be observed through the contents, structures and classification. (Rescher, 1969; Schwartz, 1992.) Value can be classified and differentiated according to value

1. Subscribership
2. Object
3. Benefits
4. Purpose
5. Relationship between subscriber and beneficiary
6. Relationship of value to other values

Subscribership describes the owner of the value. The value is owned by an individual or by a group. A person may own individual values but also group values. Person can e.g. be part of a professional group and own thus values characteristic for a professional group or as a citizen of a certain country, person has values based on what nation appreciates and regards valuable. (Rescher, 1969.) Schwartz (2012) indicates that all values have universal features. Values are beliefs and they refer to some desirable goals. Values are transcended in specific actions and situations and they serve as standards guiding individuals' and groups' behavior. Values are also ordered by importance and they are relative. Tradeoffs exist among competing values and they guide attitudes and behaviors of an individual and groups. (Schwartz, 2012.) Studies also indicate that there are universal compatibilities among the values e.g. in social relations, but also conflicts are found among group and individual values (Schwartz, 1992).

Rescher (1969) and Schwartz (1992) categorize values according to certain value objects. Table 1 illustrates categorizations of objects consisting of the thing values, environmental, political, religious and societal values as well as individual and group values.

Table 1 Value classification of the objects (Rescher, 1969; Schwartz, 1992)

Name of the value type	Explanation	Sample value
Thing values	desirable feature for object	speed, security
Environmental value	desirable feature	pureness, cleanness
Political values	features in the society	possibility to influence
Religious values		truth, honesty
Societal values	features in the society	justice, equality
Individual value	character, talents, abilities, habits, personality	brave, intelligent, kindness, skillful
Group values	relationship between individual and group	respect, trust,

Value is inevitably linked to benefits individual is seeking through his or her values. Benefits are the human wants, needs and desires that are involved in value expectation and are fulfilled when the value is realized. (Rescher, 1969.) Schwartz (1992) indicates that if values are viewed as goals, the accomplishment of the goal must serve the interests of the individual and/or group. The value in relationships is either egocentric or collective (Rescher, 1969; Schwartz, 1992). Schwartz (1992, 2012) found ten single values that have motivational attributes affecting individual and collective values. The motivational values are self-direction, stimulation, hedonism, achievement, power, security, conformity, tradition, benevolence, and universalism. To accomplish egocentric, individual goals and interests, power, achievement, hedonism, stimulation and self-direction are regarded as the most motivational values. The benevolence, tradition and conformity are regarded as values motivating the group to accomplish the collective goals. (Schwartz, 1992, 2012.) The group values are formed inside a squad of people, who are committed to share the same values (Rescher, 1969). As an example certain family traditions may guide family values, professional groups like doctors have benevolence to save lives no matter what circumstances are. Nation-oriented people receive conformity of equal rights and justice of the citizens. (Rescher, 1969; Schwartz, 2012.) Universalism and security serve both individual and collective interests (Schwartz, 1992, 2012).

A specific purpose may determine value in the context of a certain state of affairs like buying product or service. Professional counselling can be acquired for legal purposes or for losing weight. Food fulfils the nutrition purpose and removes the sense of hunger. The value of the purpose is also seen as exchanged, persuasive or bargaining value. Money is often times a medium of exchange and acts as a *mechanism* through which the benefits and the purpose of the value are realized. (Rescher, 1969.)

To summarize the value concept, values are believes and goals consisting of emotional, motivational, rational and functional attributes. Values provoke individuals and groups to action to achieve desirable goals and benefits. A person may have both individual and collective group values. Conflicts and compatibilities are found in values and tradeoffs are required among competing

values. To achieve the goals and benefits a certain mechanism is required to exchange the value. (De Ruyter et al., 1997; Rescher, 1969; Ruskin, 1894; Schwartz, 1992, 2012.)

### 3.3 Value and value creation in firm's stakeholder group

Zahra (2005) states critical question for the business managers is to identify where and how value is created. As the stakeholder theory emphasizes stakeholders in business networks form interfaces where value potential exists and the problem of value creation is possible to solve by answering how to redefine, re-describe and reinterpret the stakeholders' interests (Freeman et al., 2010).

Lepak, Smith and Taylor (2007) express the difficulty among scholars to define what value creation is, the process where value is created and the mechanism that enables value creation in the organization and business networks. Value is perceived to be relative and subjective in nature and is conceived to be formed in the dynamic and multi-contextual circumstances in the reality of life (Lepak et al., 2007; Voima, Heinonen & Strandvik, 2010). Values are linked to benefits and are manifested in the context of exchange receiving monetary, bargain or exchange value (Rescher, 1969). Value has a user and a creator. Value user and creator accomplish trade-offs between benefits and costs. (Lepak et al., 2007; Rescher, 1969; Voima et al., 2010.)

Lepak et al. (2007) separate the value concept to use value and exchange value where use value refers to the specific quality of the product or service in the organizational context. Bowman and Ambrosini (2009) have made similar conclusions, but they determine use value as properties of products and services, which provide utility aspect for the user. Bowman and Ambrosini (2009) claim that use value is created in a moment the product or service is delivered to the customer. Many scholars have lately challenged this traditional opinion of the use value. Use value no longer exists embedded in the outputs of the products or is a function of a product. Use value is also less emerged during the manufacturing process only. (Keen & Williams, 2013; Saarijärvi et al., 2013; Voima et al., 2010.) Value is considered to be activated and realized when the user gains experience of the product or service in use (Voima et al., 2010). The new perspectives of the use value challenges also the traditional thinking of the exchange value. Figure 3 exhibits how exchanged value is linked to value creation and how use value traditionally shifts to exchange value in a moment when medium of exchange like money is transferred from the buyer to the supplier (Bowman & Ambrosini, 2009; Lepak et al., 2007). In traditional customer-supplier relationship aim has been to optimize the received use value versus paid exchanged value. By optimizing use-exchanged value ratio, firms seek to achieve competitive advantage and maximize profits. (Bowman & Ambrosini, 2009.)

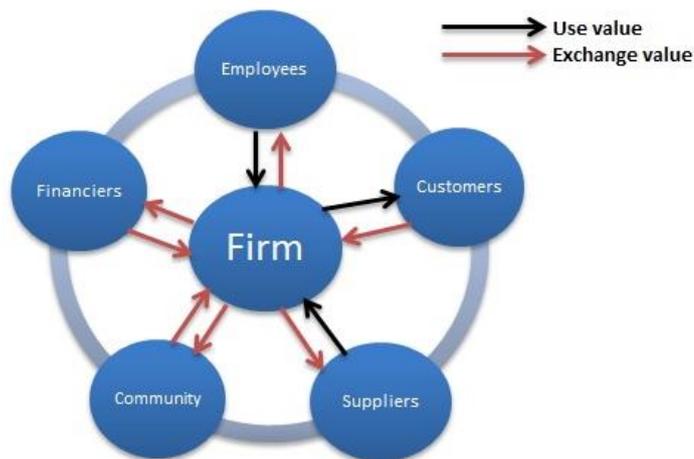


Figure 3 Use and Exchange value (Bowman & Amrosini, 2009)

However, profit maximizing is not the only element the value users and creators are seeking. Cost savings, improved profitability and quality or scalability act as incentives for optimizing use-exchange value. Soft values like functional and confidential partner relations and loyalty are appreciated and valued in mutual business relation and may lead to competitive advantage in the long run. (Sainio, Saarenketo, Nummela & Eriksson, 2011.)

Ojala and Tyrväinen (2011) indicate value occurs not only in customer-seller relationships but also among the other actors in the business networks. It is identified that the actors in business networks may own certain resources and qualities the firm is lacking. By belonging to the business networks the firm is possible to benefit the business network's resources and receive value. (Ojala & Helander, 2014.) The value in the business network may appear directly or indirectly (Ojala & Helander, 2014). Ojala and Helander (2014) indicate the direct value in the context of cloud computing business network occurred in the monetary form but also in the form of critical resources. The critical resources from the external stakeholders allowed the case study firm to deliver the service but also to create and improve the functionalities of the products. The firm experienced in-direct value in the form of improved market and networking potential, and by improved marketing and brand awareness. New references were also mentioned as in-direct value. (Ojala & Helander, 2014.) Keen and Williams (2013) determine value as a function of the choice space in digital business context. By this they mean that digital business environment offers more extensive opportunities field compared to traditional manufacturing business. In the highly regulated industries the value is often times tied to product features and pricing plays a significant role. Even though the drivers of digital business are the same as in traditional business, the digital business is driven by the opportunities to enlarge the choice space and find new value dimensions for its stakeholders like customers and suppliers. (Keen & Williams, 2013.)

### **3.4 Value creation dimensions and drivers**

As indicated value has an emotional, practical and logical dimension (De Ruyter et al., 1997). To provide new value dimensions to stakeholders in organizational context Heinonen (2004, 2006) proposes that customer perceived value can be conceptualized in four dimensions; technical, functional, temporal and spatial dimensions in service and product value context. Technical dimension consist of the technical elements included in the product or service. Functional dimension is related to the functional aspects of the service and product. Temporal dimension of value observes benefits and sacrifices related to time and consider the temporal aspects affecting to perceptions of the value. The spatial dimension observes the benefits and sacrifices related to location. (Heinonen, 2004, 2006.)

Value is created when certain activities and processes occur inside and between the firm and its stakeholders. The activities like procurement from suppliers, management of resources (human, financial), and activities increasing production efficiencies are examples of the drivers affecting firm's use value and value creation. (Bowman & Ambrosini, 2009; Freeman et al., 2010.) Zott and Amit (2010) add novelty, customer lock-in and complementarities as value creation drivers. By novelty Zott and Amit (2010) means the adoption of new activities (content), and forming a new ways of linking the activities (structure). Novelty in governing the activities can also lead to value creation. As an example Zott and Amit (2010) mention how Apple included music distribution as an activity (content novelty) by linking distribution to the development of the iPod hardware and software (structure novelty). Governance novelty occurred when Apple's customers were able to download music legally to Apple's devices. (Zott & Amit, 2010.) Customer lock-in occurs when the stakeholders are attached to firm's activity system forming kind of a symbiosis. The symbiosis is so attractive and valuable to all stakeholders involved (value creator or user) that none of them are not willing to depart the relationship. More value could be obtained and created to customers by bundling complementary activities instead of running the activities individually. (Zott & Amit, 2010.) In Apple's case Apple's strong and desirable brand definitely affects customer's perceived value.

### **3.5 Mechanisms and tools to identify value in business relations**

As value is found in the interface of the firm stakeholders, activities and processes inside and between the firm and stakeholders, are there any mechanisms how to identify value? Nickerson, Silverman and Zenger (2007) provide one perspective and solution to identifying new value opportunities and improving firm's current value creation processes. They claim that problem-solving perspective (PSP) offers comprehensive approach to value identification and crea-

tion. Central point in the PSP is to understand the characteristics of the problems in firm's activity processes. To identify valuable problems, the organizational structures and the processes where knowledge is constantly assembled form key factors in problem identification. (Nickerson et al., 2007.) There is plenty of explicit documented knowledge in the organization, but also tacit knowledge exists in the organization structures. Nickerson et al. (2007) challenge managers to ask themselves "what processes enable the identification and selection of problems that ultimately reveal value-creation solutions for the firm?" PSP offers an effective way for identifying value creation elements and drivers and there for organization should create a specific process for problem identification. The process would consist of individual, group or organizational activities and efforts to aid discovering the hidden problems from unseen value landscape. (Nickerson et al., 2007.) Nickerson et al. (2007) present two processes for the search of the problems: analytical and synthetic process. Both analytical and synthetic process provides a sequence of steps to stimulate the problem identification. Each step in the analytical and synthetic process demolishes and disperses the firm's value chain to evaluate each step quantitatively. The synthetic process differs from analytical process by asking more novel question in less structured environment. By combining and integrating novel questions the customer problems can emerge, which may lead to the new business opportunities or even to radical innovations. Both processes thus assist to identify valuable customer problems. Once the problems are identified management's task is to organize a search for the valuable solution proposals to create value. (Nickerson et al., 2007.)

Keen and Williams (2013) presented a value architecture framework (figure 4) to identify the value elements and the value processes in the organization. The value architecture consists of value narrative, value engine and opportunity platform. The value narrative describes who the stakeholders are and gives answers to whom the firm is about to create the value now and in the future. Value engine illustrates the activities and the processes where the value exists and how value is possible to create and deliver. In the opportunity platform exists the potential for the new value generation. The new technologies and innovations often times offer the potential for new value creation and capture. (Keen & Williams, 2013.)

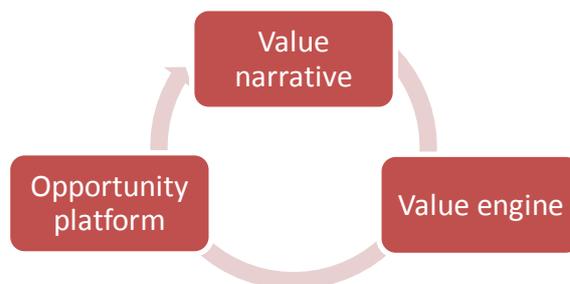


Figure 4 Value architecture (Keen & Williams, 2013)

Saarijärvi et al. (2013) presented similar kind of solutions to value detection, but they include value co-creation element to identify and illustrate value in firm's business networks. The technological advances and the new forms of the customer interaction replace the conventional thinking of commerce. This force firms to rethink, what kind of value is created, for whom, by which resources and through which mechanism. Value co-creation analytical framework supports business managers to analyse the possibilities for value creation (figure 5). (Saarijärvi et al., 2013.)

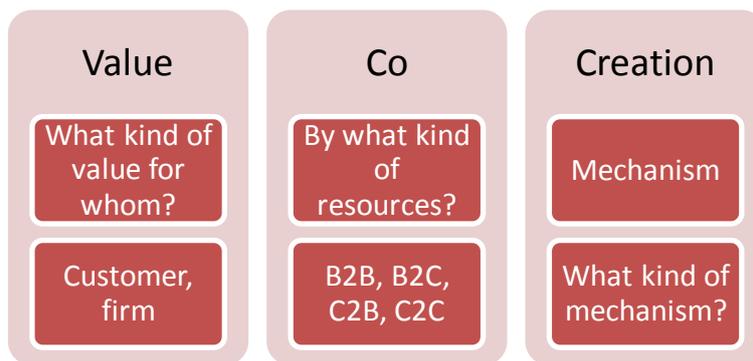


Figure 5 Value co-creation analytical framework (Saarijärvi et al., 2013)

Value co-creation occurs, when certain mutual (customer-supplier) motivations realize. They can be monetary or other benefits valuable enough to motivate for value co-creation. (Saarijärvi et al., 2013.) As Saarijärvi et al., (2013) mentioned the technological advances and the new forms of the customer interaction change the value creation potential. Internet is a modern world's market and communication place offering customers a chance to become active participants in value creation process. Nambisan and Nambisan (2008) identify five different roles the customers can contribute in value creation process while utilizing modern technology platforms. The roles are product conceptualizer, product designer, product tester, product support specialist and product marketer. In product conceptualizer's role the customer is encouraged to interact with the company to generate and improve products and new ideas. Acting as a product designer, customer can design a customized version of the product fitting exactly to customer's own desires. Product testing and support specialist roles permit the customer to test and interact as a professional to share the professional knowledge and expertise to peer customers. In these roles, customers have a possibility to influence on company's activities and co-creation value with other participants. (Nambisan & Nambisan, 2008.)

## 4 BUSINESS MODEL

Business model as a phrase is commonly used among business professionals. Business model is often related to innovations, technology or strategy. Reality reveals that business model concept is understood very differently among business managers. For one, business model is about making money and receive profit, and for another business model is linked to strategy, revenue generation or marketing activities. Third might think business models have something to do with business planning and processes. The notion itself is differently understood even inside the firms, so it is no wonder that managers have difficulties to figure out how to use and benefit business model concept in business design and development. The aim of this chapter is to describe how business model is defined in literature and describe why business models matters and what elements are required to design a successful business model. The core business model building blocks and components are presented next and finally the process and methods to design the business model framework are presented.

### 4.1 What is business model all about and why it matters?

Zott, Amit and Massa (2010) performed an extensive research by reviewing 133 academic papers related to business models. The literature review offered various definitions, but due to inconsistency and confusion in definitions, Zott et al. (2010) summarized and ended-up to present eight the most prevalent definitions. The summary reveals scholars define business models as architectures to illustrate the content, structures, activities, resources, processes, revenues, costs, actors, value propositions, capabilities and economic value and logic of the company. (Zott et al., 2010.) Other scholars support Zott et al.'s (2010) summary. Afuah (2004) defines business model as a framework for making money and indicates business model as a set of activities firm performs to offer its customers benefits and creating profits. Ceravolo, Damiani, Fasoli and Gianini (2010) present business model as firm's formal description of the components and

functions to generate revenue and make profit through activities. Osterwalder and Pigneur (2010) announce business model as the rational of how an organization creates, captures and delivers value. Table 2 illustrates the definitions summarized by Zott et al. (2010) complemented with the definitions by Afuah (2004) and Osterwalder & Pigneur (2010).

Table 2 Business Model definitions (expanded from Zott et al., 2010)

	Definition	Author
1.	Business Model (BM) is architecture of the product, service and information flows describing various business actors and their roles and potential benefits of various business actors. A description of the revenue sources.	Timmers, 1998
2.	The BM illustrates the content, structure and governance of transactions, which create value through the utilizing business opportunities.	Amit&Zott, 2001
3.	The BM is the heuristic logic connecting technical potential with the realization of economic value.	Chaebrough & Rosenbloom, 2002
4.	The BMs are narratives. How to create value to customers and how to capture value and make money,	Magretta, 2002
5.	A BM is venture strategy, architecture and economics, which aim to create sustainable competitive advantage in target markets. BM includes value proposition, customer, internal processes and capabilities, external positioning, economic model and personal/investor factors.	Morris et al., 2005
6.	BM consists of four elements: customer value proposition, profit formula, key resources, key processes, and by combining them value is created and delivered.	Johnson et al., 2008
7.	BM articulates the logic, the data and other evidence supporting a customer value proposition and a viable structure of revenues and costs for the enterprise delivering the value.	Tece, 2010
8.	BM is a reflection of the firm realized strategy.	Casadesus-Masanell & Ricart, 2010
9.	BM is a framework for making money. It is "a set of activities, which a firm performs, how it performs them, and when it performs them so as to offer its customers benefits they want and to earn profit".	Afuah, 2004
10.	BM is a formal description representing the components and functions of the business implemented by a company to generate revenue and make profit from a sequence of activities.	Ceravolo, Damiani, Fasoli & Gianini, 2010
11.	BM describes the rational of how an organization creates, captures and delivers value.	Osterwalder & Pigneur, 2010

The academic literature review highlights the importance of the value creation, delivery and capture in business models. Majority of the scholars presented in table 2 emphasize the value creation, delivery and capture as central elements in the business model design. It can be suggested, that value creation, delivery and capture form a basis for business model design. To answer the question what business model is all about, we can say that business model design is value creation, value delivery and value capture between a firm and its stakeholder groups.

IBM published 2006 a Global CEO Study, which included 765 in-depth interviews with CEOs around the world. The interviews unveiled that CEOs were focusing almost 30 percent of their innovation efforts on business models. The financial analyse revealed even more interesting data. The companies that had improved their operating margins faster than the competitors during five years observation period were placing twice many efforts on business model innovation as underperformers. In addition the study revealed that the major business model innovations occurred in the strategic partnerships and the changes in organization structures. One CEO emphasized a need to develop a business model based on strategic partnerships creating value for all parties including the whole industry. CEOs found, that cost reduction and strategic flexibility were the greatest benefits from business models, which lead to the possibility for improved revenue generation. (IBM Global Business Services, 2006.)

Other evidences that prove the business models really matters are reported by Nunes and Breene (2011) and Sosna, Trevinyo-Rodriquez and Velamuri (2010). Nunes and Breene (2011) claim that high business performers are far on their way to new success in business, when their existing business is performing well or indicating some decline. The high business performers identify the changes in customer needs already in the early phase and they react to changes by creating new solutions and business models even though the existing business have not necessarily reached its peak (Nunes & Breene, 2011). Sosna et al. (2010) made a five year exploration with a company operating in a dietary product business in Spain. The changes in the external business environment were obvious as the economic recession weaken the future market views. The company renewed its business model and as a result the annual revenue increased 5,6 times and the number of the outlets increased by 1072 between years 2002 - 2007. The business model renewal was accomplished through trial and error but the overhaul was worth to perform as it strengthened company's position in the market. (Sosna et al., 2010.)

A good business model is said to begin from observing human motivations and ending in a rich stream of profits (Magretta, 2002). To design a novel business model, a business manager requires a set of qualities like creativity, insight and good communication skills. Business model design requires also knowledge from the business environment and markets, information from competitors, customers and suppliers. (Teece, 2010.) Manager need also intelligence to combine the information in order to form a business model, that creates value not only for the firm but also to its primary stakeholders like custom-

ers, suppliers and other partners (Teece, 2010). Managers must also be aware that business model is provisional and needs to be refined or even reinvented over the time (Magretta, 2002; Nunes & Breene, 2011; Teece, 2010). Business model design is at its best a journey to investigate thoroughly industry, customers, stakeholders and firm's internal activities. It offers a manager a great learning experience to discover a winning business model through which the firm achieves competitive advantage and profit.

## **4.2 Value creation components in Business Model design - customer-centric orientation**

A wide literature research in business models was accomplished to discover which elements are essential and worth to involve in business model development. The study revealed, that value networks, pricing, customers (target market), resources (assets) and value proposition and capabilities are identified most frequently as building blocks in the business model design literature. Customer information, relationships, value creation and customer benefits received less attention. (Morris, Schindehutte & Allen, 2005; Shafer, Smith & Linder, 2005.) However, the recent studies outline that traditional business models based on firm's inside-out model no longer is sufficient when designing innovative and competitive business models. Inside-out approach requires heavy marketing campaigns to push the products to the markets. (Moormann & Palvölgyi, 2013.) Roldsgaard and Bajrovic (2011) estimate the next meta-trend will be the customer-centric outside-in approach in business evolution. The studies emphasize that firms must specify customer value propositions and recognize what benefits customers are looking for, what customer problems the firm is about to solve and how customer value is created and delivered so that the firm is permitted to capture value (Moormann & Palvölgyi, 2013; Osterwalder & Pigneur, 2010; Shafer et al., 2005). The firms, who adopt outside-in customer-centric approach in business model design, are more likely to create value and loyalty among the customer relations in long-term. It is claimed that outside-in approach improves firm's productivity. (Moormann & Palvölgyi, 2013.) Moormann and Palvöglyi (2013) emphasize that precondition for designing a customer-centric business model is the knowledge and intelligence of the customers' needs, processes and business environment. The knowledge about the customer processes and activities improves the firm to identify implicit and explicit customer needs and therefore address and create value throughout the customer business processes (Moorman & Palvöglyi, 2013).

Based on the presented recent research literature, the building blocks for customer-centric and value-based business model primarily is suggested to consist of customers, customer's value proposition, customer relationships, customer involvement, customer business environment and customer activities and processes. These elements form a core for designing a customer-centric,

value-based business model framework (figure 6). Customer information is gathered from each primary building block to form a holistic understanding what customer problems and needs are and where value creation potential exists. (Chesbrough & Rosenbloom, 2002; Moormann & Palvöglyi, 2013; Osterwalder & Pigneur, 2010; Teece, 2010; Zott & Amit, 2010;)

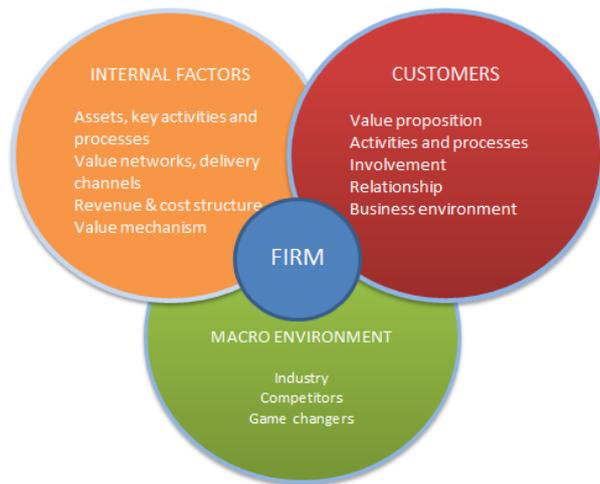


Figure 6 Business Model elements

The second dimension of the business model framework performs the requirements and elements that are needed to deliver customer value. It also presents the financial aspects of value creation, delivery and capture. The building blocks of the second dimension consists of firm's resources and capabilities, key activities and processes, value networks, product and service delivery channels, revenue and cost structure and the mechanism how value is created, delivered and captured. In the context of the value networks as a business model building block, it is worth to mention Porter's (2008) five competitive forces and the bargaining power of the suppliers. According to Porter (2008) powerful suppliers are capable of capturing more value if they have dominant position in the value chain. Dominant suppliers have the power to charge higher prices from their customers and shift some of the costs to other industry participants. They have also the power to limit the quality of the products and services. This might affect the profitability of the other companies in the value network. (Porter, 2008.)

The third dimension consists of elements related to the firm's macro level business environment. Industry, competitors, and game changers like threat of new entrants, substitute products (Porter, 2008), disruptive innovations and technologies are elements affecting the firm's performance. By exploiting the PESTE analysis, the firm observes the changes in political, economic, social and technological environment. The legal and demographic factors like gender and the age of the population are sometimes added to PESTE analysis. All of these elements influence firms' performance and there for affects the business model

design. Profit is an outcome of the successful execution of the business model elements.

### 4.3 Business Model design process

Osterwalder and Pigneur (2010) emphasize, that every business model design project is unique and owns different challenges and obstacles as well as critical success factors, which are challenging to predict in advance. The situations the business model design is started in organizations differ and the outcome depends on the context. Start-up companies seek different issues than established organizations. (Osterwalder & Pigneur, 2010.)

The academic literature provides numerous articles of the business processes and process modelling, but little information is available of the business model design process. The best business model design process description that correspond the study objectives were found from Osterwalder & Pigneur (2010) literature. The iterative process provides elements, which support the business model design process by Osterwalder & Pigneur, (2010). Iterative process refers to a systematic, repetitive, and recursive process. An iterative process approach involves a sequence of tasks, which is completed multiple times in exactly the same way each time. (Basset.) The outcome of the iterative process approach is that organization learns during the iterations and improves in the early phase its performance. In the ever changing business environment, the iterative Business Model development process provides an agile opportunity to investigate customer's problems and needs and react early enough to find new solutions to the changed customer requirements.

Osterwalder and Pigneur (2010) present five phases, mobilize, understand, design, implement and manage, as a sequence of tasks of the business model design process. In "mobilize" phase manager's task is to plan and assemble all the elements for the successful business model design and to communicate the reason and motivation behind the new business model project. Manager's role is to create a common language to describe, design, analyse and discuss business model among the design team. A frame for project objectives is created in mobilize phase. In the second "understand" phase project team observe and gather information from the customers, business environment, new innovation etc. in various sources. The collected information is analysed and the new knowledge is created. The elements that are relevant for business model design are selected in observing "understand" phase. Design and implementations phase means action. Alternative and viable business model prototypes are brainstormed and team's task is to evaluate and validate the best business model options for testing and implementation. It is relevant to gather data during all the design phases and reflect the lessons-learned. The final "manage" phase, business model is adapted and modified to respond the customer and market action. The business model design team's role is constantly to monitor and

evaluate, adapt and if necessary transform the current business models. (Osterwalder & Pigneur, 2010.)

#### **4.4 Business model validation through trial-and-error**

Business model design project is not effortless and the organization faces various challenges when renewing or creating the new business model. The organization's internal and external environment is ambiguity and unpredictable. Manager in charge of the business model design project must see the forest for the trees and navigate with the business model team under the uncertainty and pressure. Developing the new business model prototypes take time and efforts. The critical question after executing several tests and evaluating alternative business model prototypes is which business model is the right one for the company. (Osterwalder & Pigneur, 2010.)

Magretta (2002) and Sosna et al. (2010) indicated that trial-and-error is the manner to discover the most appropriate business model. The five phase design process by Osterwalder & Pigneur (2010) equals the trial-and-error approach. Literature presents only few proposals for business model evaluation and validation. Engdahl and Rensfelt (2011) utilized SWOT -analyse in business model evaluation. They benefited Business Model Canvas (BMC) to create common and shared understanding of the business models. They placed a set of questions to assess the nine BMC building blocks. The building blocks were scored from -5 to 5 to evaluate building blocks' strengths, weaknesses, opportunities and threats (SWOT). The best one was selected based on the SWOT scores. (Engdahl & Rensfelt, 2011.) Gordjin and Akkermans (2001) created a certain assessment criteria system to build scenarios for business model evaluation. Scenario planning is exploited especially in organization strategy work forming a link between the organization's future and strategy. The scenario planning is a method to create alternative future paths, which are based on the prior research and analyse. Often times the collected and analysed data is positioned to scenario matrix, through which the four future paths, desirable, probable, possible and "wild guess" paths are created. (Bell, 2000.)

## 5 ADDITIVE MANUFACTURING AND THREE DIMENSIONAL PRINTING

The industrial manufacturing overrode the hand production over 200 years ago, when machines became all the more common in various products production. New machine and material innovations enabled Industrial Revolution, which has continued until current days. The leading economists and industrial professionals have predicted that the additive manufacturing (AM) technology will be the next big thing to transform the way products are produced in a future. In the following chapter the notion additive manufacturing (AM) and three dimensional printing (3DP) are declared. In addition the impacts of the AM on product manufacturing and firm's business model is evaluated.

### 5.1 Basics of the AM Technology

A beloved child has many names. Often times additive manufacturing, rapid manufacturing, rapid prototyping or three dimensional printing are used when speaking about material adding process or production. Additive manufacturing includes the material adding methods like stereo lithography, laser sintering and three dimensional printing. (FIRPA, 2014.) Finnish Rapid Prototyping Association (FIRPA, 2014) recommends using notion additive manufacturing (AM), when discussing material adding production. Petric and Simpson (2013) indicate 3D printing and additive manufacturing are perceived as synonym as both refer to layer-by-layer production method. According to Petric and Simpson (2013) additive manufacturing is used to create final parts and metallic components, whereas three dimensional printing is utilized in small run and part prototypes production.

AM technology has existed already three decades, but so far the utilization has been limited. AM technology is based on the digital computer aided design (CAD) and a physical model is formed by adding materials cumulatively (Liu & Zhou, 2010). The greatest advantages the literature mentions of the additive

manufacturing are cost-effectiveness, speed and tailor made products. In addition the variety in materials and improved accuracy are mentioned by the AM technology users. (Mertz, 2013.) The conventional manufacturing design contains restrictions, but AM technology enables to design and produce new forms and structures that are impossible in traditional way. AM provides ability to produce nearly anything that can be imagined. (Petric & Simpson, 2013.) This will lead to possibility to design and produce new products and parts never existed before. New business opportunities for companies will arise.

A number of materials like metal, composite, nano materials and even live cells are used in 3D printing (Liu & Zhou, 2010; Mertz, 2013). The aerospace and medical instrument industries have been the leading industries to benefit 3D printing (Mertz, 2013; Petric & Simpson, 2013). The aerospace industry is using metal 3D printing to produce more light-weight components and to reduce manufacturing lead times (Petric & Simpson, 2013). The medical instrument companies fabricate often times unique products and small runs of complex parts. For example implants and invisalign braces are unique and tailor made for patients. (Mertz, 2013; Petric & Simpson, 2013.) Producing tailor made implants and braces in conventional way are time and cost consuming. 3D printed implants and braces no longer need handcraft, which also reduces design errors in addition to costs. (Mertz, 2013.) The Cornell University's Sibley School of Mechanical and Aerospace Engineering in Ithaca is working among very ambitious project. Their goal is to move from printing passive and single plastic or metal parts to print multiple active materials simultaneously. As a result, the 3D printer would produce ready-to-use devices including wires, actuators and batteries. (Mertz, 2013.)

## **5.2 Impacts of the AM on value formation and firm's business model**

Petric and Simpson (2013) describe AM technology as a disruptive technology. By this they mean additive manufacturing have impacts on how products are designed, built and delivered. The economies of scale of the conventional manufacturing are challenged by economies of one, which advantages AM technology presents. Petric and Simpson (2013) have estimated and compared the principles of the conventional and AM technology in respect of economies of scale and economies of one (table 3). The traditional manufacturing enables high volumes, which leads to low unit price. With AM technology it is possible to produce tailor made products with variable costs. The roles and responsibilities in traditional supply chain are clear and well-defined. AM technology enables local production and collaboration with various stakeholders. Product delivery time to end-user shortens, when AM service provider is able to produce and deliver the product locally. In addition the transportation costs decrease when products are delivered locally. (Petric & Simpson, 2013.)

Table 3 Economies of scale and Economies of one (Petric &amp; Simpson, 2013)

Conventional/Additive manufacturing	Economies of Scale	Economies of One
Competitive advantage	Low cost, high volume & variety	Tailor made products
Supply chain	Well-defined roles and responsibilities	Non-linear, vague roles & resp. local collaboration
Distribution	High volumes covers transportation costs	Local customer/producer
Economic model	Fixed & Variable costs	Nearly all costs variable
Design	Standard and aim to Simplicity	Complex and Unique
Competition	Precise	Continuous change

To summarize this chapter, AM technology will effect on manufacturing ecosystem and value chain. The additive manufacturing enables design for function instead of design for manufacturing. Design for manufacturing sets limits to product forms and structures, but AM technology enables to design and produce even most complicated forms and structures. This opens limitless opportunities for designers to discover new product solutions and value adding elements. Apparently AM technology will not entirely replace mass production, but it is obvious that the design for function enables new value formation possibilities. Ability to produce and deliver small quantities, tailor made and complex products more flexibly and rapidly for local customers unfolds new value creation and business opportunities.

### 5.3 Summary of the literature review

The stakeholder theory presented by Freeman et al. (2010) determines customers, employees, suppliers, financiers and community as the firm's primary stakeholder groups. The stakeholder theory reveals the business ecosystem forms dynamic relationships between the stakeholders and value potential exists in stakeholder interfaces. By examining the stakeholder's activities and value creation processes it is possible to notice where and how value is created and captured. The value potential is actualized when certain business activities oc-

cur between stakeholders. The stakeholder theory suggest that value should be created to all firm's stakeholders in an effective way. The claim is argued with the assumption that interest groups are more responsible and loyal for the organization when they are engaged in value creation process and are thus able to influence organization's activities. (Freeman et al., 2010.) This claim was supported by the Schwartz (2012) and Rescher (1969) who presented that commitment to values guides and motivates the person to action.

The literature indicated that value has dual aspect. Value is expressed verbally and by behavior action and there is a relationship between value owner and beneficiary. In addition the value has a relationship to other values. Object, benefits and purpose are associated to value. (Rescher, 1969.) In organizational context, value creation and the mechanism how and where value is created, is complicated due to relative and subjective nature of value. However, the scholars agree that value has a user and a creator. Use value and exchange value occurs between value user and creator. (Lepak et al., 2007; Rescher, 1969; Voima et al., 2010.) In organizational context the use value refers to a specific quality and/or property of the product or service. (Bowman & Ambrosini, 2009; Lepak et al., 2007.) Lately the notion use value is extended to cover the moment, the product or service is delivered or used by the customer. Exchange value emerge in a moment, when value user and creator accomplish trade-offs. Money is traditionally used as a medium of exchange. (Lepak et al., 2007; Voima et al., 2010.) Heinonen (2006) highlighted that customer perceived value can be conceptualized in technical, functional, temporal and spatial dimensions. Technical and functional values consist of technical and functional elements whereas the temporal value is related to time and spatial value to location aspects (Heinonen, 2006).

The literature provided suggestions and methods how to identify and find value in stakeholder interfaces. The problem-solving perspective (PSP), value architecture and value co-creation analytical framework were presented. PSP performed by Nickerson et al. (2007) suggests that by identifying valuable problems in firm's internal and external structures and processes, the firm is able to identify new value creation and business opportunities. Organization has explicit and tacit knowledge and by systematically collecting and analyzing the knowledge, new insights of the customer problems and problem solutions might emerge. PSP include analytical and synthetic processes. Both processes have a sequence of steps to stimulate the problem identification. Each step disperses and demolishes the firm's value chain so that each sequence is possible to evaluate quantitatively. (Nickerson et al., 2007.)

Keen & Williams (2013) suggest firms to create value architecture for structured and continuous value detection and creation. The purpose of the value architecture is to keep firm's value detection and business model alive by studying continuously the stakeholder interfaces. The value architecture consists of value narrative, value engine and opportunity platform. Value narrative describes the stakeholders the firm creates use value. Value engine illustrates the activities and processes, where value exists and the potential for value crea-

tion and delivery. Opportunity platform presents the new innovations and opportunities for value generation. (Keen & Williams, 2013.)

The recent research literature indicates that business model is value creation, delivery and capture between the firm and its stakeholders. Traditionally value networks, pricing, customer segments, company assets, value proposition and capabilities have formed the basis for business models. However, the changes in technologies and business environment force business managers to adapt more customer-centric and value-based approach when designing business model. (Moormann & Palvölgyi, 2013; Morris et al., 2005; Shafer et al., 2005.) Based on the literature it is suggested the elements for customer-centric and value-based business model primarily should consist of customers, customer value proposition, customer relationship, customer involvement, customer business environment and customer activities and processes. The secondary business model elements are examined from the firm's perspective and it is suggested that secondary building blocks consist of firm's assets, key activities and processes, value networks, product and service delivery channels, revenue and cost structure and mechanism of how value is created, delivered and captured. The third area of the business model framework is related to firm's business environment. The building blocks of the third area are the industry where the firm is operating, competitors, PESTE analyze and the game changers.

Essential issue for business managers is to internalize that work with business models is iterative and continuous. Knowledge is a fuel for the business model design. (Osterwalder & Pigneur, 2010; Teece, 2010.) In order to design innovative and winning business models, the business managers need knowledge of the primary and the secondary business model elements as well as of the third business environment element.

The importance of the customer involvement in firm's value creation process maintains a vital role due to uncertainty and volatility in the business environment. The customer involvement improves the firm to identify customer problems and needs in the early phase, which shortens the respond time and enables the firm to find interfaces where value could be created. The customer's involvement, moreover, deepens the customer relationship and loyalty towards the firm, which increase the stability and predictability. (Saarijärvi et al., 2013.) It is thus suggested, that the customer-centric and value-based business model should consist of building blocks that identify customer segments, customer value proposition, customer activities and processes, customer business environment and customer relationship and involvement. By utilizing these building blocks, the firm is able to learn and identify where the true customer value exists, and create a winning business model to capture value to the firm.

The literature also revealed, that the business managers face difficulties to understand what is meant by the business model notion and how to benefit business model in practice. Business managers lack of knowledge how to create and implement the business model and how business model benefit the business and managers' work. In addition the managers often time understand the business model as a strategic level issue and the business model design is only

accomplished once a year in the company. The business model design should be a continuous operational level function that is executed throughout the company. The reason for this is that continuous business model design process offers an excellent learning opportunity for the managers and the organization to create, deliver and capture value. By scanning continuously the external and internal business environment, the managers learn e.g. from the customers, the markets and competitors and from the firm's internal activities, processes and capabilities. It is proved, that the companies, who deliver business model design continuously, are more competitive and profitable than their rival companies.

## **6 RESEARCH METHOD**

This chapter focuses on presenting the research objects and method applied in the study. Firstly the research objects and scope are presented. Secondly the research strategy and methods are described and the basis for the data material is explained. Data collection and analysis and research timetable are presented lastly.

### **6.1 Research objectives and scope**

The aim of the study is firstly to investigate the literature and discover where and how value is created in business relations. The secondary aim is to declare through literature which elements, processes and methods are relevant in business model design. As an outcome of the literature review, intention is to constitute a customer-centric and value-based business model framework where customer and customer value proposition form a core. The third study target is to investigate how additive manufacturing technology impacts on company's business model and value creation among Finnish machine industry companies. The third study section formed an empirical part of the study. The study objectives and scope are presented more detailed in chapter 1.1.

### **6.2 Research strategy and methods**

Myers and Avison (2007) indicate that qualitative research method's aim is to enable to examine the study phenomenon and to understand the people operating in a certain social context. In addition Hirsijärvi and Hurme (2008) mention qualitative research's aim is to explain contextual information and understand the interpretations and perspectives of the actors. The actors are able to articu-

late their perceptions of the situations in the past and evaluate the elements affecting their development in a future. (Hirsijärvi & Hurme, 2008.) Based on these considerations, the phenomenon of how AM technology impacts on the company's business model in Finnish large and SME companies in machinery industry, the qualitative research method proved to endorse the study objectives in the most comprehensive way. The actors of the study, the interviewees, were able to articulate and describe how AM technology is involved and affecting their current business. In addition the interviewees were able to estimate in the light of their current understanding the effects of the AM technology to the company business in a future.

To obtain the real-life understanding of how AM technology impacts on the company's business model, it was considered to conduct the semi-structured interview as the means of data collecting. According to Gillham (2005) the semi-structured interview is the most important way of executing a research interview due to its flexibility and the quality of data that can be obtained. In addition the use of in-depth interviews enables for deeper understanding of the research phenomenon (Gwinner, Gremler & Bitner, 1998). In semi-structured interview the same questions are asked from all the participants involved in the interviews. The forms of the questions go through a certain development process confirming topic focus areas. However, the relationship between the interviewee and interviewer enables openly asks clarifying and additional questions and raises the important topics under discussion. (Gillham, 2005.) In the study, the study actors, the interviewees, articulated their perception according to the planned interview structure and themes. The same questions were asked from all the interview participants and they were able to freely comment and articulate their views of the study phenomenon. The flexibility during the interviews enabled to inquire clarifying questions which allowed to emerge issues, which otherwise would have remain hidden. This affected the study results and validation.

### **6.3 Selection of the case firms and interviewees**

The inspiration for the empirical research came from Ideascout Oy. Ideascout Oy is a consulting company, who received an assignment from the municipality of Tampere to investigate the utilization level of the AM technology and interest to benefit metal 3D printing in the small and medium size (SME) metal companies in Pirkanmaa area. Statistic Finland (2014) determines SME as a company with less than 250 employees and turnover up to 50 million euros. Large company is a company exceeding 250 employees and turnover 50 million euros (Statistic Finland, 2014). The empirical research was executed partly together with Ideascout Oy. The companies for the interviews were selected from the machine industry in Pirkanmaa and Middle-Finland areas. The interviews concerned utilization or interest to utilize AM technology in company's busi-

ness operations and AM technology's impact on business model now and in a future.

The interviewees were selected by performing a preliminary phone interviews in the companies operating in the machine industry in Pirkanmaa and Middle-Finland areas. The purpose of the preliminary phone interviews was to declare the interest level of the company towards the AM technology and metal 3D printing. If a company indicated no interest towards AM technology, the company was left out from the study. The preliminary phone contacts among SMEs in machinery industry revealed that majority of the SMEs do not benefit AM technology. As the responses of the preliminary phone interviews appeared to be recursive, the five SMEs were selected to in-depth interviews due to their interest to improve company's knowledge and investigate the business opportunities in the field of AM technology and metal 3D printing. However, to increase the knowledge and investigate the study objectives properly, it was estimated and decided by the researcher to include the study also two large companies from the machine industry who currently utilize AM technology in their research and development functions. Similarly the AM professional service provider company was selected to provide more in-depth perspectives of the AM technology's value creation potentials and impacts on company business model. As a result eight companies were selected to the study. These companies indicated interest and willingness to increase their knowledge and benefit AM technology in their business now and in a future. Six of the interviewed companies were SMEs of which five operated in machine industry and one as an AM professional service provider. Two of the companies were large companies in machine industry. The number of the interviewed companies was estimated to be sufficient to provide reliable and valid research results.

### 6.3.1 Company profiles

Two of the interviewed companies offered engineering design services for domestic and international customers, one company produced agricultural machines and one offered products and services for military industry. The interviews also included a company offering oil-free air turbo compressors, a company producing tailor-made gear wheels and gearboxes as well as a company providing machines and lifecycle services for machine industry. Relevant and professional insights were received from a small company offering AM related professional services. The managing director of this company has got acquainted with AM technology since 2003 and has used the technology ever since.

The companies were categorized 1-5 based on AM technology knowledge and experience level. The category was determined as 1 = No knowledge, 2 = Beginner, 3 = Moderate, 4 = Advanced and 5 = Professional. Three of the interviewees owned a beginner level knowledge, one interviewee represented moderate knowledge level and the three interviewees were regarded as advanced level expertise. The company providing AM services showed professional level expertise (table 4).

Table 4 AM technology knowledge and interest levels

Category	Number of companies	Interest level to benefit AM
1-2 (Beginner, No-knowledge)	3	Exploring, not using
3-4 (Moderate, Advanced)	4	Use for prototypes. Additional information of materials, printers and service providers.
5 (Professional)	1	Offers AM services. More information of current printers and materials required.

In this study the companies in category 1-2 (no knowledge/beginner) had some knowledge of the AM technology, but they do not currently utilize AM technology in their business. These companies are actively studying how the AM technology would fit and improve their business and the industry they are operating. The companies in moderate and advanced level (category 3-4) represented companies, who actively utilize AM technology in their business. A company with moderate knowledge indicated an interest to gain more information of the current materials and printers. Three advanced level (4) companies had benefited plastic 3D printing for years in their business and their knowledge level from printers and materials was excellent. However, these companies expressed a need to update the knowledge of the current printers and materials used in plastic and metal printing. Especially the knowledge of how to mix materials and material quality in the end products were highly appreciated. A professional level (5) company owned excellent knowledge of the current printers in the market, but wished to improve its knowledge from the metal printing and materials. In addition the company expressed its interest for market research to declare demand-supply in a market. The respondents consisted of company owners, managing directors, product managers and design engineers.

#### 6.4 Data collection, questionnaire and implementation

The material for literature review was mainly collected through the University of Jyväskylä Nelli database portal, Information technology and Economics databases. The literature review was completed by examining the latest business articles and reviews. The literature provided a basis for the primary and secondary study objectives. The empirical research was conducted and data col-

lected by interviewing seven companies in machine industry and one company offering AM technology professional services.

The questionnaire for the empirical study was formed together with Ideascout Oy. The questions were divided to four themes consisting 15 questions (table 5). The first theme addressed the background and context information of the company. The aim of the first theme was to discover how and in which conditions the company utilizes additive manufacturing and to clarify if company uses AM technology in-house or buys the service from external service provider. The first theme's purpose was also to clarify the knowledge and expertise level of the AM technology in a company. The second theme consisted of the current beneficiary and value adding elements of the AM technology within the company. The benefits and value adding elements were divided to consider company and customer benefits. The third theme covered the subjects from the business development and business model perspective now and in a future. The fourth theme covered the questions related to resources and skills needed for AM technology implementation in the company. Lastly all the interviewees were able to express freely comments and feedback outside the questionnaire.

Table 5 Structured interview themes

<b>Theme</b>	<b>Questions</b>
Current status	1-4
Value adding elements	5-6
Business model	7-11
Resources	12-15

As indicated in chapter 6.3 preliminary phone interviews were performed to find companies to meet the study criteria. After preliminary phone interviews, time for personal company meeting and interview was organized. Each company was visited and interviewed once and the company representatives were interviewed personally face-to-face. The research included six SMEs and two large companies (figure 6). The companies represented defence, tooling and agriculture machine industries as well as professional service companies in machine industry. Five interviewees were either company owners or managing directors and three interviewees hold project manager or design engineer position. Four companies owned professional and advanced level skills and four companies were classified as beginner level companies. Four interviews in SMEs were delivered together with Ideascout Oy in Pirkanmaa area. The rest four interviews were accomplished in Middle-Finland area by the researcher alone.

Table 6 Company size, business role and skill level

Company size, business role and experience level	Number
SME company	6
Large company	2
Owner/Managing Director	5
Design Engineer/Product Manager	3
Professional/Advanced level	4
Beginner level	4

Prior to the interview, each interviewee was declared the purpose of the interview and the permission to record the interview and publish the name of the company in the study was asked. Due to refusal to publish company names by some of the companies, it was decided not to publish any company names in the study. The interviews accomplished with Ideascout Oy were documented by writing notes. The notes were written by the representative of Ideascout Oy while the interviews were conducted by the researcher. The interviews accomplished by the researcher alone were recorded by Iphone voice recorder. The recordings were transcribed and attached to study material. The average interview length was approximately 60 minutes. The time proved to be appropriate and all the themes and questions were performed and accomplished properly. All the questions and interviews were conducted in Finnish. The reason behind this was due to some interviewees' limited ability to express him or her other than native language.

## 6.5 Data analysis and the study reliability and validity

Content analysis is one of the analyzing methods in qualitative research and its aim is to produce various researches (Tuomi & Sarajärvi, 2003). Content analysis was used to analyze the material, which was collected by conducting semi-structured interview. Hirsijärvi and Hurme (2008) mention predesigned interview frame and questions improve the quality of the interviews. Prior to the interviews, research themes and questions were constructed, discussed and evaluated together with Ideascout Oy. A pilot interview was conducted by Ideascout Oy in order to test the validity and accuracy of the themes. Slightly modifications to the questions were done after the first interview round. To confirm the quality of the interviews, the companies were selected based on the preliminary questionnaire, which was done by phone. To improve the research validity, it was checked at the end of the interview that all the themes were covered and questions asked. In addition additional notes were done during the interview.

Due to refusal to voice record the interviews by some interviewees, the interviews were recorded by writing notes. To receive equal and accurate information, it would have been beneficial, if all the interviews were voice recorded. The voice recordings enable to revert and revise the material afterwards. It is obvious that the content of the written material is not as comprehensive as voice-recorded material. On the other hand the interviews accomplished with Ideascout Oy provided an opportunity to ask more additional questions as there were three persons to perform the interviews. Due to time limitations of finalizing the study, the interviewees were not able to review their interviews. The questionnaire material was transcribed and classified into a table to obtain more comparable data. The classification was performed according to the themes. The similarities and differences were investigated based on the inductive logic (Tuomi & Sarajärvi, 2003).

Hirsijärvi and Hurme (2000) mentions the research reliability is achieved when the study yields the same results after repeating the study twice with the same person or if two researchers have same conclusions. They also emphasize the aim of the research is to reveal the conceptions and the worlds of the study objectives. Considering the responses received from the interviewees, it is assumed to receive similar conclusions if the conditions are similar.

## 7 FINDINGS

The following chapters present the findings from the empirical study. Firstly basic information is presented and AM technology's benefits and value adding elements are presented. Where and how value is created in AM business relations and the impacts of the AM technology on company's business model are evaluated and presented. The other study observations are discussed lastly.

### 7.1 Background information of the empirical study results

The empirical study disclosed that three companies utilize AM for producing prototypes and miniature models. AM service provider offers AM printing services for prototype use but also for printing end-use products. The rest four did not benefit AM at their current business, but showed interest to learn more about AM technology and metal 3D printing. None of the companies, excluding the AM service provider, print products to end-use purposes. Two companies own printer suitable for AM. Three companies utilize subcontracting and the rest three were observing the AM benefits between the subcontracting or acquiring an own printer. AM service provider owned professional level knowledge and the companies utilizing AM in prototype and miniature products indicated advanced level knowledge. One interviewee expressed moderate knowledge and three interviewees were beginner level with little AM technology knowledge (figure 7).

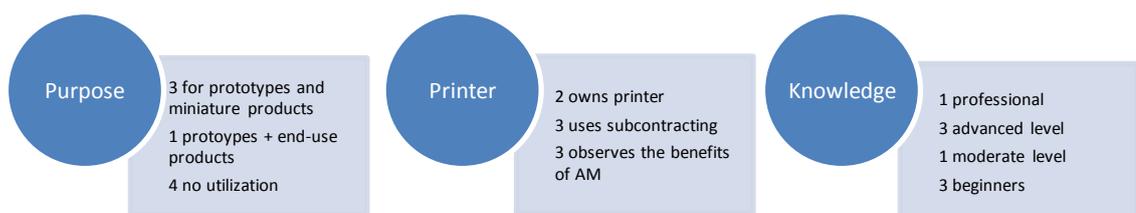


Figure 7 Results of the first theme

## 7.2 AM benefits and value adding elements for a company and its customer

AM technology benefits varied between beginner and advanced-professional level companies. Table 7 presents the benefits companies expressed as the most valuable for a company. The beginner level companies indicated that AM technology would accelerate firm's new product development and generation. AM technology possibly provides a chance to inquire a leading position and achieve competitive advantage among the competitors. One company pondered AM would enable to design more tailor made products and produce end-use products immediately. AM technology would also permit to produce and deliver spare parts faster minimizing the stock rate. The third beginner level company estimated current low-pressure molds could be replaced by AM molds or new stainless steel products could be designed and printed directly for function. In general beginner level companies assumed the AM technology would allow more flexible and fast service and product offering. The environmental issues were considered important among the beginner level companies.

Table 7 AM company benefits

Category	Company benefits
1-2 (Beginner, No-knowledge)	As an technology early-adaptor competitive advantage, new and tailored products, production to function, spare part delivery, minimize the stock rate, AM molds, environmental issues
3-4 (Moderate, Advanced)	3D designed, realistic prototypes, early human errors detection, cost and time savings in product design, fastens product testing and modification, marketing purposes, environmental issues
5 (Professional)	Expanding AM services to new customers

Moderate and advanced level companies utilize AM in new product design and in all product R&D phases. AM enables to produce prototypes and miniatures exactly as they are 3D designed. In addition human design errors are detected in the early product design phase and the corrections for the second prototype version can easily be done. Especially, if molds are needed for industrial product manufacturing, AM streamlines mold design and production processes. Traditional expensive work phases like tooling or manual work remain away in AM. This leads to cost and time saving in product design and product manufacturing. Cost savings with AM technology were considered remarkable.

Production molds are really expensive. If there is a human error(s) in prototype design, it is preferable to detect and repair the error in AM printed prototype, which costs around 1000 euros. It is cheap compared if error occurs in final production mold. To repair the error in final production mold is expensive and sometimes even impossible.

Design Engineer – Agriculture machines

The other benefits moderate and advanced level users mentioned were related to new product design and product testing. As AM technology enables to produce real-like prototypes and parts quickly and cost-effectively, new forms and structures are possibly to produce. Also functional and field tests are possible to run earlier. This enables to perform modifications in the early phase, which shortens the product development time and improves product quality.

It is possible to present AM printed prototypes to customers as they look correct and as in final products. AM printed prototype products stand up all kinds of scrutiny. In our case, AM prototype printed with current plastic material endures the normal product usage, but is not as durable as the final product in extreme conditions. AM printed prototype is possible to attach to other equipment already now.

Product Manager – Defense industry

Three companies utilized AM produced prototypes in marketing purposes. The companies indicated easiness to demonstrate sketched products to the customer, as AM prototype gives a genuine feeling of the product form, structure, colour and usage. Two companies expressed that environmental issues are highly appreciated and AM technology most obviously reduce environment pollutant load. The companies' estimations of the AM technology's customer benefits and value creation varied between beginner, moderate-advanced and professional levels. Table 8 illustrates what the beginner, moderate-advanced and professional level companies evaluated to be the most valuable and precious issues for their customers.

Table 8 AM customer benefits

<b>Category</b>	<b>Customer benefits</b>
1-2 (Beginner, No-knowledge)	New product solutions savings in energy consumption, improved machine durability and lifetime, accelerated investment pay-back time.
3-4 (Moderate, Advanced)	Cost and timesavings in product concept design, realistic prototypes, reduces mold costs, easiness to illustrate the final product or solution.
5 (Professional)	Material information and printing for function or prototype use.

The beginner level companies' estimations for customer value adding elements varied individually. One company presumed that customer value adding elements might be lighter products leading to savings in customer's energy consumption. One interviewee assumed that 3DP might improve customer's machine durability and lifetime, which would accelerate customer's investment payback time. The same interviewee also thought 3DP could enable faster spare part delivery, if spare parts are 3D printed. The other interviewee pondered that through AM technology they could widen the stainless product offering for a customer.

Cost efficiency and timesaving were considered as the most valued advantages of the AM technology among the moderate and advanced level users. The new product concept design time has shortened from months to few weeks as the prototypes and even molds can be done directly from 3D images to final prototype or product part. The AM technology allows customers to receive a genuine feeling and touch of the product as 3D printed prototype reminds the final product in forms, structure and texture. In addition AM enables to produce immaculate prototypes before the final production mold. One interviewee also mentioned the ability to observe entire interior design and ergonomic aspects, when all the parts are 3D printed, finalized and assembled as in the final outcome. All the previously referred elements are to improve the quality and customer's preferred value.

By utilizing AM in product design, we are able to examine the various product design aspects simultaneously. Firstly the prototype is possibly to install to its final position with right size, colour and surface structure. Secondly we are able to explore and test the functionality of the prototype. In my case it means I am able to test how the armrest affects to the seat's rotation and ergonomics in general. Thirdly we are able to execute collision tests.

Design Engineer - Agriculture machines

### **7.3 Impacts of the AM on business models and value creation**

The empirical study revealed the business models in the small companies develop and emerge by themselves. This means SME companies base their business on one or few long-term customer relationships usually with large companies and adapt their business to meet the customer's needs. There is less long-term business planning among SME companies compared to large companies. However the study findings unveiled, that SMEs are interested in to explore AM and how it will affect their business and customers. Two of the beginner level companies estimated, if AM technology is part of the company's service and life cycle management, they will apply current customer-centric and value creation business model strategy with old and new customer relations. By this they mean they will integrate customers to AM development and implementa-

tion process. By integrating customers to AM process, companies wish to share and minimize the risks. In addition it is assumed the mutual value in business relations is achieved. A third beginner level company considered the AM technology may allow more customer tailor made products and improved manufacturing process. A possibility for new business areas may also arise, such as customer-centric maintenance services independent from the manufacturer. The beginner level companies also considered AM might enable to design complicated product forms and to produce small product series or spare parts. In addition, if 3D printers and materials are well developed, some tailored materials could be used in certain machinery parts.

The large companies estimated that utilization of the AM technology will increase within the next 5 years. These companies expressed if AM technology allows in a future to produce products that are impossible with current methods and technologies, new value creation opportunities and business models will arise. Such new products could be more complex, light and tiny in structure. Also totally new product forms could be designed and produced.

In optronics, the aim is to have as tiny pieces as possible. In business wise it means we are able to design much complex forms and structures. We are able to design and produce smaller and lighter pieces. The honeycomb and cavity structures are impossible to produce with current methods. With AM technology it can be achievable.

Product Manager - Defense industry

The interviewees indicated if various materials are able to be printed simultaneously the final products could be produced immediately for function. The interviews also revealed that if the materials and capacity of the 3D printers improve and the printer and material prices fall, 3DP enables small-scale serial production as well as on-demand production. For one advanced level company, AM technology possibly opens new customer relations in global level. This impacts the company's current business model and value creation potential.

Considering the findings from literature review, the value potential exists in the business ecosystems and stakeholder relationships. The findings from the empirical study reveal that the AM technology ecosystem in Finland is not yet developed and the stakeholder relationships in AM technology are occasional especially among the SMEs. However value creation potential of the AM technology exists in subcontracting relationships between small and large companies. The small companies might replace some of their tooling work to AM and thus shorten the production time and reduce costs. SMEs could also already now produce final prototypes or end-use products with AM. On the other hand the large companies' ability to detect new value opportunities would improve, if all stakeholders in current supply chain would enhance the dialog with each other. For example the study indicated the AM professional service provider owns many years' experience and knowledge of the AM technology and materials. If the stakeholders would discuss with each other more closely, new value creation potential may arise in technology and material use. Small companies might also find new value creation opportunities by forming joint ventures and

offering products and services in collaboration to their customers. As mentioned AM technology has enabled to develop and create products that have been impossible to produce with current methods. Tailor made products with more complex forms and structures are possible to produce and products can be printed locally, if the AM ecosystem is developed. The time and money savings are remarkable, when old work phases remain away and production and transportation time is shortened. New value creation opportunities arise also in the education and services sector. AM technology require new skills and knowledge, which provides new value creation challenges for educational institutions. Value exists in AM technology ecosystem and in stakeholder relations like AM technology and service providers, 3D design engineers and educational institutions. New business model innovations will follow when the AM ecosystem develops.

#### **7.4 Future resources and other observations**

The study revealed that innovative and forward thinking persons are required so that AM technology unfolds in Finnish large and SME companies. The companies who utilize AM technology expressed a need for an expert level knowledge and information about the new materials and printing machines. Especially information of the new composite materials, mixing various metals and machine capacities and post processing methods were expressed. The large companies indicated a willingness to acquire expertise outside the company. The requirements at the beginner level SME companies were similar, but the SME companies' requirements were more related to general market information like the demand, utilization rate and the AM technology and processes in overall. The SMEs need information for investment plans as their role in AM ecosystem is rather service provider than user.

The questionnaire lastly included a possibility for open discussions and questions. In general the firms expressed a positive opinion towards AM technology and willingness for additional information. The concerns that emerged were related to limited printer capacity, materials and to electricity consumption. The firms utilizing AM technology, expressed the current materials are not applicable to final products and the current printer capacity does not support cost-effective production. In addition firms considered customer reactions to test new materials in critical components. One SME pondered if AM technology increases firm's electricity consumption and if current electricity production is sufficient. For a tooling company AM technology is a threat for current business as most likely tooling will vanish or at least decreases if AM technology generalizes. Threat of competitors was regarded as major risks among SMEs. One company considered AM technology as one production method among the others.

## 8 CONCLUSIONS

This chapter presents the study conclusions and illustrates the literature findings to empirical research. The conclusions how companies in machine industry could exploit stakeholder theory and customer-centric, value-based business model design to enhance AM technology's adaptation among the industry's ecosystem and value networks are evaluated and presented. The impacts of the AM technology on company business model and value creation are also described.

### **8.1 Customer-centric and value-based business model for evaluating AM technology's impacts on company business model**

Business model is a tool to scan the changes in customer interfaces, business environment and in other stakeholder groups. Business model is not a strategy, but instead is lead from the company strategy. Keen and Williams (2013) indicated new technologies and innovations often times offer the potential for new value creation and capture. If the diffusion of the new technology like AM accelerates rapidly, it is obvious it will impact on company's business and business models (Aridlio & Seidenstricker, 2013). As literature emphasize managers must reinvent the company business model before it's too late. Even though the new business model design is time consuming and laborious work, sticking to traditional business may be fatal. (Aridlio & Seidenstricker, 2013; Nunes & Breene, 2011.) AM technology is a game changer and apparently affects and changes the firms' business, value creation potential and the business ecosystem in machine industry. It is thus essential for business managers to re-evaluate and reinvent current business models.

Considering the study objects where and how value is created in business relations and which elements and processes are essential for customer-centric and value-based business model design, the literature revealed value exists in firm's primary stakeholder interfaces and value is activated when business ac-

tivities occur between stakeholders. The stakeholder theory and customer-centric value-based business model design provide excellent tools to discover and emerge the new value creation possibilities. They even usher and force managers to investigate and evaluate the opportunities and threats AM technology creates for the company now and in a future. Stakeholder theory directs the managers to study the primary, but also other stakeholder groups. By evaluating each stakeholder's interests it is possible to define the AM technology's influences to value creation in current business ecosystem. It is obvious that AM technology will change and streamline value networks and value creation potentials in machine industry. To facilitate the stakeholder identification and mapping the study recommends implementing the questions presented by Freeman (1984):

1. Who are our current and potential stakeholders?
2. What are their interests and rights?
3. How does each stakeholder affect us (challenges and opportunities)?
4. How do we affect each stakeholder?
5. What assumptions does our current strategy make about each important stakeholder?
6. What are the current "environmental variables" that affect us and our stakeholders?
7. How do we measure each these variables and their impact on us and our stakeholders?
8. How do we keep score with our stakeholders?

The questions improve managers to illustrate the current stakeholders and their value expectations. Questions also improve managers to re-define and re-describe current and new stakeholders and identify value potentials in the ecosystem utilizing or willing to utilize AM technology. Implementing stakeholder theory and re-evaluating the current business model the problem of value creation is possible to solve. The stakeholder theory and new business model innovation allow business managers to recognize the benefits and sacrifices and potentially also identify the direct and in-direct value in AM technology business ecosystem (Ojala & Helander, 2014).

The literature emphasizes customer centricity and value creation as the core elements in modern business model design. Based on the literature and the findings from the study it is thus suggested the companies should implement the customer-centric and value-based business model framework presented in figure 8 if they decide to redesign and reinvent current business model. By doing so, the companies improve their ability to meet the changes AM technology is inevitably accomplishing.

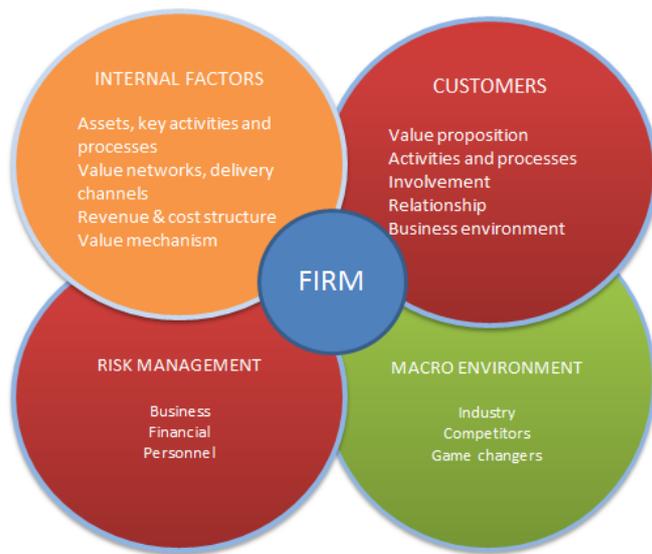


Figure 8 Elements of the Customer-centric and Value-Based Business Model Framework

Customer-centric and value-based business model framework primarily consists of customers, customer value proposition, customer relationship, customer involvement, customer business environment and customer activities and processes. Many SMEs in machine industry are subcontractors for larger companies and as the study indicated SMEs role in AM technology would be AM service provider. The stakeholder theory and business model framework improves both SMEs' and large companies exploring and finding elements for value co-creation with the existing and new customer relationships. Stakeholder theory and business model framework also assists business managers to identify the value subscription and purpose as well as the benefits customers are seeking. It also contributes SME's customers to involve and adapt new technology. Implementing the business model framework iteratively, the SME's have a potential to discover new value creation drivers or value dimensions presented by Heinonen (2006) and Zott & Amitt (2009).

The customer involvement in firm's value creation process improves the firm to identify customer problems and needs in the early phase, which shortens the response time and enables the firm to find winning solutions for value creation and capture. The companies indicated reluctance to engage financial and personnel resources solely to the new technology even though the benefits and potential for new value creation exist. The financial risks are considered to be too high to bear by single company only. As Schwartz (2012) emphasized security is an attribute applied both in individual and collective values. Combining technological, human, managerial and financial capabilities and investing potential for value co-creation in AM business ecosystem it is possible to minimize the financial risks and increase the security among each stakeholder. As Ojala and Helander (2014) emphasize belonging to the business networks the firm is possible to benefit business network's resources and receive value. All stakeholders in Finnish machine industry have a role to minimize the risks

and accelerate AM technology diffusion. Only committing collectively it is possible to create and capture new value opportunities within the industry.

## 8.2 AM value drivers and impacts on company business model

Ardilio and Seidenstricker (2013) encourage business managers bravely invent new business models as the renewed business models act as a key driver for adapting new technologies. AM technology is considered to be a game changing technology affecting businesses in various industries. AM technology changes the traditional manufacturing enabling to produce locally tailor made products cost and time effectively. Customers do not need to be content to mass production products, but instead they are able to acquire products suitable for their specific needs and desires. AM technology changes where and how value is created in manufacturing ecosystem and business networks. AM technology influences new business model innovation and design.

Considering the empirical study executed in SME and large companies in machinery industry in Finland the indications of the AM technology benefits followed the findings described by Petric & Simpson (2013) and Mertz (2013). The large companies utilize AM in prototype design and production and in miniature model production, but not for the final product manufacturing. AM technology streamlines and accelerates the product development process and manufacturing time leading to remarkable time and cost savings in product development. Large companies prefer to utilize external service providers for AM prototype products because the AM printers are relatively expensive and require special skills. AM prototypes advance marketing and environmental issues in large companies. SMEs assumed AM technology opens new business opportunities, but it is also a threat to current business. Especially the companies in tooling business are vulnerable to AM technology and these companies should carefully observe AM's impacts on current business model.

From the business model design perspective the study revealed that if printers and materials improve, new products are possible to design and print directly to function. The properties of the new products were evaluated to be more complex in forms and structures, lighter and more durable and tiny. Improved AM technology would enable more diverse spare part and product offering as well as on-demand small-scale serial production. The usage of the AM technology will most likely increase especially among the large companies within the next five years. Reason for this is that interviewees estimated the materials and printers are developed enough enabling even the final production.

AM technology opens new business opportunities especially for the SMEs as the large companies are reluctant to invest own time, resources and money to the AM technology. However, it is notable that dominant suppliers have the power to shift some of the technology costs to other industry participants (Porter, 2008), which means higher risk rate for other stakeholders. Based on the

study findings the costs of the AM technology appear to concern more the SMEs than large companies. For this reason SMEs indicated a need for a diligent research of the AM technology prior committing and investing on it. SMEs are willing to integrate and explore the value-adding elements with customers before the final investment decision. It can be argued AM technology has more significant impacts on SME's business model than large companies'.

As the study revealed numerous AM technology benefits and interest and demand exists to utilize AM technology in machine industry in a near future. To overcome the obstacles and bottleneck situation, it is suggested the business managers both in SMEs and large companies explore in collaboration the AM technology's benefits and discover solutions to reduce technology and business barriers and risks. AM technology include latent value creation potential for all stakeholders in many industries. Commitment to new technology accelerates the technology diffusion and enables to discover new business models and innovations in all companies.

## 9 SUMMARY AND FURTHER STUDY

This study investigated where and how value is created in business relations and which elements and processes are needed to form a customer-centric and value-based business model. In addition the impacts of the AM technology on company business model in Finnish machine industry was observed. Stakeholder theory revealed value exists in the firm's primary stakeholder interfaces like customers, employees, suppliers, community and financiers. Value is actualized when certain business activities occur between stakeholders. The customers and value co-creation is in the hub in the customer-centric, value-based business model design. Customers, company macro environment, risk management and company's internal factors form the elements in the value-based business model design. The customers are observed from various dimensions and business manager's task is to create a mechanism and process to collect continuously information of the customers, their business environment, activities and processes as well as risks in order to incorporate customers to value co-creation and to build long-lasting mutual relationships.

The study revealed AM technology is still rather unknown technology in Finland and AM is mainly used for prototype purposes. AM technology is rarely used for final production. AM impacts on company business model as it among other things streamlines and accelerate the product development processes and traditional product manufacturing time. AM enables to produce more tailor made products for specific needs and to design new product structures and forms that have never existed before. Cost and time savings in R&D functions were mentioned as the most valuable factors. Human design errors are detected in the early product design phase, which accelerates the product development lead time. AM prototypes were also utilized in marketing purposes and environmental issues were highly appreciated.

The research disclosed the major obstacles of using the AM for the final production are insufficient printer capacity and the materials. In addition lack of technology knowledge and services prohibit companies to benefit AM technology in full scale. The companies indicated reluctance to invest on own 3D printer and personnel due to high printer prices and limited machine utilization

rate. However, companies estimated printer prices will fall when AM printer patents expire and materials and printers develop. Many research companies indicated interest to utilize AM technology in final production.

The study research group was rather heterogeneous, which partly affected to study relevance. More comparable results could be achieved if the research is limited to more homogenous business groups nationally or internationally. Further research is required and it is suggested to explore AM technology's impacts from disruptive technology's perspective. It is notable that as a game changing technology, AM affects not only companies but also other stakeholders like customers, suppliers, community, employees, financiers and shareholders in various industries and societies. When printers and materials develop, new knowledge and skills are required and created. Transforming the traditional manufacturing AM technology creates entire new professions and jobs. This means new possibilities for the educational institutions, business owners and people. Combining technological, human, managerial and financial capabilities and investigating value potential in AM ecosystem it is possible to increase the security among stakeholders, minimize the risks and accelerate the diffusion of the AM technology. During the research period new information was published in accelerating phase of the improved AM printers and materials as well as of the new AM implementation and application areas. This provides indications that AM technology is generalizing and should be considered as a technology transforming the conventional way products are designed, produced and transported.

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## ATTACHMENT 1 RESEARCH THEMES AND QUESTIONS

### Theme 1

1. How and for what purposes you utilize AM in your company?
2. When did you start explore AM seriously?
3. When did you start to utilize AM in your company?
4. Does your company own a 3D printer or do you use subcontracting?

### Theme 2

5. Specify AM/3D printing value adding elements for the company so far.
6. Specify AM/3D printing value adding elements for the company's current customers and/or potential new customers.

### Theme 3

7. Specify the impacts of the AM/3D printing on company business model.
8. Specify the impacts of the AM/3D printing on the company activities and processes.
9. Evaluate how AM/3D printing effects on company's business and customers within 5 years.
10. What threats/opportunities AM/3D printing provides for the company and other stakeholders?
11. Specify the risks AM/3D printing causes for the company, customers and other stakeholders.

### Theme 4

12. Specify what resources company needs related to AM in a future.
13. If special skills and resources are required, what would it be?
14. What is the best way to acquire such special skills and other resources?
15. Other questions