Possibility-Driven Design in Design-Oriented Communities

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Abstract

This study examines possibility-driven design in design-oriented communities. Possibility-driven design refers to design through possibilities which make people flourish and thrive since it provides long-term positive effects on people’s lives. The essence of the possibility-driven design lies in the positive development and opportunities of everyday human practice and needs.

This study explores characteristics and drivers of ways of working and practices which prevails in design-oriented communities. The study combines emergent design flexibility and exploration of possibilities to design artefacts in the positive side of the solution spectrum. Empirical data is from the global open design community and local design-oriented community. This study approaches possibility-driven design from five perspectives: human-centred design, open design, business design modelling, affordances theory and intuition. Its aim is to offer insights and widen our understanding of how the possibility-driven design is manifested in design-oriented communities. Five publications, three empirical and two conceptual studies, are included in this study.

This study contributes to design research, especially possibility-driven design research in three ways. First, it proposes explanation to why community members participate in collaborative activities of design-oriented communities. Second, it introduces ways of working and practices which prevail in design-oriented communities and third, it presents opportunities which can promote innovation practices in design situations.

Practical implications of this study can be categorized into commercial, social and innovative. An understanding of current and potential strategic possibilities could prepare organizations to be more creative and able to answer to ambiguous demands of the markets, especially when facing the new challenges of digitalization. The findings can be valuable for policy makers who work with various groups of people in the society. The findings can be used to strengthen and support innovation practices in design situations.

Keywords  Possibility-driven design, design-oriented community

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Tekijä
Pia Tamminen

Väitöskirjan nimi
Mahdollisuusjohteen muotoilu ja suunnittelu muotoiluorientointueissa yhteisöissä

Julkaisija
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Tiivistelmä
Tämä tutkimus käsittelee mahdollisuusjohteen suunnittelua ja muotoilua muotoiluorientointueissä yhteisöissä. Mahdollisuusjohteen muotoilu tarkoittaa suunnittelua ihmisten käyttävän tarpeiden luomien mahdollisuuksien kautta, jotka saavat ihmiset menestymään siitä syystä, että mahdollisuusjohteen muotoilu tarjoaa pitkäänaisia positiivisia vaikutuksia ihmisten elämiin. Mahdollisuusjohteen muotoilun ydin on ihmisten käytäntöjen ja tarpeiden kautta syntyperien tilaisuuksien positiivisessa kehityksessä.

Tämä tutkimus tarkastelee työtapojen ja käytäntöjen ominaisuuksia ja ohjaavia tekijöitä. Tutkimus yhdistää suunnittelun ja muotoilun joustavuuden ja mahdollisuuksien tunnistamisen tuotteiden ja palveluiden muotoilussa lähetyksällä niitä positiivisilla ratkaisuilla. Empiirinen aineisto on peräisin globalista avoimen muotoilun yhteisöstä ja paikallisesta muotoiluorientointueesta yhteisöstä. Tutkimuksen tavoitteena on tarjota oivalluksia ja laajentaa ymmärrystämme siitä, kuinka mahdollisuusjohteen suunnittelun ja muotoilu toteutuvat muotoiluorientointueissa yhteisöissä. Tähän tutkimukseen sisältyy viisi julkaisua, joista kolme on empiristä ja kaksi konceptualialaista tutkimusta.


Tämän tutkimuksen käytännön vaikutukset voidaan jakaa kaupallisiihin, sosiaalisiin ja innovatiivisiin luokkii. Nykyisten ja potentiaalisten strategisten mahdollisuuksien ymmärtäminen voi valmistaa organisatioita olemaan luovempia ja kykenemään vastaamaan markkinoiden epäselviin vaatimuksiin, erityisesti kohdatessaan digitaalisatioon liittyviä haasteita. Tulokset voivat olla arvokkaita päättäjille, jotka työskentelevät erilaisten yhteiskunnallisten ihmisryhmien kanssa. Tulokset voidaan käyttää innovatiokäytäntöjen vahvistamiseen ja tukemiseen suunnittelutilanteissa.

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Espoo, October 22, 2016
Pia Tamminen
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**Publication 4:** Tamminen, P. 2016. Fiskars Village: Exploring possibilities for collaboration in a Design-Oriented Community. *Journal of Design, Business and Society*, Vol.2, issue 2, pp. 147-162. ISSN: 20552106 (print), 20552114 (online). DOI: [http://dx.doi.org/10.1386/dbs.2.2.147_1](http://dx.doi.org/10.1386/dbs.2.2.147_1).

Author’s contribution

**Publication 1:** Community-based business design model

This paper was fully written by Pia Tamminen, based on data collected, analyzed and reported by Tamminen. Tamminen presented the publication in the 19th DMI Academic Conference.

**Publication 2:** Possibility-driven spins in the open design community

This paper was based on the original idea of Pia Tamminen. Quantitative data were collected by Jarkko Moilanen, and the qualitative data by both Tamminen and Moilanen. Tamminen was responsible of building the framework, conducting the empirical analysis of the data and reporting.

**Publication 3:** The role of design in service-dominant logic

This paper was based on the original idea of Pia Tamminen. Tamminen was responsible for building the framework and writing of the paper. Katriina Järvi was involved in the discussions related to the paper. The paper was presented in the RESER conference by both Tamminen and Järvi.

**Publication 4:** Fiskars Village: Exploring possibilities for Collaboration in a Design-Oriented Community

This paper was fully written by Tamminen, based on data collected, analyzed and reported by Tamminen.

**Publication 5:** Understanding the Role of Intuition in Decision Making When Designing for Experiences: Contributions from Cognitive Psychology

This paper was based on the original idea of Professor Tonetto. The conceptual framework was developed by Tonetto and Tamminen. Tamminen contributed to the designers’ theoretical approach and complemented the conceptual paper with empirical cases.
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1. Introduction

Interdisciplinary research, such as this study, acts in areas between different schools of thought and tackles paradoxes. Polanyi (1966) encountered contradictions when pondering about the existence of tacit knowledge within frontiers of physical and social sciences and referred to Meno’s paradox discussed by Plato (c. 428/427 – c. 348/347 BC) in those situations. Meno’s paradox deals with the absurdity of gaining knowledge; ‘either you know what you are looking for, in which case no search is needed as there is no problem, or you do not know what to look for, in which case you cannot expect to find anything’ (Polanyi, 1966, p.22). My approach to the paradoxes presented in this study is to examine them with an open mind and reflection.

1.1 Motivation

The world is changing in many ways as technological disruptions and new innovations force entrepreneurs, researchers, service providers, lawyers, venture capitalists as well as financial and marketing professionals to create state-of-the-art competitive and flexible ecosystems (Henton and Held, 2013). The current economy can be seen to be oriented towards production beyond consumption for people are able to participate in the development of artefacts they use (Heimans and Timms, 2014). When consumers turn compassionate with the societal transformations of the world, swift responsiveness and future foresight are required in thinking and practice (Hands, 2009). The role of design has become more significant due to growth of large-scale social, economic and industrial issues and challenges with a complex environment of needs, requirements and constraints (Frieman and Stolterman cited in Dorst, 2015, p.9). The complex environment consists of multiple projects which cross several organizational boundaries and various stakeholder, producer and user groups (ibid.). Individuals and organizations want to tackle the issues, and one way to do that is to turn to designers for help. Expert designers are known for ‘solving the unsolvable’; they can create new solutions where others see none, and find opportunities where others see only problems (Dorst, 2015).

If an organization wants to create a complete customer experience, every aspect of the organization, including both product and service designs, need to work together to produce those experiences (Utterback et al, 2006). Especially the Western societies experience transformation from a materialistic value system to a post-materialistic one which prioritizes personal goals such as belongingness and self-expression (Desmet and Pohlmeyer, 2013). New companies
can be seen as troublemakers since they do not follow traditional ways of working, and even their business design model is different; active individuals have needed resources and conduct required work, and operational processes as well as service offerings are transparent. However, customers find the offerings attractive and cost-effective which makes sales of the companies increase.

This study investigates characteristics, ways of working and practices in design-oriented communities. The communities can be defined around their collective identity built around a subject matter, which is central in defining who they are (Wenger et al., 2002). This study takes place in the context of design-oriented communities, and their collective identity built around design. Design comprises products and services as well as the processes that produce them (Simon, 1996; Walsh, 1996). This study takes a pragmatic and empirical approach for sense making of the world (Giacomin, 2014). Design attitude conveys opportunities for invention to each design situation by questioning the basic assumptions but with a determination to change the world to a better place than before (Boland Jr. and Collopy, 2004).

Two predictions of the futurist Alvin Toffler (1980) are studied in this study. Toffler’s book The Third Wave predicted that as the communication technologies advance, people prefer to work in ‘electronic cottages’ instead of factories and offices. Toffler also introduced a term prosumerism in his book. A prosumer is a person who both produces and consumes what she produces, and Toffler saw already in the 1980’s indications of that. The prosumerism was a consequence of the Industrial Revolution where people were categorized to producers and consumers, and the split led to an industrial society based on ‘production for exchange’ (Toffler, 1980, p.277).

Toffler (1980) was partly right in his prediction of people working in the ‘electronic cottages’ although the walls of an electronic cottage are as blurred as the limits of Internet. There are no boundaries to the digital raw material, data, either, hence Internet is open. People use IT tools and applications, browser based services and their digitalized work is stored in the cloud services. Toffler was also partly wrong; despite the fast advancements of information technologies, like-minded people still congregate at industrial clusters like Silicon Valley and New York City (Porter, 1998; Brown and Duguid, 2002; Henton and Held, 2013). The close physical proximity engenders benefits that cannot be achieved with remote connections and virtual relationships or explained with the sheer rational thinking (Avital, 2011).

Toffler’s (1980) notion of prosumerism is in line with the notion of open design which aims at collaborative creation of artefacts and digital manufacturing at the point of use. The development of open design can be compared to the early days of computing and to a ‘cathedral-bazaar’ analogy (Raymond, 1999). According to the analogy, design was earlier performed in cathedral-like places where designers operated with expensive devices and software, and all design and knowledge were kept hidden from the public. Today, design can exist anywhere and it is open; model designs are shared publicly and derived work is a normal procedure (von Busch, 2012). Internet and digitalization of design models has enabled all people to become designers just like Viktor Papanek (1972)


has claimed. The transformation from closed ecosystems to open ones has changed the way we perceive design and design processes as well as the production of artefacts (von Busch, 2012).

Heimans and Timms (2014) shed light to the on-going power shift in the world; the old power, which is closed, inaccessible and leader-driven, is being replaced by a new power with quite opposite characteristics; the new power is human, diffuse, participatory and peer-driven. The amount of political protests and start-ups with unconventional business models is constantly increasing although we are probably only seeing the beginning of the new era (Heimans and Timms, 2014). The new power models take different forms, and their core is in people’s need to participate and share their work and possessions in ways that are beyond consumption (ibid.). Open and networked challenges are caused by the passing of the structures and systems of the industrial age and a networked society (Dorst, 2015). Understanding of their ways of working and the most significant drivers will enable us to better cope with the changes and balance the shift between the powers (Heimans and Timms, 2014). The impact of the changes is still un-known but it will evidently be significant to the companies, societies and communities themselves (von Busch, 2012).

In today’s dynamic, complex and networked world (Dorst, 2015), collaborative, open-minded and reflective practices are paramount in order to create long reaching solutions (Kennedy, 2011). Could the focus be on possibilities instead of missed opportunities? Designers, as many other professionals, are creative, but do they hit on new ideas merely by trying everything as it happens to cross their minds, or do they have hunches and visions that spur and point to possible solutions? ‘Designerly’ knowing (Cross, 1982, 2001) and various design methodologies could bring a fresh perspective to the seemingly unsolvable challenges of businesses and societies of the world, which currently focus too much on efficiency and management of risks and crisis.

1.2 Objective and scope

This study sheds light to the possibilities that lie in design-oriented communities. It also raises awareness of the potential of design-oriented opportunities which can make individuals prosper and enable communities to flourish. The aim of this study is to widen our understanding of the ways of working and practices of design-oriented communities, to describe their characteristics and to propose ways to support innovation practices in design situations. The main topic of the study, possibility-driven design, focuses on opportunities that enable people to flourish, thrive and provide long-term positive effects on their lives (Desmet and Pohlmeyer, 2013). Possibility-driven design stems from positive design; it can create artefacts without referring to any problems, but still be based on human practice and needs (Desmet and Hassenzahl, 2012). Possibility-driven design seems to promote subjective well-being of individuals and communities (Desmet, 2011; Ruitenber and Desmet, 2012; Jimenez et al., 2014).
Design is defined as both the process and the outcome of that process, the artefact itself (Simon, 1996; Walsh, 1996), whether it is a product or a service. Design-orientation refers to distinguishing characteristics of an organization culture which reinforce the capabilities to generate competitive advantage by design-oriented behaviour (Calabretta et al., 2008). The design-oriented behaviour is acquired by a design education and by cultivation of designerly ways of working. According to Cross (1982, p. 226) designerly way of working indicates that designers work with wicked problems, and they are focused on finding solutions compared to scientists who focus on solving problems. Designers’ mode of thinking is constructive, and they use visualisations and prototypes to translate abstract requirements into concrete artefacts (ibid.).

Designers’ ability to empathize and connect knowledge and inspiration are strengths in today’s technology-oriented world, but to guarantee long-term success of the designed solutions, the strength and benefits of design-oriented thinking and practices need to be understood better. Wild ideation, designerly knowing (Cross, 1982, 2001) and collaboration, defined as a group of people working together to accomplish an agreed activity or achieve an agreed goal (Chiu, 2002), are normal ways of working in design-oriented communities, which is the context of this study. The design-oriented communities refer to communities which cultivate organization cultures containing designerly mind set, such as an aim of constructive solution-finding, which differentiates them from the other, non-design-oriented organizations (Calabretta et al., 2008; Desmet and Hasselzahn, 2012).

Collaboration makes human technological development possible and ties communities together by being an inherent sociocultural attribute of being human and enabling teaching, learning and sharing act as social glue (Tooze et al., 2014). Ryan and Deci (2000, 2006) propose in the self-determination theory that autonomy can enhance personal well-being of people. Autonomy refers to autonomous acts which are endorsed by the self, fully identified with and ‘owned’ (Ryan and Deci, 2006). Working methods with similar values, autonomy and democracy, are valid in voluntary-based communities (von Hippel, 2005). Democracy is also used when developing business design models with long-term solutions for companies in ways that also add value to other organizations and communities (Fraser, 2007, 2009; den Ouden and Valkenburg, 2011).

The scope of this study needs to be defined clearly due to the inter-disciplinary nature of design and the diversified approaches which view possibility-driven design from different perspectives. All the approaches include elements related to possibilities and open up new perspectives to understand the concept of possibility-driven design. Although the approaches are presented in this study as separate entities, in reality they overlap; for example, human-centred design can be embedded in the open design as members of the open design community can create artefacts for themselves and others. Figure 1 illustrates the perspectives constituting this whole study. It focuses on ways of working and practices of the design-oriented communities at individual and community levels. The chosen approaches stem from a basic assumption that people design artefacts
because the activity and its outcome generate subjective well-being, which is turn generate social welfare (von Hippel, 2005; Desmet and Hasselzahn, 2012). The possibility-driven design is viewed from different perspectives, which frame this study accordingly (Figure 1):

1. **Human-centred design** focuses on the people’s intended use of artefacts through understanding of their needs and experiences (Giacomin, 2014). Design thinking and engineering design thinking can be considered as human-centred methodologies (Brown, 2008; Lockwood, 2010). Design thinking is seen as a mind set, a methodology and a creative innovation process in which designer’s sensibility and methods of problem solving are applied (Lockwood, 2010). The assumptions are that everyone is capable of designing (Papanek, 1972) and the ability to think in creative ways is inherent within human cognition as part of what makes us human (Cross, 2011). This study intends to view the possibility-driven design through the lens of human-centred design.

2. **Business design modelling** refers to an interactive symbiosis that prevails in organizations and delivers both market and customer experience value (Fraser, 2007, 2009). Its main components, user understanding, concept visualization and strategic business design, create a foundation for a sustainable and robust business development for organizations and support flourishing of individuals (ibid.). This study aims to adjust the business design modelling concept to fit to design situations where many independent companies work together. Design situation is defined as a set of all available information that can be recognized in a design by a designer, hence it includes information of the environment and the past design activities of the designer (Taura et al., 2002).

3. **Open design** is a collaborative creation of artefacts by a group of individuals who share a common interest in developing and manufacturing of goods digitally at the point of use (Atkinson, 2011). A well-known form of ‘open’ is in the form of open source software, which has enabled many collaborative projects such as the Linux operating system (von Busch, 2012). An open design community is a community of voluntary actors, who are united by openness and the shared instrumental goal of creating, adapting, adopting or producing models and artefacts (Gläser, 2001; West and Lahkani, 2008). In this study, open design is viewed through the 3D printing open design community, which is part of the global open design community. As the term ‘open’ indicates, there are no clear boundaries in the open design community (Avital, 2011). However, activities around 3D printed artefacts constitute a relatively apparent area within the open design community.

4. **Affordances** can be seen as opportunities for action (Gibson, 1986; Pols, 2012). The affordances are properties of an environment relative to an actor, and they contribute to the actor’s behaviour in the environment (Gibson, 1966). While an actor, or user, is in the environment, her senses receive and attune dynamic meanings of affordances emerging in that situation, and this is regarded as an active and exploratory system (Gibson,
This study focuses on affordances and their perception in design situations, and enhances our understanding of why active individuals and organizations aggregate together to form communities.

5. **Intuition**, a natural part of human thinking (Kahneman and Tversky, 1982; Laughlin, 1997; Kahneman, 2011; Raami, 2015), is an act of recognition (Simon, 1996). This study discusses intuition taking place in design situations and the development of designers’ intuitive skills. The study sheds light to how novice and experienced designers perceive, understand and use intuition.

![Figure 1. Five different approaches to the possibility-driven design.](image)

1.3 **Positioning and structure of the study**

This study is a compilation dissertation which consists of scientific publications on a related set of problems, and a summary of the findings. The first part of this study includes introductory and summary chapters, which outline the theoretical framing and literature review, introduce the research questions and the research design, and present the research methodology, results and discussion related to the results. The second part comprises three scientific journal articles and two conference papers.

The main research question is: What constitutes possibility-driven design in design-oriented communities? In addition, there are four sub-questions, which refine the main question by reviewing it with different approaches:

1. Why do members of design-oriented communities participate in activities of the community?
2. How do the design-oriented communities operate?
3. What kinds of affordances are perceived in collaborative design situations of the design-oriented communities?
4. What is the role of intuition in design endeavours?
The relationship between the research questions and the publications is presented in Table 1. A publication marked with a bolded letter X in the table is the main contributor to the research question, and the other marked publications support that. Two of the publications, publication 2, Tamminen and Mollanen (2016): ‘Possibility-Driven Spins in the Open Design Community’ and publication 4, Tamminen (2016): ‘Fiskars Village: Exploring Possibilities for Collaboration in a Design-Oriented Community,’ provide more responses to the research questions than the other publications by focusing more deeply on the designerly ways of working in the open design community and design-oriented local community, respectively.

Table 1. Mapping of the research questions to the respective publications. The main contributions are marked with a bolded letter X.

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The publication 1, Tamminen (2014): ‘Community-Based Business Design Model’, discusses constitution of a community-based business design modelling. The publication builds on Fraser’s (2007, 2009) business design model, which creates new opportunities and growth strategies to companies by introducing and expanding design thinking methods and mind sets across independent organizations or companies when developing shared business processes. It proposes an enhancement to Fraser’s (2007, 2009) model by taking into account ways of working and practices of several independent organizations within a design-oriented community. Publication 1 responses to two sub-questions: Why do members of design-oriented communities participate in activities in the community? and How do the design-oriented communities operate?
The publication 2, Tamminen and Moilanen (2016): ‘Possibility-Driven Spins in the Open Design Community’, presents the main characteristics and ways of working that frame and drive activities in the open design community. The term method of operation is used in the article to describe the way of working in the community. In this study, the term way of working is chosen to be used because it provides a wider perspective to the design activities of the community members. Publication 2 provides responses to all four sub-questions.

The publication 3, Tamminen and Järvi (2014): ‘The Role of Design in Service-Dominant Logic’ is a conceptual paper1 discussing the main differences of design thinking and engineering design thinking through the lens of the service-dominant logic. The discourse related to design thinking and engineering design thinking is also valid in other contexts, and consequently publication 3 provides responses to a sub-question How do the design-oriented communities operate?

The publication 4, Tamminen (2016): ‘Fiskars Village: Exploring Possibilities for Collaboration in a Design-Oriented Community’, views the design-oriented local community through the lens of affordances which exist in collaborative activities of the community members. The case study identifies and describes themes that encourage and support perception of collaborative affordances in the community and perceived affordances of community members at individual levels. Publication 4 provides responses to all four sub-questions.

The publication 5, Tonetto and Tamminen (2015): ‘Understanding the Role of Intuition in Decision Making When Designing for Experiences: Contributions from Cognitive Psychology’ is a conceptual paper that illustrates designers’ ability to use intuition when designing for experiences. Publication 5 provides responses to a sub-question: What is the role of intuition in design endeavours?

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1 The paper was presented in the European Association for Research on Services (RESER) conference in 2013.
2. Theoretical framework

This section introduces the theoretical framework which consists of the intellectual bins (Miles and Huberman, 1994) of the study. The intellectual bins form the high level conceptual framework which incorporates researchers' personal interests, the topical research about the possibility-driven design and the research theories related to it (Maxwell, 2005; Ravitch and Riggan, 2012). The theoretical framework can provide a proposal of the interrelationships among the intellectual bins (Ravitch and Riggan, 2012). The core of this study lies in the possibility-driven design concept which is approached with different design research topics: human-centred design, business design modelling, open design, affordances theory and intuition (Figure 2).

![Theoretical framework of the study.](image)

Possibility-driven design is human-centred, and it focuses on exploring the positive development of the solution beyond neutrality (Jimenez et al., 2014; Desmet and Pohlmeyer, 2013; Desmet and Hasselzahn, 2012). The human-centred design focuses on people, their needs, desires, and emotions (Norman, 2015). A structural model of human-centred design reveals a bridge between human-centred design thinking and engineering design thinking which focuses on efficiency and function (Brown, 2008; Lockwood, 2010; Giacomin, 2014). Business design modelling identifies elements which enable collaborative value
creation across organizations prior the conventional monetary business modelling (Fraser, 2007, 2009). Although the amount of open design research has grown recently (e.g. von Busch, 2012; van der Beek, 2012; Tooze et al., 2014; Cruickshank and Atkinson, 2014), this is probably the first attempt to study the possibility-driven design through the lens of the open design. Affordances theory focuses on opportunities for action (Gibson, 1986; Pols, 2012), and therefore it offers an activity-based approach to the possibility-driven design. According to Lawson (2004), expert designers focus on acquiring knowledge about solutions rather than about problems. This is a result of designers’ ability to exploit affordances, opportunities for action (Gibson, 1986; Pols, 2012), they perceive in the environment. Designers’ use of intuition varies although it can be a useful tool when designing artefacts. The two-sided arrows in Figure 2 illustrate the interactive nature of the research and the evolution of the theoretical framework as the research progresses.

2.1 Possibility-driven design

Possibility-driven design is based on the notion that people want to design artefacts because the activity and its outcome generate happiness, and the established mentality and culture of innovation yield direct improvement to people’s lives (Desmet and Hasselzahn, 2012). Human flourishing can be based on the way the personal resources, such as a smart phone as ‘an extended mind’, are exploited (Biswas-Diener, 2008), which opens up new perspectives for design. Functions of artefacts and what users do with them can address meaningful goals, which in turn promote subjective well-being (Desmet and Pohlmeyer, 2013).

Based on the possibility-driven design concept, design activities focus on finding long-term solutions. This is different from problem-driven approach to design, which focuses on removing prevailing problems (Roozenburg and Eekels, 1995; Lawson, 2004). Another difference between the possibility-driven approach and the problem-driven approach is that the possibility-driven approach requires more activities from individuals as it aims to find suitable solutions instead of removing existing problems or ensuring the absence of unhappiness and outcomes of the possibility-driven design are long lasting (Desmet and Pohlmeyer, 2013; Jimenez et al., 2014). The possibility-driven design is framed in a way that people are able to act autonomously and decide themselves how to handle design situation (Desmet and Hasselzahn, 2012); for example, an active individual can design a door handle based on her unique needs and 3D print it to replace the broken door handle. The problem-driven approach attempts to diminish or neutralize people’s concerns, values and needs, which become significant only when the situation poses a threat, resulting in negative emotions like fear and anger (Desmet and Hassenzahl, 2012). A shift in a mind set from focusing on a neutral solution to focusing on a positive solution can be challenging, and it may require means beyond mere problem-solving (ibid.).

The possibility-driven design is closely related to the notion of design-inspired innovation (Utterback et al., 2006), but there is a theoretical difference in these
definitions; the innovation refers to only one facet of design, the newness (Kolko, 2007; Berends et al., 2011) whereas design comprises of every single aspect of the solution, including all parties working together on the entire customer experience. On the other hand, the design-inspired innovation emphasizes the integration of design to three types of knowledge: knowledge about user needs, technological opportunities and product language (Utterback et al., 2006). The leading thought of the possibility-driven design is that an idea or an attractive challenge is developed further simply because it can be done, and the drive comes from the puzzled minds of creative people (Norman and Verganti, 2014). Although this study focuses on the possibility-driven design, the prevailing assumption is that the possibility-driven design and design-inspired innovation can learn from each other hence the social and creative qualities of the challenges are emphasized by the possibility-driven design whereas the design-driven innovation focuses on cumulative and incremental improvements to the existing artefacts and solutions.

The possibility-driven design can be studied with several approaches. The design goal can be to evoke emotions such as pleasure and enjoyment (Jordan, 2000; Norman, 2004; Desmet et al., 2007). Emotional design addresses emotion and aims to evoke an emotion that is a person’s experience in a social context (Cupchik, 2004). Experiential approach, with its design efforts centred on enjoyable and meaningful moments (Norman, 2002; Hassenzahl et al., 2013; Camere and Bordegoni, 2015), is closely related to emotional design, but it takes into account both utilitarian and emotional aspects, which evolve over time (Rhea, 1992). Experience design concentrates quite often on user experience (Hassenzahl et al., 2010) or interaction design (Battarbee and Koskinen, 2005). Interaction design stems from the interaction between people and their environment, such as a human and a computer (ibid.). Game design (Gaver, 2002) requires a more holistic understanding of the different aspects of design; there are implications at psychological, social and cultural levels without forgetting aesthetics, functionality and interaction. Dunne (2005) combines practice and theory; he views the development of design approaches through aesthetics and critical assessment of possibilities created by electronic products. Bianchini and Maffei (2012) study a shift in the traditional relationship between design and companies due to democratization of design technologies, increasing personalization of production and new distribution models, which enables designers to become entrepreneurs. The shift offers various possibilities for designers to work independently without the rules and regulations companies follow. The common nominator for all the approaches mentioned above lies in their humanistic nature; the focus is on humans, their experiences and emotions with emphasis on possibilities for new ways of contentment instead of removal of problems (Desmet and Hassenzahl, 2012).

2.1.1 Positive design

The concept of positive design stems from opportunities to help people flourish (Jimenez et al., 2014). Flourishing refers to being the best person one can be; as an optimal human functioning and living to one’s full potential (Ryan and Deci,
The support for human flourishing and happiness is also a goal for every human being (King and Napa, 1998; Desmet and Hassenzahl, 2012).

The positive design framework (Figure 3) combines positive psychology (Ryan and Deci, 2001) and design theory, and consists of three elements; design for pleasure, design for personal significance and design for virtue (Desmet and Pohlmeyer, 2013). The goal of positive psychology is to reach an understanding of how and when people flourish (Seligman and Csikszentmihalyi, 2000; Jimenez et al., 2014). The elements of the positive design framework promote people’s subjective well-being and desire to be meaningful. In the framework, virtue indicates being a morally good person (Desmet and Pohlmeyer, 2013). Virtuous behaviour makes a normative distinction between what is good (e.g. altruism) and what is bad (e.g. animal torture) (ibid.). Pleasure implies experiencing positive feelings, which can originate from physical, social, psychological and ideological human-artefact interactions (Jordan, 2000). The pleasure is momentary and focuses on the presence of positive affect and absence of negative affect (Desmet and Pohlmeyer, 2013). Personal significance arises from a sense of personal meaning and pursues personal goals and aspirations (ibid.). The framework does not favour any of the elements over the other but suggests that each person has her own fit depending on personal preferences, values, skills and aspirations. However, if design imparts a negative effect on any of the three elements, it cannot be considered as positive design (ibid.). The concept of positive design serves the purpose of possibility-driven design as it reflects people’s strive for an active involvement with long-term perspectives (Desmet and Hassenzahl, 2012).

Figure 3. Positive design framework, modified from Desmet and Pohlmeyer’s model (2013).

Lyubomirsky et al. (2005) recognize three major factors which govern people’s happiness; a genetically determined set point for happiness, circumstantial factors and intentional activities. Presumptions for their claim are that happiness can be pursued, and motivational and attitudinal factors are entrenched in people’s perception of being happy. According to Lyubomirsky et al. (2005), 50 percent of people’s happiness is decided by the generally determined set point, 10
percent depends on circumstances and 40 percent is based on intentional activities of people. Individuals’ general set points depend on their genetics and can be assumed to be stable over time as well as resistant to influences (Lyubomirsky et al., 2005). Circumstantial factors, such as nationality, cultural background, personal history, age, gender, marital status, income and health, are incidental but relatively stable elements of a person’s life (ibid.). Intentional activities, which comprise a relatively big part of the happiness, can be seen as possibilities which offer sustainable ways to pursue happiness. The intentional activities include volitional efforts, i.e. actions and practices people choose voluntarily to be engaged in, as well as behavioural and cognitive activities (ibid.). In this study, people’s intentional activities are studied in the context of design-oriented communities.

The concept of the possibility-driven design is presented in the publication 2 by Tamminen and Moilanen. The publication lays the foundation for the entire study because it introduces the concept of the possibility-driven design and opens up a new avenue to the author to see the ways of working and practices in design-oriented communities. The publication is a case study in the open design community context, and identifies the main characteristics and ways of working that describe the activities in the community.

2.2 Human-centred design

An inclusive focus of the human-centred design is on the people and their intended and intuitive use of artefacts. Human-centred design highlights the importance of human involvement and connects human understanding and behaviour; artefacts are inseparably linked to how their users perceive them, can think of interfacing with them and using them, and how users can find their stake in the artefacts with others (Krippendorff, 2004). The practical approach of the concept has evolved over the years through usability, interaction design, and design for customer experience (Giacomin, 2014). Numerous studies about branding (Aaker, 2002; von Hippel, 2005; Lindström, 2005; Hatch and Schultz, 2008; Gobe, 2009; Hill, 2010; Shaw et al., 2010; Du Plessis, 2011) have noted the importance of recognizing customers’ perceptual, cognitive and emotional needs, which can be seen as the basic elements in the human-centred design (Giacomin, 2014).

An overall assumption of human-centred design is that technology should complement human abilities as well as enhance and support development of artefacts and solutions (Norman, 1993). Machine-centred view, based on technology, focuses on efficiency, such as operations per second, and sees people as disorganized and emotional, and machines as precise, orderly and unemotional (ibid.). The human-centred view sees people as creative, attentive to change and capable of making decisions based on both qualitative and quantitative assessment, modified by circumstances and context (ibid.). The human-centred view sees machines as dumb and insensitive to change (ibid.). In addition, according to the human-centred view, machines make decisions based on quantitative evaluation of numerically specified, context-free variables (ibid.).
Design thinking is the core creative process for any designer (Cross, 2011). Engineering design thinking stems from the claim that design can also be a central activity in engineering (Dym et al., 2005). It can be challenging to make a distinction between the terms ‘engineering design’ and ‘design’ as many disciplines, even within engineering, play a role in the design and manufacture of an artefact (Norman, 2015). An example of a profession in which engineering design thinking is emphasized on a daily basis is an industrial designer. The industrial designer needs to understand technology, its possibilities and constraints as well as the situation of the user and visions of the customer’s strategies (Johansson et al., 2003). The relationships and differences of engineering design thinking and design thinking are presented in this chapter. In addition, a model to frame the current conceptions and the discrepancies of the two design thinking modes are presented.

2.2.1 Design thinking

Design thinking consists of designers’ sensibility and methods to match people’s needs in a feasible way by taking into account the capabilities of organization business strategies to translate insights into solutions which can in turn be converted into customer value and market opportunities (Brown, 2009). Design thinking can be applied to, for example, IT, business management and education, and it is an engine to for social, cultural and economic prosperity (Buchanan, 1992; Hobday et al., 2012; Dorst, 2011; Jimenez et al., 2014).

Design thinking can be divided into two schools of thought, design thinking and engineering design thinking, based on their origin. The roots of engineering design thinking lie in fact-based natural sciences (Cross, 2006), whereas designers’ approach is based on design discipline and empathy, intuitiveness, imagination and ideas (Neumeier, 2009). One of the corner stones of the design thinking is the human-centricity (Brown, 2008; Lockwood, 2014), which is illustrated in Figure 4 with a human character in the middle of the circle. The general concept of design thinking has emphasis on observation, collaboration, fast learning, visualization of ideas, rapid prototyping of concept and concurrent business analysis (Figure 4; Lockwood, 2014). The activities, presented in Figure 4, occur on need basis; they can happen simultaneously and iteratively and many times during a design situation or design project (ibid.). According to Ryle (2009), designers aim to ‘know how’ phenomena occur and offer an appropriate solution to the need. Designers’ approach to the design thinking methodology is illustrated as an ‘appropriate’ input to the design thinking methodology in Figure 4. On the other hand, engineers aim to ‘know what’ happens in phenomena (Ryle, 2009). For that reason, an approach of engineering design thinking is illustrated as a ‘true’ input to the design thinking methodology in Figure 4. Both design thinking and engineering design thinking work with the same design thinking methodology but their starting point is different. The design culture views the world through practicality, ingenuity and recognition of experienced emotions while concentrating on ‘appropriateness’ whereas the culture of science values objectivity, rationality and neutrality while aiming at being ‘the truth’ (Cross, 2008).
Technical rationality of engineering design thinking stems from positivism (Schön, 1983) and the ‘hard’ knowledge of science. According to positivism, propositions need to be either analytically or empirically testable, otherwise they are meaningless (ibid.). The rational behaviour of engineers comprises a systematic procedure of first analysing the problem, after that breaking it into sub-problems for an evaluation of sub-solutions, finding suitable sub-solutions, and selecting a suitable combination of the sub-solutions as the overall solution (Cross, 2011). In engineering design thinking, materials, mechanisms, structures and systems are also stressed (Buchanan, 1992).

Designers’ behaviour originates in the ‘soft’ knowledge of artistry and unvarnished opinions (Schön, 1983). Designers explore and generate solutions, and for them an understanding of a problem is tightly integrated with the synthesis of the design process (Lawson, 1997). Design concepts can also be designers’ personal insights, an outcome of a considerable cognitive effort (Cross, 2011). Designers stress various possibilities in the conception and planning of the artefacts (Buchanan, 1992).

In the following sub-chapters, the relationship of engineers’ and designers’ work principles, work approaches, focus of work, customer understanding, perception of time, and scope and quality are discussed. The presented arguments are generalized although the outline is not that strict in the reality.

Work principles

Engineers value objectivity, facts and sense making (Cross, 2008, 2011). Mathematical and computational models do not allow any inconsistencies or multiple
perspectives (Krippendorff, 2004). Designers concentrate on the subjectivity and understanding of the social and emotional aspects of the customer (Cross, 2006) while keeping science and technology in the background (Lawson, 1997). Designers’ solutions do not need to have right or wrong answers.

Work approaches

Engineers apply scientific theories and techniques to problem solving. Solution to a problem is obtained inductively and deductively, and if necessary, abductively (Peirce, 1903). Each step is a logical continuation to the previously acquired knowledge and experience based on available facts (ibid.). Engineers use intuition, or ‘leaps of faith’ (Martin, 2009) reluctantly, the work is usually built on sheer facts and evidence (Cross, 2011). Designers’ mode of thinking can be inductive, deductive and abductive (Dorst, 2011). Abductive form of reasoning (Peirce, 1903) is a natural part of designers’ work, whereas engineers make discoveries by inductive reasoning and justifications by deductive reasoning (Roozenburg and Eekels, 1995; Dorst, 2011).

Focus of work

Engineers focus on problem solving (Lawson, 1997). The problems are divided into smaller sub-problems, and the focus is first put on solving those piece by piece after which the solved sub-problems are assembled together (Cross, 2011). Designers focus on finding solutions to ill-defined problems or problems that might not even exist (Lawson, 1997). However, finding a solution to a latent, ill-defined problem can force designers to focus on the problem setting (Schön, 1983). For designers, problems and their solutions are intertwined and developed together (Cross, 2011). An entanglement can occur when relevant features of the design situation emerge during a design process as tentative solution concepts, and by being recognized, their properties and characteristics are used in the solution concept or the problem concept or both (ibid.).

Customer understanding

Engineers are technology-oriented, and customers’ needs are seen through technical lens and fulfilled with help of technical applications. The technical artefacts can include a thick manual, and their use might require a profound familiarization with the instructions. Engineers’ more quantitative, numerically specified approach makes customers more distant, which excludes hidden or more eccentric customer needs. Engineers can see customers as targets, not as partners or stakeholders (Krippendorff, 2004). Designers use ethnographical approaches to understand customers; they are prioritized and outcome of the work is based on meanings (Lockwood, 2010). The ultimate target for designers is to see beyond the obvious and know what customers want before they realize it themselves (Love, 2000). On the other hand, designers can jump into conclusions too early in the process without evaluating all facts and ending up missing many possible options for a solution (Cross, 2011).

Perception of time

Traditional way of working of an engineer is to execute when a plan is ready and end-result known (Cooper, 1990). Today’s agile working methods and focus on
innovations with fast prototyping has changed the perception of time somewhat (Lockwood, 2010), but the existence of plans is still essential. Designers’ approach to complex problems can be inclined towards abductive reasoning and therefore they find appropriate solutions for the problems in more unpredictable ways (Cross, 2011). The time engineers need to plan and execute is relatively well known in their projects whereas designers need time for free-flowing activities so extra time needs to be reserved in the overall schedule of designers’ work (ibid.). Designers’ work style is not necessarily bound to a clock but driven by inspiration, ideas and prototyping. To an outsider, designers’ ways of working can appear as procrastination, hence they tend to work with ambiguity and leave many options open for as long as possible (ibid).

Scope and quality

Since the beginning of industrialization, engineers have focused on mass production and economies of scale and scope although these concepts were not yet known at that time. Designers’ legacy lies in the craftsmanship with a long history and focuses on tailor-made artefacts to last for generations (Johansson et al., 2003). However, even today the perspectives of engineers and designers are reflected in ways they perceive the production scope. A designer creates a unique artefact to meet the customer needs whereas an engineer thinks of the current set up of production lines, synergies with solutions provided to other customers and how the offered artefact could serve the needs of the future (von Hippel, 2005).

If engineers compare machines and humans, they see humans as unreliable, unstable, unpredictable, inaccurate and slow (Krippendorff, 2004). Therefore, quality systems and standards are created to support an effective mass production. Engineers have created criteria to align and integrate production of artefacts and solutions to the development of technology. Designers, on the other hand, perceive quality as embedded in their solutions. They can also challenge norms for example by being roughly ready (Lockwood, 2010).

2.2.2 Modelling of human-centred design

Human-centred design researchers (Norman, 1993; Pullin, 2009; Sinek, 2011; Norman and Verganti, 2011; Giacomin, 2014) acknowledge the importance of the interaction between designers and stakeholders and the construction of right questions; ‘why’, ‘how’, ‘when’, ‘what’ and ‘who’. Giacomin (2014) proposes a human-centred design model, in which scientific facts and physical, perceptual, cognitive and emotional characteristics of human factors form the base of the pyramid (Figure 5). On top of the basic attributes lie progressively more complex, interactive and social aspects (Giacomin, 2014). The metaphysical meaning an individual forms by being in contact with design is on the top of the pyramid (ibid.).

Human-centredness is a core attribute of the concept of design thinking (Brown, 2008; Lockwood, 2010; Figure 4). If Giacomin’s (2014) structural model (Figure 5) is viewed with design thinking and engineering design thinking perspectives while taking into account their respective characteristics and
natural ways of working and knowing, the differences of the two schools of thought can be overcome. The design thinking approaches Giacomin’s human-centred design model from the top, i.e. meaning-making perspective while finding responses to a question why. Engineering design thinking has another perspective; it approaches the human-centred design model from the bottom, i.e. evaluating and defining first the numerical facts of the situation while finding responses to a question what (Figure 5).

![Giacomin's structural model of human-centred design with design thinking and engineering design thinking approaches](image)

**Figure 5.** Giacomin’s (2014) structural model of human-centred design with design thinking and engineering design thinking approaches, adapted with Giacomin’s permission.

The considerations on the top of the human-centred design pyramid can be regarded as the key to social acceptance, commercial success, brand identity and business strategy (Giacomin, 2014). However, overall design of an artefact is based on the scientific facts related to physical, perceptual, cognitive and emotional characteristics of humans, which are essential attributes of the human needs. A comprehensive understanding of the human factors creates a solid foundation and offers a variety of paths into people’s minds (ibid.). Krippendorff (2004) emphasizes the importance of human-centeredness in today’s
post-industrial culture, in which roles of information technology, democratization, and diverse perspectives of individuals and communities are stressed.

The publication by Tamminen and Järvi is a conceptual study about the relationship of the design thinking and engineering design thinking. It points out the differences of the two schools of thought that originate from respective design and natural science disciplines. The publication suggests that value can be created and synergy found in the intersection of design thinking and engineering design thinking if both schools of thought adopt a constructive way and recognize each others’ strengths when building long-term design solutions.

2.3 Business design modelling

In this study, business design modelling is defined as an interactive symbiosis that prevails in organizations and delivers both market and customer experience value (Fraser, 2007, 2009). The presence of values of created solutions for the customers’ businesses in the system development is inevitable, and participatory design takes that into account when enabling the development of work practices of skilled practitioners (Suchman, 1993). Participatory design refers to the social and rational idea of democracy that takes into consideration conditions for proper and legitimate user participation (Bjögvinsson et al., 2012). In addition, participatory design aims to affirm that participants’ tacit knowledge is taken into account in the design process (Bjögvinsson et al., 2012). Participatory business models, which are representations of companies’ business design logic, urge the companies to redefine concepts and roles that diversified actors play in relation to each other (Buur et al., 2013). The development entails challenges to designers since their task is to understand stakeholder needs, visualize new solutions and translate innovative ideas into effective strategies (Martin, 2009; Fraser, 2007, 2009; Brown and Martin, 2015).

Fraser (2007, 2009) has developed a business design model which combines the design mix, i.e. blend of performance, quality, durability, appearance and cost (Kotler and Roth, 1984), and the design thinking methodology (Fraser, 2007, 2009). Fraser’s (2007, 2009) model is based on participatory design; both a company and its stakeholders are involved in iterative processes of the business design modelling, and based on the participatory design standpoint, those affected by a design should have a say in the design process (Bjögvinsson et al., 2012). The aim of the symbiotic model is to maximize the impact of organization outcome by delivering both market and experience value, and designers play an important role in facilitating and driving the collaborative and creative design thinking processes (Fraser, 2007, 2009). The business design model is based on user needs and ultimate customer target (ibid.). It requires open-minded collaboration, abductive thinking (Peirce, 1903) with ‘leaps of faith’ (Martin, 2009) and an ability to explore new solutions with persistency (Fraser, 2007, 2009).

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2 Tacit knowledge refers to practical and diverse skills that are fundamental in creating artefacts (Bjögvinsson et al., 2012).
There are three gears in Fraser’s (2007, 2009) business design model: user understanding, concept visualization and strategic business design (Figure 6). The first gear, user understanding, implies reframing of the business through the eyes of a user or a critical stakeholder (Fraser, 2009). An empathetic approach and consideration of circumstances, needs and feelings of the user are employed in the first phase (Fraser, 2007). Inventing radically new solutions or finding out unmet needs requires open-minded thinking and willingness to take risks. New opportunities for value creation can be achieved for example by taking another perspective to the challenge and defining innovation criteria differently (Fraser, 2009). The aim of the first gear is to see beyond the obvious solutions. The second gear comprises visualization of a concept (Fraser, 2007). The concept visualization is an iterative ideation process with prototyping and user evaluations by cross-functional teams (ibid.). The aim is to define a user-driven solution through each individual’s base of functional expertise and experience. The third gear, strategic business design, provides strategic concepts by an iterative alignment of the future realities (Fraser, 2007). The concepts can require reprioritization of activities, new definitions for strategic, operational and economical relationships, and determination of the net impact of the new model (Fraser, 2007, 2009). The outcome of the strategic business design phase, and the whole iterative process, is a business design model with identification and design of inter-related activities, which enable a commercial gain and a sustainable competitive advantage (ibid.).

![Diagram of Fraser's three gears of design model](image)

**Figure 6.** Modified model based on Fraser’s (2007, 2009) three gears of design model (Tamminen, 2013).

New business opportunities and business models can be developed by expanding design thinking across organizations and business development processes to maximize corporate outcomes (Fraser, 2009). Companies usually create new artefacts in collaboration with relevant and suitable parties outside of their own organization, which causes companies to have an increasing dependency on the outsiders (Chesbrough, 2003). Companies are also concerned about their customers’ perceptions and experiences related to artefacts and systems they provide (Verganti, 2009). In social innovation initiatives, the network of involved parties is rarely stable at the outset, and balancing of the value exchange becomes an important issue due to the presence of both profit and non-profit organizations (den Ouden and Valkenburg, 2011). The organizations, which evaluate the feasibility and attractiveness of the entire proposition of an innovation,
can estimate the delivered value differently (ibid.). The complexity of the participatory business design models increases as more parties bring in value in terms of knowledge and artefacts, but at the same time, as the needs of many stakeholders are taken into account, a better and longer term anchoring of the solution in society can be achieved (ibid.). Fraser’s model (2007, 2009) involves companies, whether they are profit and non-profit organizations, to propose new meanings and possible futures to their customers with the help of design thinking as well as to make the companies respond to the commentary and feedback of customers and stakeholders.

The publication 1 by Tamminen is a case study in a local design-oriented community context. The publication discusses the role of business design modelling when creating a business design model with a long term solution that serves organizations when they create a common and sustainable model that can satisfy the needs of the involved parties as well as their customers and bring additional value to the whole arrangement.

2.4 Open design

Open design can be understood as a collaborative development process that is open for anybody to participate in (Tooze et al., 2014). Open design can also mean an unrestricted use of design blueprints, documentation of their use and their distribution (ibid.). Open design is disruptive, and it embodies a paradigm shift in which the design object lacks identity but the fixed identity exists in the on-going change process conducted by the consumer who has earlier been a passive consumer but become an active user, ‘a prosumer’ (van der Beek, 2012). A design object, a customer, and a subject, a designer, are clearly separated in a traditional design process, but an open design process can be found to be ‘in-between’, i.e. in the space between individuals (ibid.). The nature of open design process is generative; re-design, adaption, refinement and extension alternate within it in a continuous mode (Avital, 2011).

Open design is a representation of today’s possibilitarian movement, which perceives changes as new possibilities (Stikker, 2011). There are two shifts that have enabled the movement; first, the development of information and communication technologies have made access to advanced production techniques possible and reduced the dependency on professional design (Atkinson, 2010). The technological advancements have also enhanced possibilities for designers; they can design, produce and distribute own designs case by case based on circumstances and needs (Bianchini and Maffei, 2012). Second, the amount of active individuals involved in creative activities and collaboration of diverse disciplines has increased (ibid.). On the other hand, realitarians, an opposite to possibilitarians, fear that the cult of professionals is replaced by the cult of amateurs, who know themselves what is best for them (Stikker, 2011; Atkinson, 2011). Kadushin, a designer known for his open design work, describes the nature of the open design and its relationship to designers in a following way (Troxler, 2011b, p.115):
You're designing for a consumer, but you're also designing for a user. Somebody has to use it as a design, to change the design.

Two researchers, Henry Chesbrough and Eric von Hippel, have influenced the open design research, among other disciplines, through open innovation. An open innovation uses a distributed form of creative and hands-on problem solving (Von Busch, 2012). The open and distributed form of problem solving can produce faster and more dynamic systems of user-generated products in design process contexts (ibid.). According to Chesbrough’s open innovation model (2003, 2012), a company commercializes own and other companies’ ideas and innovations, and seeks ways to go to the market with in-house ideas by deploying them by means which are different from the company’s current business models. Von Hippel (2005) focuses on user-centred innovation communities and democratization of innovation. He defines innovation communities as ‘meaning nodes consisting of individuals or firms interconnected by information transfer links which may involve face-to-face, electronic, or other communication’ (2005, p. 96). There is a similarity between the research on innovation work done by users and the participatory design, which has its roots in the research of democratic forms (Ehn, 1993), and the thinking climate of Scandinavia in the 1970’s (Iversen, 2012). Common nominators between possibility-driven design and von Hippel’s (2005) innovation work framework can be found: users are attracted to the notion that it becomes progressively easier to get precisely what they want by designing artefacts by themselves, and an innovation of the users increases subjective well-being and social welfare (von Hippel, 2005; Desmet and Hassenzahn, 2012). In addition, the social welfare increases if the solutions are freely revealed by the users (Henkel and von Hippel, 2005).

A well-know and widespread form of ‘open’ is the production of open source software, which is a distributed program development by software developers (von Busch, 2012). The software developers contribute to the public good of open source software by writing software code for projects (von Krogh et al., 2003). An inherent character in the development work of open source software and open innovation is the closeness to user innovation networks and communities to share and modify existing artefacts or to develop something entirely new (von Hippel, 2005; Füller et al., 2007). In a similar vein, free revealing of information related to a new design with the intention of collaborative development of it with new users can be included in the definition of open design (Raasch et al., 2009).

2.5 Affordances theory

According to Gibson (1966), an affordance is an intrinsic property of the environment relative to an actor, i.e. features of the environment directly contribute to particular behaviours or outcomes. With the term affordance Gibson refers to both the environment and the actor as they are complementary to each other and constitute meanings: 'the affordances of the environment are what it offers
the animal, what is provides or furnishes, either for good or ill’ (1986, p.127). The affordances theory links what objects of the environment can offer to a user who exists in that environment with the possibilities for the behaviour of the user (Wells, 2002). The process of designing for possibilities, i.e. possibility-driven design, can be challenging as possibilities are not apparent, which makes spotting of them not easy (Jimenez et al., 2014). The concept of affordance can be seen as a tool for focusing on connections in design among a user, actions and artefacts (Hartson, 2003). Affordances constitute an active and exploratory system, in which senses of a user are received and attuned to dynamic meanings while being in the environment (Gibson, 1986; Krippendorff, 2005). Rietveld and Kiverstein (2014) propose that a better understanding of the relational nature of affordances and their potential new ways of increasing openness is important for creative professions as the professionals can provide novel functionalities and innovative ways for users and artefacts to interact. Affordances play critical roles when designing artefacts and systems that are practical, reliable, affordable, functional, usable, and understandable (Norman, 2015).

Gibson (1966, 1986) focussed on direct perception, which refers to a perception that does not require an actor to conduct any internal processing or mediation. The existence of an affordance does not depend on the actor’s ability to perceive it, hence an affordance does not change although needs and aspirations of the actor might change. However, an affordance can constitute niches, which affect how an actor behaves. Gibson (1986) explains his view with an example of a horizontal, flat and rigid surface that affords support. The surface provides support for one actor but may not do the same for another actor due to their different sizes. Affordance can be seen as an action capability of the actor, not a property of the experience of the actor (McGrenere and Ho, 2000).

Norman (1988) introduced the concept of affordances for the design field in his book ‘The Psychology of Everyday Things.’ For him, ‘the term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used’ (Norman, 1988, p.9). Although Norman’s views have been studied more in the HCI (Human-Computer Interaction) community (Gaver, 1991; McGrenere and Ho, 2000; Hartson, 2003), his thoughts have also impacted other areas of design research (Shaw and Turvey, 1981; Turvey, 1992; Greeno, 1994; Wells, 2002; Lawson, 2004). Morineau et al. (2009) and Meineri and Morineau (2014) have studied affordances and affordance-specifying information. They refer to affordances as interactions between information coming from the environment and the mental state of a user, which impacts the affordance-specifying information she is able to pick up (Wells, 2002; Meineri and Morineau, 2014). Norman (1999) emphasizes the mental and perceptual capabilities of a user and causalities of things; the actions the user perceives possible are more relevant than what is the truth, hence affordances are perceived properties of a user. Norman couples affordances with users’ past experiences and knowledge and stresses their interpretation of meaning. Norman (2015) also states that af-
fordances can be a bridge between traditional engineering which focuses on ef-ficiency and function with the more design-inclined aim of fitting people’s needs, desires and emotions.

2.5.1 Design endeavours in design situations

Designing endeavours in design situations can be categorized based on how an actor perceives her environment and how an actor understands the artefact (McGrenere and Ho, 2000; Shu et al., 2015). Design situation is a set of all information that can be recognized in a design by a designer (Taura et al., 2002). Four different perspectives, Gibson (1986), Norman (1988, 1999), Krippendorff (2004) and Shu et al. (2015), to affordances in design situations are presented in Table 2. Gibson’s interests lie in the actor and how she perceives the environment (Gibson, 1986). Gibson labels the aspects as ‘design of the affordances of an object’ and ‘design of the perceptual information that indicate the affordances’ accordingly (Gibson 1986 cited in McGrenere and Ho, 2000, p.3). Norman (1988, 1999) sees a clear distinction of the two perspectives; an interaction between a user and her environment can be defined as ‘designing the utility of an artefact’, and when the focus is on the artefact, the design situation refers to ‘designing the way in which that utility is conveyed to the user of the artefact’ (McGrenere and Ho, 2000, p.3). Norman is interested in manipulating the environment in a way that an actor can easily perceive the utility of an artefact. Norman finds the differentiation important and emphasizes smart design: ‘Sloppy thinking about the concepts and tactics often leads to sloppiness in design’ (Norman, 1999, p.41). Further, Krippendorff and Butter (1993) and Krippendorff (1995) have the third perspective to the design endeavours; the first- and the second-order understandings.

An interaction between a user and her environment can be seen to be analog to Krippendorff’s first-order understanding, which is ‘an understanding of something incapable of understanding on its own or of someone whose understanding does not interfere with the phenomena to be understood’ (Krippendorff, 2004, p.56). The first-order understanding correlates with causal explanations and prefers general theories and laws of nature (ibid.). In a similar vein, focusing on features and functionalities of an artefact in design situations can be seen to be analog to Krippendorff’s second-order understanding, which is ‘an understanding of how others understand their worlds, including the artefacts and human beings that occur in these worlds’ (Krippendorff, 2004, p.57). The second-order understanding is recursive; it is an understanding of understanding, for artefacts exist in the recursive practices of communities of users (ibid.).

The fourth perspective of Shu et al. (2015) focuses on product affordances and defines affordances as relational qualities that depend on attributes of a user and an object. The framework of Shu et al. (2015) contains user-perceived affordances and designer-intended affordances (Table 2). A user-perceived affordance refers to user’s interaction with a product when she perceives a set of affordances corresponding to her actions or imagines how she can use the product. Designer-intended affordances refer to affordances that represent intended use of a product (Shu et al., 2015).
Table 2. Affordances in design situations according to Gibson (1986), Norman (1988, 1999), Krippendorff (2004) and Shu et al. 2015.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Focus on the interaction between a user and an environment</th>
<th>Focus on the artefact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gibson (1986)</td>
<td>Design of the affordances of an object</td>
<td>Design of the perceptual information that indicate the affordances</td>
</tr>
<tr>
<td>Norman (1988, 1999)</td>
<td>Design of the utility of an artefact</td>
<td>Design the way in which a utility is conveyed to the user of an artefact</td>
</tr>
<tr>
<td>Krippendorff (2004)</td>
<td>Understanding of something incapable of understanding on its own or understanding does not interfere with the phenomena to be understood</td>
<td>Understanding of how others understand their worlds, including the artefacts and human beings that occur in these worlds</td>
</tr>
<tr>
<td>Shu et al. (2015)</td>
<td>User-perceived affordances</td>
<td>Designer-intended affordances</td>
</tr>
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Representational affordances

Kannengiesser and Gero (2012) and Gero and Kannengiesser (2012) propose a framework for situatedness-originated representational affordances, which are reflexive, reactive and reflective affordances. They are based on their ability to produce descriptions of the interactions between a user and an artefact in a design situation. Reflexive affordances are used in routine designing endeavours. They are direct responses of a user to specific set of stimuli to which the user is exposed, and there exists a unique and pre-existing response. The resulting actions, such as use of biological reflexes, do not need cognitive skills of the user to produce the desired outcomes. A static world in interaction with a user’s internal notions and memory, e.g. shapes of door handles, is a reflective affordance. Reactive affordances are used in innovative designing endeavours. They contain some interaction between a user and the environment, and the user can choose from several possible and pre-existing actions. An assessment of the made decisions is evaluated by the affects of the actions against a set of criteria. The change in the user’s goals does not impact the existing reactive affordances of the environment; for example, unlocking a door can happen either by turning a key clockwise or counter-clockwise as there are no other ways to unlock the door. There is more ambiguity in reactive affordances than in reflexive affordances; the degree of the user’s confidence over made decisions and the possibility for successful outcomes of the made actions are lower than in the category of reflexive affordances. Reflective affordances are used in creative designing endeavours. They can generate new systems of action possibilities through reflection and exploration. Cues a user picks up from the environment as well as her expectations can change depending on the filtering and emphasis she uses. Exploration of new solutions, e.g. button-operated automatic doors, produces new expectations and new criteria for assessing the made actions. The experiments can be conducted in thoughts or they can be physical ones. ‘Hidden affordances’, which are not obviously perceived or understood, are reflective affordances. The dynamics of the representational affordances can vary; for example, a reactive affordance can change into a reflective one if the chosen action does not provide a desired end result (Kannengiesser and Gero, 2012).
Affordances as opportunities for action

Gibson (1986) and Pols (2012) views affordances as opportunities for action. Pols (2012) develops this notion further and focuses on distinguishing what an artefact affords with a descriptions-of-affordances-model with four activity levels, an opportunity for manipulation, an opportunity for effect, an opportunity for use, and an opportunity activity. Pols (2012) makes also a differentiation in terms of the knowledge a user needs in order to perceive an affordance under that description. The first activity level is an opportunity for manipulation. The manipulation affords intentional basic actions, such as pressing a button. The first level does not require special knowledge of a user. The second activity level is an opportunity for effect. It connects the manipulation and its effects; for example, hitting a letter ‘a’ in a keyboard generates the same letter to appear on a computer screen. The activity requires a user to have knowledge of functional parts or cultural symbols of the artefact (Norman, 1999; You and Chen, 2007). The third activity level is an opportunity for use. It indicates what a user can do with the artefact; for example, writing an article with a computer pertains to this level. The affordances can be present at the same time or they can be sequential. A user needs to have a mental model or abstract knowledge in order to use the perceived opportunities (Norman, 2002; Hartson, 2003). The fourth and the highest activity level in an opportunity for activity. Affordances can affect the social world since they are usually part of larger socio-technical systems (Pols, 2012). The fourth level requires a user to obtain abstract, institutional and social knowledge; for example, working out a psychological theory is part of the fourth category (Kroes et al., 2006; Ottens et al., 2006). All the four levels are connected; a single affordance can be described in different ways depending on the interpretation and acquired knowledge of a user who perceives it. Feedback enables a user to move between the levels (Pols, 2012).

Affordances and product semantics

According to Krippendorff (2005, p.113), ‘affordances signal the habits of being-in-the-world’, i.e. artefacts are social constructions, which should function according to the meanings they provide to users who are affected by them. Krippendorff builds on Gibson’s (1986) thinking and distinguishes three meaning-making types of affordances, direct perception, enacted affordance and constructed accordance (Krippendorff, 2005). A direct perception indicates that a usability of an artefact or environment is taken for granted; features such as a flat surface, creates meanings directly. An enacted affordance implies that an artefact manifests an anticipatory affordance. An enacted affordance can cause disruptions, challenge the previous meanings of affordances and result in learning, as well as strengthen the take-for-granted nature of direct perception. A constructed affordance means that a user can develop an abstract conceptual model of an affordance. The conceptual model based on constructed affordances is more vulnerable to disruptions than direct perceptions or enacted affordances.

You and Chen (2007) compare the affordance concept and product semantics. They refer to affordances as ‘visual cues that indicate required operations on intended function of a product’ (You and Chen, 2007, p.24). Product semantics
is a study of the symbolic qualities of artificial forms in the cognitive and social contexts of their use, and applications of this knowledge to industrial design (Krippendorff and Butter, 1984 cited in You and Chen, 2007, p.26; Krippendorff, 1989). As a comparison, both affordance and product semantics presume that users perceive meanings of artefacts, but affordance concept can assume direct perception whereas product semantics assume that some information processing is usually needed before the perception can happen. Moreover, according to product semantics, user’s personal experiences, socio-cultural background and needs influence her interpretation of the product. When compared further, the existence of affordance is dependent on user’s awareness and demand for potential opportunity for action (Pols, 2012). Product semantics, on the other hand, focuses on the meaning of a product, i.e. the communication and social issues in the product design. In addition, the concept of affordances and product semantics are actualized differently in product design; affordances have a reciprocal nature, which is reflected in product design as physical characteristics to assist or prevent certain user behaviour (Norman, 1999). Product semantics focus on supporting users in appropriate interpretation of products, and designers ground their use of metaphors and symbols on this when transforming meanings into the form of products (You and Chen, 2007).

The publication 4 by Tamminen focuses on affordances and perception of affordances in collaborative design situations in a design-oriented local community. The publication defines affordances as perceived opportunities for action (Pols, 2012), and includes a short theoretical description of the affordances theory. The main focus and contribution of the publication lies on themes that enable and support perception of affordances at the community level and on identification and description of affordances perceived by individuals of the design-oriented community.

The publication 5 by Tonetto and Tamminen touches on affordances although it focuses on intuition related to decision making in design situations, it recognizes the existence of affordances, which have a transactional relationship between an individual and the environment (Gibson, 1979, 1986). Norman’s (1988, 1999) concept of perceived affordances suggests that knowledge required for a specific behaviour does not have to be in an individual’s head, but it can be distributed in the surrounding environment or the constraints of it (Norman, 1988, 1999).

2.6 Intuition in design situations

Designers need to invent matters beyond customer expectations and make decisions based on dearth information so the use of intuition is quite a natural, if not necessary, part of designers’ work. Intuition is integrated in human thinking (Kahneman and Tversky, 1982; Laughlin, 1997; Kahneman, 2011; Raami, 2015). Current research proposes that cognitive processing is used to rationalize intuitions hence individuals search confirmatory evidence attempting to justify their use of intuition (Reynolds, 2006; Sonenshein, 2007). However, over-analysing intuition with rational thinking can reduce the accuracy of intuitive judgements
(Nordgren and Dijksterhuis, 2009). Raami (2015) compares the focused state of consciousness in intuiting with flow experiences, which are influenced by sensation of effortless performance and learning of new (Csikszentmihalyi, 1996). Attention keeps the mind open, focuses on the present moment and acknowledges the essence of the target. Intention targets the future with both the conscious and non-conscious willpower (Lipton, 2005). The term non-conscious denotes unconscious and subconscious mental processing, such as associations, affections, habits, memory and feelings (Glöckner and Witteman, 2010; Raami, 2015). Self-knowledge and awareness of personal goals and values steer creations of innovative and complex designs, which includes both explicit and implicit elements (Rijken, 2011). Intuition can be used to judge very implicit examples and design choices because ‘you have to feel its soul and formulate its mission’ (ibid., p.156). Intuition has been researched from different perspectives, and it is understood in slightly different ways depending on chosen approach and discipline of the research. Lack of clear typology and terminology causes misunderstandings related to the concepts and processes of intuition (Raami, 2015). Herbert Simon (1992, p.155) defines intuition as ‘nothing more and nothing less than recognition.’ The statement is based on the observation of experts’ behaviour; they look for cues in a situation and combine that with information stored in their memory to provide answers. Intuition, as an act of recognition (Simon, 1996), is involved when recognizing synergies and creating links between hidden elements in a design situation. An individual can develop and apply intuiting by focusing on her ability to read subtle signals, such as patterns (Raami, 2015).

Intentional practice and consciousness of own personal abilities are needed when developing intuitive skills (Hogarth, 2001; Sadler-Smith and Shefy, 2004; Seligman and Kahana, 2009; Raami, 2015). Certain conditions, such as open-ness to experiences and tolerance to ambiguity, support intuitive insights (Monsay, 1997; Bastick, 2003). Rest, relaxation and keeping the conscious mind busy with a simple routine task, such as dish washing and jogging, can increase the function of accessing intuition (Surel, 2012; Raami, 2015). Positive emotions, such as playfulness and fun promote also intuition (Larsson, 2002). Self-knowing, self-esteem and self-experience are important elements in intuition (Raami, 2015). These elements refer to a person’s commitment to listen to her own gut feeling, not let others impact her decisions or activities, and acknowledge that she has data others cannot perceive and understand (ibid.). Expanding own thinking beyond rational thinking requires courage, good self-esteem and openness to new perspectives (Kautz, 2005; Surel, 2012).

Intuition may also be incorrect (Kahneman and Tversky, 1982; Glöckner and Witteman, 2010; Kahnman, 2011). Situations which raise anxiety and stress might cause domination of intuition (Bastick, 2003; Dayan and Di Benedetto, 2011), so the reliability of intuition is important. Practice and trust are essential when interpreting intuitive signals and evaluating their reliability (Nadel, 2006). There can be biasing effects, such as wishful thinking, insights, imagination, instincts, expectations or denial, in intuition (Sadler-Smith and Shefy, 2004). The human consciousness can easily edit and modify the reality to fit
personal expectations as it cannot tolerate a discontinuity in coherence (Hayles, 2014). Accuracy of intuition can increase over time with proper feedback (Shefy and Sadler-Smith, 2004; Raami, 2015).

### 2.6.1 Expert designer and novice designer in design endeavours

A difference between expert and novice designers lies in the information and skills they acquire; as the amount of precedents designers have acquired increases, their behaviour changes accordingly (Simon, 1992). Experts have a holistic approach to a design situation and respond to changes based on their past experience and knowledge related to similar cases (Cross, 2004; Sadler-Smith and Shefy, 2004). Novice designers decompose a design situation into discrete elements (ibid.) and follow more rules-based processes of rationalist approaches (Dreyfus and Dreyfus, 1986; Sonenshein, 2007). On the other hand, appropriate problem scoping can lead to successful designs of novice designers (Schön, 1983; Cross, 2004).

Lawson (2004) emphasises the importance of designers’ perceptions and precedents stored in their memories which are also in active use when designers work. He suggests a development model which describes how designer’s practices evolve from a novice to an expert. The stages can overlap and they do not have to be sequential; the current stage does not have to be completed before the next stage can begin. An acquisition of design domain schemata is a basic practice that every designer needs to be able to do. As designers’ knowledge increases, their portfolio3 of precedents develops accordingly. As designers’ portfolio grows bigger and richer, they are able to identify guiding principles for the structure and filtering of precedents in design situations. As the number of design situations increases, designers are able to recognize precedents and patterns in the situations, and handle them with little or no analysis. As the variety of design situations increases, designers build a repertoire of possible ways to solve recognizable problems integrated into the schemata. According to Lawson (2004), a designer can be seen as competent and professional, once she has a fairly wide selection of design schemata and precedents. The stage of recognizing guiding principles takes time but it also ‘generates’ an expert designer; a designer creates her own style and becomes known for her personal ideas. Master designers acquire recognized design gambits, which are integrated into the schemata and linked to recognized problem situations (ibid.).

A classification of design expertise was developed by Lawson and Dorst (2013) based on research in cognitive sciences (Dreyfus, 1992; 2002). The expertise in the model represents seven different ways of design thinking with their own methods, critical skill sets and modes of reflection (Dorst, 2015). On the first level of expertise, ordinary people do naive design in their everyday life. On the second level, novice designers explore design as a series of activities organized in a formal process. Advanced beginner designers move away from the use of standard solution to design problems, which are highly individual and situated,

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3 Designers’ portfolio can contain descriptions, illustrations and samples of their work.
and acquire an ability to discuss and criticize design. On the forth level, competent designers handle and understand common situations within their design domain. They can control the activities better, which in turn can gain strategic impact by several projects. As competences and skills increase, expert designers are able to express an approach or a set of values through their design work. The practise can be characterized by an implicit recognition of design situations and an intuitive response. Master designers work on a level of innovation that can question the established ways used by experts and push the boundaries of the field. On the highest level, visionaries aim to redefine their design field explicitly by presenting their radical ideas in for example design concepts and publications rather than in finished designs.

In a similar way as a skill to design, a skill to use intuition can be developed through practice and experience (Baylor, 2001; Raami, 2015). Conscious intuiting refers to an ability to tackle a clash between the rational and intuitive minds in order to strap the intuition. The development of personal intuitive skills can be supported with the help of for example coaching, group discussions and supplying of methods, which increase consciousness of personal intuitive perceptions and insights (Raami, 2015).

The publication 5 by Tonetto and Tamminen is a conceptual study which views intuition from the perspective of cognitive sciences. It defines intuition as a way of processing information based on automatic, affective and personal standards, but does not see it as an opposite of rationality (Simon, 1956, 1957; Epstein, 1994; Kahneman, 2003). The publication links affordances and affordance-specifying information individuals can pick up in the environment (Wells, 2002; Morineau et al, 2009; Meineri and Morineau, 2014), with the different design practices between expert and novice designers (Cross, 2001, 2004; Ho, 2001).

2.7 Design-oriented community

The main characteristic of a community is its members’ consciousness of the existence of like-minded members in the community (Weber, 1978). The shared connection between all members; for example, an occupation or a hobby (McAlexander et al., 2002), shared rituals and traditions (Douglas and Ishwerwood, 1980), and the sense of moral responsibility, which includes helping other members of the community (Muniz and O’Guinn, 2001) ties the members together. The bounds of correct and appropriate as well as wrong and inappropriate behaviour are recognized in communities (Muniz and O’Guinn, 2001). Sometimes communities are regarded as clans with emphasis on shared values, such as sustainability or environmental advocacy, and goals, cohesion, participativeness and teamwork (Calabretta et al. (2008). Different forms of exchange, such as voluntary services and transfer of social and intellectual capital, are also activities of communities (Chen and O’Mahony, 2009).

Design-orientation is understood as a characteristic reflected in an organization culture that differentiates it from the other, non-design-oriented organizations (Calabretta et al., 2008). Members of a design-oriented community have a collective identity built around design, art and craftsmanship, which is central
in defining who they are (Wenger et al., 2002). Community members can be considered as a network of stakeholders (Krippendorff, 2005). The creation and negotiation of meaning is the most frequently shared activity in communities although also other things, such as cognitive, emotional and material resources are shared (McAlexander et al., 2002). Chen and O’Mahony (2009) suggest that community members want to avoid practices that limit their abilities to work creatively. They fear that if the used ways of working resemble too much conventional organizing practices of corporations, their interests would be excluded, and as a result of that, their respective missions could not be realized. According to Chen and O’Mahony (2009), having fun can be a salient element in working with open source tasks, and based on the findings of their study, implementation of market-driven practices or standards on the content of a software release can make the work to be ‘less fun’.

A community of practice (CoP) is an open-ended and dynamic social entity, which evolves as its members interact with each other and external parties (Wenger, 1998). A practice is understood as a bodily and ‘intellectual’ activity that can be reproduced (Hielscher 2008; Reckwitz, 2002). The interactions bring new ideas and influences from the outside world to the community (Neufeld et al, 2012), which in turn can change the values and meanings of the community (Wenger et al., 2002). The shared meanings generate the boundaries and potential liabilities of the community (ibid.). Conventions evolve in CoPs over time; they are slow to be adopted, but once adopted, also slow to go away (Norman, 1999). Constrains reflect the behaviour of users so they can be relatively easily tested in CoPs because some activities are encouraged and some other banned due to different experiences and goals of the members, which lead to different interactions with the artefacts at different times (Heft, 2003; Vyas et al., 2006). A CoP is a node of communication; the dissemination, interpretation, and use of information and best practices happens in them (Brown and Duguid, 1991; Wenger at al., 2002; Füller et al., 2007). The literature highlights the importance of knowledge transfer between community members, hence it is seen as a salient element in organizational learning, especially in CoPs subsumed within an organization (Wenger et al, 2002; West and Lakhani, 2008).

A community of interest (CoI) is formed by stakeholders from different CoPs to solve a particular problem which is a collective concern (Fischer, 2001). West and Lakhani’s (2001) definition of a community as a voluntary association of actors united by a shared instrumental goal but lacking in a priori common organizational affiliation is another definition of a CoI. CoIs can be thought of as ‘communities-of-communities’ (Brown and Duguid, 1991, p.53), or as producing communities (Gläser, 2001) which do not need to share values and norms; instead they can use different knowledge systems and memberships can be perception-based, i.e. members can be active, less active and even invisible but they belong to the community based on their own claim (Gläser, 2001; Fischer, 2001). CoIs have a temporary nature; they convene for a specific project and dissolve after the project has ended (Fischer, 2001). Learning in CoIs happens through shared meanings across the boundaries of members’ individual knowledge systems (ibid.). A shared context for communication is created by
boundary objects, which provide referential anchoring by adapting to local needs and constraints, and maintaining a common identity across the CoI members (Star and Griesemer, 1989; Fischer, 2001; Fischer, 2004).

CoPs can contribute to the success of organizations, enhance knowledge transfer both globally and locally, and compete for talented people with expertise and capabilities to innovate (Wenger et al., 2002). CoIs can be more innovative and dynamic than CoPs because of members’ competences, use of multiple knowledge systems and possible critics embedded in diverse approaches to the common interest, which in turn can be a source of collective creativity (Fischer, 2001). Critics, breakdowns and social creativity offer unique opportunities for reflection and learning (Schön, 1983; Fischer, 2004; Dorst, 2015).

2.7.1 Open design community

Active individuals engaged in open design and DIY (Do-It-Yourself) design activities form an open design community (Menichinelli, 2008; Stappers et al., 2011; von Busch, 2012). An open community offers a medium for collaborative creative contributions, for example, thoughts, knowledge, know-how and designs toward a solution or product are shared and developed there (Benkler and Nissenbaum, 2006; West and Lakhani, 2008). Members of the open design community share a philosophy that there should be an alternative to proprietary designs, thus they participate in open design projects to produce open design, which is analogue to the open source software community (O’Mahony and Bechky, 2008; Avital, 2011). Members are active participants and also consumers in the community (Bricklin, 2001; Benkler and Nissenbaum, 2006; Moilanen and Vadén, 2012). The term ‘prosumerism’ was introduced by Toffler (1980) to illustrate the transformation of roles in creative efforts. The term prosumer can be regarded as a portmanteau of the words ‘professional’ and ‘consumer’. Both the users and the designers have become savvier due to the Internet which provides more information and opportunities to be involved in. Additionally, the design process incorporates areas of expertise from different parties and some areas of human endeavours are adopting design perspectives (Stappers et al., 2011). The challenge is not only the transformation of roles but also responsibilities and empowerment of the involved parties; prosumers can also participate in strategic planning, information gathering and conceptualization (Stappers et al., 2011).

The values bridge ideological borders and strengthen the commitment to peer-to-peer lateral power (Rifkin, 2014). Interpersonal bonds provide information, support, sociability, social identity and a sense of belonging, which appeal to DIY type of persons who are libertarians, social entrepreneurs and communitarians (von Hippel, 2005). The other essential features in peer production related to the 3D printing open design community are transparency, self-selection, self-direction and the freedom to act based on self-articulated goals and principles (Benkler and Nissenbaum, 2006). Hence, the benefits of peer production are not only monetary; learning, enhanced reputation and a pleasure of crafting are also considered as its positive effects (Troxler, 2011).
Functionally novel innovations that require profound understanding of users’ needs and use-context information for their development can be created in open communities (von Hippel, 2005). In contrast to more conventional collaborative design processes (Lahti et al., 2004; Rahman et al., 2013), the working processes in the open design community are more dynamic and can shift in many ways (Moilanen and Vadén, 2012). A cause for a change could be, for example, a team decision to change the employed design tools or digital environment where the designs are shared and stored (ibid.). The term open peer-to-peer (P2P) design emphasizes the need to co-create a community that collaborates in a common activity (Menichinelli, 2008). The designs are done for and with the community by the community members. The activities include designing, developing and managing participatory public services as well as creating businesses emerging from the communities and managing interactions between businesses and communities (Füller et al., 2007).

Open design artefacts can be developed in two ways; they can be single-aim projects or there can be global commons-based peer production initiatives such as Ponoko, Shapeways and Thingiverse4 (Balka et al., 2009; Troxler, 2011). The common-based peer production can be defined as a socio-economic production system that emerges in the digitally networked environment (Benkler and Nissenbaum, 2006). Physical facilities such as hacker spaces and fabrication laboratories (fab labs) are for people to meet, share their designs and work on their projects (Troxler, 2011). Equipment and locations are funded by membership contributions, course fees, donations and subsidies (ibid.).

Knowledge sharing in communities
Knowledge can be a source of and a barrier to innovation (Carlile, 2002). The interpretations of knowledge can vary, which makes communication and collaboration difficult (Carlile, 2002). A semantic approach to knowledge recognizes that despite a common language, knowledge can be tacit (von Hippel and Tyre, 1996; Polanyi, 2009). Nonaka (1994) suggests that the mutual understanding can be acquired through communities of interaction where the semantic differences of knowledge can be overcome by individuals working together and that way the tacit knowledge can be converted explicitly across possible barriers. Polanyi’s (2009) statement of people knowing more than they can tell denotes the embedded characteristic of knowledge as well. Von Hippel’s (2005) explanation of information ‘stickiness’ corroborate the local aspect of knowledge; community members scattered all over the world tend to rely largely on information they already have in stock. However, von Hippel (2005) enhances the theory by explaining how Internet and advanced communication technologies can widen the sharing of knowledge. According to him, some community members are willing to reveal their ideas and others find the information interesting and use it, which makes the communities flourish.

Theories related to the design-oriented communities are touched on two publications of this study. The publication 1 by Tamminen focuses on a local design-oriented community, in which individuals and mainly small organizations are

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in close physical proximity. The publication 2 by Tamminen and Moilanen focuses on the open design community which is global in nature. The publications describe characteristics of the respective local and global communities and shed light to ways of working and practices in both contexts.

2.8 Summary of the theoretical framework

The concept of positive design provides reasons and motivating factors for individuals to aspire to possibility-driven design (Desmet and Pohlmeyer, 2013). Inspired individuals can spread out their enthusiasm and generate social welfare and well-being in the community (Wenger et al, 2002; von Hippel, 2005; Henkel and von Hippel, 2005; Desmet and Hassenzahl, 2012). The theoretical concepts related to possibility-driven design are summarized in Table 3.

Human-centred design focuses on people’s intended use of artefacts through understanding their needs, experiences and aspirations (Giacomin, 2014). It comprises design thinking (Brown, 2008). A bridge between design thinking and engineering design thinking can be build with the help of the structural model of the human-centred design. Companies and their stakeholders can benefit of business design modelling done in collaboration by involved parties. The business design modelling explores and identifies shared values and synergies needed to gain a sustainably competitive advantage (Fraser, 2007, 2009, 2011; Brown and Martin, 2015). A process to acknowledge the needs and shared targets of involved parties, individuals and communities, takes place iteratively. Open design blurs the borders of master and novice designers by enabling individuals to get involved in collaborative design activities (Atkinson, 2011; Stikker, 2011; Tooze et al., 2014). Collaborative design endeavours can contain disruptive design and manufacturing activities in which the traditional identities of a designer and a customer become ambiguous and a customer can be seen as a prosumer, a person who both produces and consumes what she produces (Toffler, 1980; van der Beek, 2012).

Affordances refer to opportunities for action (Gibson, 1986; Pols, 2012). Intuition can be defined as an act of recognition (Simon, 1996). Perception of affordances in the environment and conscious use of intuition can enable individuals to create artefacts and solutions inclined towards possibility-driven design (Gibson, 1986; Norman, 1988, 1999; Simon, 1996; Lawson, 2004; Pols, 2012). Recognition of patterns in design situations with little or no analysis, i.e. intuitively, is an ability of master designers but it is also a skill that can be learned (Cross, 2004; Lawson and Dorst, 2013; Raami, 2015).

Members of design-oriented communities share a collective identity build around design, which defines who they are. CoPs and CoIs are formed around shared practices and interests respectively. They evolve as community members interact and exchange knowledge with each other and external parties. Communities are dynamic; learning takes place fast, and new practices and conventions are formed on need basis (Norman, 1999; Fischer, 2001; Wenger et al., 2002; West and Lakhani, 2008; Neufeld et al., 2012).
Table 3. The theoretical concepts approach the possibility-driven design from the perspectives of an individual and a community.

<table>
<thead>
<tr>
<th>Theoretical concepts</th>
<th>Individual</th>
<th>Community</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human-centred design (HCD)</td>
<td>Design thinking or engineering design thinking can be preferred</td>
<td>Structural model of HCD can build a bridge between design thinking and engineering design thinking</td>
</tr>
<tr>
<td>Business design modelling</td>
<td></td>
<td>Symbiotic business design model boosts market and experience value which are constructed with help of user understanding, concept visualization and strategic business design</td>
</tr>
<tr>
<td>Open design</td>
<td>Anyone can participate in design activities</td>
<td>Innovating and sharing of designs can be done, no clear distinction between master and novice designers Potential area for disruptive designs by collaborative ways of working</td>
</tr>
<tr>
<td>Affordances</td>
<td>Perception of affordances in the environment</td>
<td>Perception of affordances in the interaction with others and the environment</td>
</tr>
<tr>
<td>Intuition</td>
<td>Master designers can use intuition intentionally</td>
<td>Constructive feedback promotes learning of the ability to use intuition</td>
</tr>
<tr>
<td>Design-oriented community</td>
<td>Identity build around design, art and craftsmanship</td>
<td>CoPs can be formed around practices ColS can be formed by stakeholders of CoPs around an interest</td>
</tr>
</tbody>
</table>

Possibility-driven design has been researched from various angles although the term possibility-driven design has not been used consistently. For example, Jordan (2004) points out the importance of taking into account human hopes, fears, dreams, values and aspirations along with physical and cognitive factors in product design. Dunne (2006) focuses on electronic products. He sees aesthetic potential outside of the commercial context and states that design, as a form of social commentary, has much to contribute to the quality of electronically mediated life. Zimmerman (2009) uses attachment theory in experience design projects to help people to become the person they desire to be through their interactions with the products. Hassenzahl et al. (2010) focus on the fulfillment of universal psychological needs, such as competence, popularity and autonomy, with positive experiences created by interactive products and technologies in the field of Human-Computer Interaction. Bianchini and Maffei (2012) concentrate on changes in the creation, materialization and accessibility of artefacts caused by the democratization of design technologies, personalization of production and growth of new distribution models. Desmet and Hassenzahl (2012) link possibility-driven design with happiness, well-being and pleasurable life, and suggest that technology can be understood as a possibility to improve life directly. Jimenez et al. (2014) discusses of the possibility-driven design as an alternative to traditional problem-driven design approach and introduces a five-stage possibility-driven design process. Research related to communities, CoPs and ColS, exists (e.g. Muniz and o’Guinn, 2001; Wenger et al, 2002; West and Lakhani, 2008; Chen and O’Mahony; 2009; Neufeld et al., 2012), but it is difficult to find connecting elements between the possibility-driven design and design-oriented communities. That is why further research is needed. The purpose of the theoretical framework of this study with human-centred design, open design, business design modelling, affordances theory and intuition is to widen and deepen our understanding on the possibility-driven design in the context of design-oriented communities.
3. Research methodology

3.1 Ontological and epistemological foundations

Ontology constitutes assumptions about the way the world operates and the perspectives held by researchers, which are, in the extreme cases, either objective or subjective. The stance in objectivism is that social entities of the reality are external to social actors who are concerned with their existence (Collins, 2010). Subjectivism represents the position that social phenomena are created based on the perceptions and consequent actions of social actors who are concerned with their existence (ibid.)

Theories are value statements; they are built on value-laden assumptions, which make them dependent on the values, and the findings are viewed through the value-laden theories (Guba and Lincoln, 1994). The essential answer lies in the qualities of the studied culture and the phenomenon, which need to be authentic (Collins, 2010). Authenticity and richness of the findings is an outcome of a critical analysis of the data. The findings arise through an interaction of the research participants and the researcher; hence the findings are descriptions of the inquiry process rather than objective observations (Guba and Lincoln, 1994). The methodological paradox is evident; how to develop an objective interpretive science of subjective human experiences (Schwandt, 1994)?

This study approaches the phenomena interpretively, which means that in order to understand the world of meanings, they have to be interpreted by the researcher (Schwandt, 1994). Interpretivism is an appropriate perspective because it aims to understand the world as it is experienced and perceived meaningful (Collins, 2010). Existing realities are constructed on local situations, specific circumstances, and perceptions, which become real when social actors - like a researcher - interpret them and give them a meaning (ibid.). There are multiple appropriate interpretations of an object; it is the prevailing culture and educational background that give the same phenomenon a different meaning (ibid.). The study is based on two preconceptions: first, the designers and design-oriented people want to prosper, share knowledge, disseminate results and learn something new (Boland Jr. and Collopy, 2004). Second, meanings for activities are created, negotiated, sustained and modified within design-oriented communities (Collins, 2010).

Epistemology focuses on the nature of information, knowledge and justification (Kangassalo, 2007). It states the question, 'How do we know the world?'
(Denzin and Lincoln, 1994, p.99). The design research has its own epistemological semantics, designerly ways of knowing (Cross, 1982, 1999), design thinking (Rowe, 1987) and experiential knowledge (Design Research Society, 2015), which are quite often person- and situation-oriented (Mareis, 2012). The idea of design is to exploit possibilities to create appropriate conditions and artefacts to fulfill the needs of customers (Norman, 1998). The intention of this study is to shed light to the possibility-driven design by studying ways of working and practices in design-oriented communities.

3.2 Research approach

3.2.1 Design research

The aim of design research is to develop an accessible and robust body of knowledge which enhances our understanding of processes, applications, methods and contexts within design (Collins, 2010). This study aims to understand people’s ways of working and practices in design-oriented communities. Herbert Simon (1996) started the discussion of design in the scientific forum in his book The Science of the Artificial. Simon argues that the paradigms of the Natural Sciences cannot be used in the Design Science as Natural Sciences use causalities to explain phenomena of the world but the same rules do not apply in Design. Design was understood in its own terms, when Rittel and Webber (1973) moved away from the desire to ‘scientise’ it and introduced the concept of wicked problems, which are poorly structured and ill-defined (Collins, 2010). Discussion related to design, science and wicked problems has been ongoing ever since (Cross, 1982, 1999; 2007; Buchanan 1992; Hatchuel and Weil, 2002; Conklin, 2005; Coyne, 2005; Farrel and Hooker, 2013). Buchanan (1992) states that wicked problems cannot be exhaustively formulated; hence the existence of a discrepancy can be explained in many ways, and the choice of explanation dictates how the problem is resolved. Hatchuel and Weil (2002) emphasize the importance of collective social interaction in the design process when finding solutions to wicked problems. Furthermore, they propose a wider use for design as a knowledge generation and integration activity. Conklin (2005) argues that today’s wicked problems cannot be solved using scientific facts, descriptions, predictions or control alone, but they need the creation and development of shared narratives and social meanings, which in turn mobilize needed capabilities to solve the specific challenges. Farrel and Hooker (2013) apply a cognitive process perspective and claim that although design and science have varying features of wickedness, their features are complementary and can therefore tame the complex issues.

According to Simon (1996), the design creation is embedded in the design research. The intentional character of design, pointed out by Simon (1996), needs to be taken into account in the design research. Design produces artefacts with a human intention, and the outsiders cannot comprehend the creative processes purely with rational thinking (Simon, 1996). Interpretation of Simon’s argument indicates that the design research is experiential research, and the design
creation is embedded in the research as well (Collins, 2010). Design research needs to develop a theoretical framework that acts as an interactive guide and ballast between the empirical research and the theory (Ravitch and Riggan, 2012). To be able to shift from knowing to doing requires practice, and to be able to shift from doing to knowing requires articulation and critical inquiry which lead a practitioner to gain reflective insights (Friedman, 2003).

Cross (1999) states that design research should focus on development, articulation and communication of design knowledge. He identifies three sources for design knowledge: people, processes and products. According to Cross’ categorization (1999), people, especially designers, and processes, designers’ ways of working, are sources for design knowledge. According to Norman and Verganti (2014), the concept of design research can take two different forms; it can be seen as exploration and experimentation that advances knowledge, develops theories and applies them. The second perspective focuses on how to improve products and sales, and sees design research as an activity of data collection and data analysis for gaining a better understanding of the topic (Norman and Verganti, 2014). This study falls into the first category of Norman and Verganti’s framework (2014); it aims to advance knowledge related to the possibility-driven design, develop its theories and suggest ways to apply them.

3.2.2 Case study research

Case study research concentrates on a functioning body or a bounded system with patterned activities (Stake, 2005). Case study research is both a process of inquiry and the outcome of that inquiry (ibid.). A case study is a research method that investigates an existing phenomenon in depth and within its real-life context, although the phenomenon and the context are not always distinguishable (Yin, 2009). Case studies can include both quantitative and qualitative data, and the focus is on contemporary events without the researcher manipulating relevant behaviours of the case study participants (ibid.).

The case study research was chosen to examine ways of working and practices of the design-oriented communities due to the exploratory nature of the research topic and the aim of gaining insights on each case (Eisenhardt, 1989; Darke et al., 1998; Yin, 2009). The approach is reflective (Stake, 2005), which suits to interpret the constant changes in the world, which in turn demand a shift in conceptualization and new perspectives to view and understand the changes and their relationships with the evolving knowledge (Chen et al., 2007).

3.2.3 Combining design research and case study research

The research design of this study illustrates the design-oriented communities and enlightens their ways of working from empirical and theoretical perspectives (Darke et al., 1998; Stake, 2005). The intellectual bins, with which this study is constructed, reflect the natural world for science, human experience for art and the artificial world for design (Cross, 1999). The concept of possibility-driven design is approached from different perspectives due to the diversified nature and various interpretations of it. The different perspectives anchor the
studied cases and the related concepts firmly together and advocate for a rigor-
ous case study research, because each persuasion of a research offers a slightly
different conceptualization of the human actions in the world (Schwandt, 1994).
Design situation is defined in this study as a set of all available information that
a designer can recognized in a design, hence it includes information of the envi-
ronment and the past design activities of the designer (Taura et al., 2002). The
empirical case studies, publications 1, 2 and 4 (Table 4), in the design-oriented
communities, and the conceptual studies, publications 3 and 5 (Table 4), create
together a conceptual framework, which acts as an interactive guide and a ball-
last for the development and implementation of empirical research (Ravitch and
Riggan, 2012). In this study, both the empirical and conceptual studies constitute a rich interpretation of the ways of working and practices in the design-oriented communities.

Table 4. Case study types and contexts of this study.

<table>
<thead>
<tr>
<th>Publication</th>
<th>Study type</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publication 1 by Tamminen: Community-Based Business Design Model</td>
<td>Empirical case study</td>
<td>Design-oriented local community</td>
</tr>
<tr>
<td>Publication 2 by Tamminen and Mollanen: Possibility-Driven Spins in the Open Design Community</td>
<td>Empirical case study</td>
<td>Open design community</td>
</tr>
<tr>
<td>Publication 3 by Tamminen and Järvi: The Role of Design in Service-Dominant Logic</td>
<td>Conceptual study</td>
<td>-</td>
</tr>
<tr>
<td>Publication 5 by Tonetto and Tamminen: Understanding the Role of Intuition in Decision Making When Designing for Experiences: Contributions from Cognitive Psychology</td>
<td>Conceptual study</td>
<td>-</td>
</tr>
</tbody>
</table>

3.3 Description of cases

Rational behind selecting design-oriented communities for data sources of this study is based on two statements; first, the possibility-driven design focuses on design for possibilities rather than removal of problems per definition (Desmet and Hassenzahl, 2012). This is implemented in practice by focusing on positive development of existing artefacts, services and conditions without having a serious problem to solve. Second, a designer looks for possibilities and possible futures instead of solving present-day problems (Hekkert and van Dijk, 2011). Therefore, possibility-driven design can be studied in design-oriented communities to understand prevailing ways of working and practices. The strategy of deviant case sampling (Patton, 2002) was used when choosing the data sources among design-oriented communities. Two information rich data sources, a global 3D printing open design community and a design-oriented local community, were chosen. The two cases have similarities and differences depending on the perspective. The similarities are related to the definition of communities; they both have typical characteristics of communities as well as features of CoPs and CoIs (West and Lakhani’s; 2001; Gläser, 2001; Fischer, 2001, 2004). The differences are mostly related to the identity of the community members and the boundaries of the communities. Members of 3D printing open design com-
Community see themselves as prosumers (Toffler, 1980) and developers of 3D printing related elements such as designed artefacts, knowledge and resources whereas members of the design-oriented local community see themselves as design-oriented inhabitants of a local design-oriented community. The global 3D printing community operates both locally and globally without clear boundaries compared to the design-oriented local community which has clearly mapped physical boundaries.

Publications 1 and 4 by Tamminen are based on studies conducted in the design-oriented local community. Publication 2 by Tamminen and Moilanen is based on a study in the open design community. Publication 3 by Tamminen and Järvi and publication 5 by Tonetto and Tamminen are conceptual studies without a specific context.

### 3.3.1 Open design community

The 3D printing open design community is part of a larger open design community, and its members work with designs based on 3D printing technology. The 3D printing community consists of bright engineers and scientists who share an ethical belief in the value of collaboration over proprietorship and access to ownership (Rifkin, 2014). The open design community consists of both experts and novice designers, but due to its open nature with ambiguous borders and anonymous memberships, it is very difficult to categorize design expertise (Dorts, 2015). Boundaries of the open design community are not clear as it is literally an open community; anybody can be a member of the open design community, and the community can be accessed whenever a member decides to do so. Community members share openness and the goal of creating, adapting, adopting or producing models and artefacts (Gläser, 2001; West and Lahkani, 2008). The 3D printing open design community is formed around a common interest, the 3D printing, which also defines the landscape of the community. A member of the 3D printing open design community can be a student, an independent designer or work for a company (Moilanen, 2013). Community members usually use pseudonyms so majority of them act unanimously in the community. Due to an ambiguous nature of the open design community, a somewhat more clearly defined part of it, the 3D printing open design community, was chosen to be the focus of this study (Figure 7).

The concept of prosumerism (Toffler, 1980) fits well with the activities related to the peer production based 3D printing. Active members of the 3D printing open design community need to have quite a good knowledge of the web based tools and applications in order to be able to contribute for the common good, i.e. shared prosperity, of the community. In addition, a long experience working with 3D printing technology lowers the threshold of participating in discussions in the community forums such as Thingiverse.com, Github.com, Ponoko.com, i.materialise.com, Shapeways.com and Cubehero.com. Community members usually use pseudonyms in the community forums for not to reveal their real...
identity. The most active members contributing to the common good are usually highly respected in the community. The community members can be independent contributors having 3D printing as a hobby or they can be professional designers or engineers. Development and production of the artefacts can happen both locally and globally in the 3D printing open design community. The local sharing takes place in physical maker spaces, hacker spaces and open design events in which people discuss, compare notes and experiences, browse around and 3D print artefacts themselves. The amount and quality of tacit knowledge shared in local spaces and events depends on the enthusiasm and expertise of the active participants. The local activists also initiate things to be shared at the global level. Anything shared online in, for example blogs, Wikipedia projects and discussion forums, becomes global. Especially the most controversial projects go through constant changes in, for example ways of working, roles taken by the community members, employed tools and platforms, and even direction or target of the development work.

Informants of the 3D printing community (presented in Table 1 in the Appendix I) consists of two groups because the data were collected in two phases; the semi-structured interviews (Robson, 2011) were conducted in the first phase, and based on the findings of it, a cross-sectional web survey was conducted in the second phase. There were eight participants in the interviews. Five participants were designers and the rest of them had an occupation linked with design; one was an architect, one was a design researcher, and one was an engineering student. Two of the informants were from the USA, three were from the Netherlands, two from Finland and one from France. Informants of the two phases were not the same persons due to different data collection methods of the phases and the time span of about a year between the first and second phase. Unfortunately, it is not possible to link specific background data to the participants of the second phase of the study due to the open nature of the conducted web survey. However, Moilanen (2013) conducted a web survey among the 3D printing open design community members, and the results of that survey provide a general description of the characteristics of the open design community members. According to the results of the survey, over 75 per cent of the members are male, and 83 per cent are of age 21-45 years. In addition, 67 per cent of the survey respondents had a master’s degree or four years of college education (Moilanen, 2013).
3.3.2 Design-oriented local community

The design-oriented local community is a small community in South-western Finland surrounded by large forests, small lakes and rivers which make it an idyllic place for recreation and out-door activities. Production of craft, designed artefacts and art has been nurtured in the community for some 30 years (Fiskars Village History, 2015). The design-oriented local community consists of design-oriented organizations, and it can be seen as a miniature model of a contemporary society with its pluralistic and networked challenges; digitalization and new technologies have replaced labour intensive manufacturing and small start-up companies have developed products and services with unconventional business models. The spectrum of product and service offerings is relatively wide from the latest technologies, such as 3D printing, to traditional craftsmanship, such as hand making of furniture, paper and candles. There are approximately 470 residents (Statistical database of Finland, 2014) and about 200 micro-companies, including roughly 120 artists, in the design-oriented community. The community is well-known for its design and art orientation, and it sees approximately 120,000 local and international visitors annually. The design-oriented community has its roots in the 1640’s as one of the earliest ironwork sites of Finland (Fiskars Village History, 2015). Fiskars Corporation, a global supplier of branded consumer products, was founded in the local area in 1649, but the last of the manufacturing operations were relocated in the 1980’s, and nowadays there is only the Real Estate unit of the company left in the area.

The design-oriented local community has clearly defined geographic boundaries, and the community members are physically part of it. Members of the local community represent themselves and the small design-oriented organizations they work for. Majority of the data were collected in eight workshops and twelve semi-structured interviews. 19 community members participated in the workshops and 12 out of them participated also in semi-structured interviews (informants are presented in Table 4 in the Appendix I). The workshops were conducted prior the interviews. There were eight female and eleven male informants. Three of the participants had Swedish as their native language and 16 spoke Finnish as their native language. Despite strong design-orientation and
existence of expert designers in the design-oriented local community, some of its members lacked formal design education or a long exposure of designerly thinking (Dorst, 2015; Cross, 1982, 2001). Occupations of the workshop participants were inclined towards design; they varied from a blacksmith to a system designer and from a restaurateur to a photographer. The participants had also other types of competences and skills, for example in the field of jewellery-making, furniture manufacturing, tourism, dramaturgy, education and event management.

3.4 Data collection in the open design community

Both qualitative and quantitative methods were used to collect data from the open design community. The data were collected in 2012-13 in two independent phases. The first data collection was done with semi-structured interviews and the second data collection was done with a cross-sectional web survey. Three media channels, email, Skype call and IRCnet chat, were used to collect data in the first phase (Table 1 in the Appendix I); invitations to participate in the pilot and the actual interview were sent by email, and the interviews were conducted by email, Skype calls and IRCnet chat. Before the data collection started, an email pilot was done to verify the relevance and suitability of the questions for the interviews (Robson, 2011). Feedback from the pilot indicated that members of the 3D printing community did not understand the questions or the research aim; therefore, the format of the questions was changed. Data from the pilot were also used in the data analysis. The semi-structured interviews, presented in Table 2 in the Appendix I, focused on three themes; first, informants were asked to draw their design process and ancillary components linked with the process. Second, informants were asked to describe the progress of their design process from the draft phase to the final design. Third, informants were asked about their sources of inspiration for their designs. Invitations to participate in the study along with the questions were sent to participants of an open design contest by email.

The semi-structured interviews concentrated on informants’ ways of working and practices related to the sketches they provided. During the first interviews so called snow ball sampling method (Arksey and Knight, 1999; Patton, 2002) was used to acquire potential new informants based on recommendations. The interviews were continued until saturation was reached. Saturation refers to a point where no new information or new properties and dimensions of developed categories emerge to explain the phenomena, i.e. practices and design processes of the 3D printing community members (Corbin and Strauss, 2008). The saturation was reached after eight interviews. In addition, 14 other persons were approached by email but they did not have time or possibilities to participate in the study. Some informants provided sketches of their design process while others only briefly answered the given questions. Some data were also received through email correspondence between the second author of the second publication ‘Possibility-driven Spins in the Open Design Community’ of this study and a well-known expert in the open design community. Communication was
done in English and Finnish. The interviews were recorded and the transcriptions were written word by word.

Findings of the first phase were reported and presented in the International Association of Societies of Design Research (IASDR) conference in Tokyo in 2013. After the conference, the manuscript was submitted to the Design Journal for publication. The feedback from anonymous reviewers was constructive but it also indicated a need for a major rework. One of the reviewers gave an advice to look into the concept of the possibility-driven design. Based on the suggestion of an anonymous reviewer, the second phase of the case study was conducted. The already existing qualitative data of the pilot and semi-structured interviews of the first phase were revisited with a possibility-driven design approach and complemented with quantitative data of a cross-sectional 3D printing survey (Moilanen, 2013).

Additional data for the second phase consisted of a cross-sectional web survey. The purpose of the quantitative data of the second phase was to provide reasons to why the open design community members want to participate in shared design projects (Pratt, 2009). The aim of the second phase was to find support for an existence of the possibility-driven design in the open design community. An invitation to the web survey was sent via Twitter, Facebook groups, developer mailing lists, hacker space discussion lists, blog posts and also to various companies and organizations providing 3D printing services. The questions of the survey were based on earlier done research in the open source area (Aalbers; 2004; Mikkonen et al., 2007), and they studied the motivation of community members to participate in the sharing and contributing activities. The survey questions (Table 3 in the Appendix I) focused on reasons why members of the 3D printing open design community participate in the design projects. There were 344 respondents in the web survey. It is not possible to count the response rate because the survey was an open call for responses.

The publication by Tamminen and Moilanen was written based on data from the 3D printing open design community. The data consisted of eight semi-structured interviews, field notes taken during the interviews, email discussions and a cross-sectional web survey.

### 3.5 Data collection in the design-oriented local community

All data were collected in 2012-2014. Workshops and semi-structured interviews were the main data sources, but also observations were made and fieldnotes taken. The workshops had a dual purpose; for the local businesses, they were set up to increase the number of visitors and the sales of the local companies as well as develop the overall prosperity of the local community. For this study, they provided a rich data source to explore ways of working and practices in the design-oriented local community. In the first planning meeting prior the workshops, the positive drive towards prosperity of the local community, i.e. the development of the common good, was seen vital because people are more creative and experimental in a positive atmosphere (Cameron, 2008). A design at-
titude and positive drive of the participants were also found relevant in the planning meeting. The design attitude is a mind-set and an approach to problem solving that goes beyond default solutions while creating new potential solutions (Brown, 2009; Dorst, 2015). It reflects the desire to do something differently from what has been done before while experimenting with materials, technologies and methods (Boland Jr. and Collopy, 2004; Martin, 2004). Representatives from all key stakeholder groups were invited to participate in the workshops by emails. Participants of the collaborative development workshops represented the key groups of the local community; the Merchants’ association, Onoma – the Co-operative of Artisans, Designers and Artists, the Village club, the Real Estate unit of Fiskars Corporation, Education centre Tako and service providers such as restaurateurs and local guides. A pragmatic approach with ‘an open door policy’ was taken when conducting the workshops because the sessions were held during working hours, and the workshop participants had to take care of their daily businesses so they could come late to the workshops or leave earlier based on their tasks at hand.

As discussions are a crucial element in the participatory design research (Jones et al., 2007; Iversen, 2012), a democratic Opera method was used in the workshops to avoid dominance of strong personalities (Slåen and Mantere, 2003). The used Opera method supported collaborative ways of working by valuing and respecting the inputs of each participant equally. The method demystified research and the terms, such as value propositions and revenue streams, used in Osterwalder and Pigneur’s (2009) business model canvas, and made the process more transparent and fair. Each workshop was steered with a clear lead question that focused and aligned participants’ thinking to the right track. The lead questions are presented in Table 6 in the Appendix I. Each participant thought about the questions first independently and then in pairs. The thoughts were shared with all participants in turn, and after becoming familiar with all ideas, voting for the most preferred ideas took place. The supported thoughts were grouped, categorized and labelled. The discussions and results of the earlier workshops were presented and discussed in the beginning of each session to set the scene for the participants and refine the outcomes of the previous workshops. Each workshop was planned beforehand, notes were taken during the sessions and a debriefing was done after each session. The author of this study was one of the facilitators of the workshops.

The development work for the prosperity of the local community took place in total in ten workshops and four planning meetings. The future scenario of the community was developed in the three first workshops. A business model canvas of Osterwalder and Pigneur (2009) was employed in the next five workshops to identify common needs, values and assets and to create a shared business model and a concept to support the shared business activities for all key stakeholders. An example of the use of the business model canvas (Osterwalder and Pigneur, 2009) is presented in Figure 1 in the Appendix I. A development plan with agreed responsibilities for the further development of specific areas and themes were the topics in the last two workshops. The plan was based on the outcomes of eight earlier workshops which had generated the future scenario
for the community, a shared business model built on) business model canvas, and a concept for the coming Christmas season. The number of workshop participants varied between seven and eleven, and 19 persons in total participated in the workshops. The workshops lasted two hours on average, and the workshops were held approximately monthly. All communication in the workshops was done in Finnish. Since the interview participants were able to comment the outcomes of the workshops, there is a linkage between the two sets of data.

Questions of the semi-structures interviews are presented in Table 6 in the Appendix I. The questions were sent to the participants beforehand. There were 24 questions, and the first seven of the questions were related to the conducted workshops, and the rest were related to the collaboration of individuals - or the organizations they represent. The interviews focused mainly on the conducted workshops and collaboration between individuals and organizations in the design-oriented local community. Workshops were conducted prior the interviews so their benefits and contributions could be discussed in the interviews. The discussions in the interviews were more personal and intimate than in the workshops. The interviews lasted an hour and a half on average. All communication in interviews was done in Finnish. The interviews were recorded and the transcriptions were written word by word. Two samples of the interview transcripts are presented in Figure 1 in the Appendix I.

Data of eight first workshops, four planning meetings, field notes, observations and nine semi-structured interviews were included in the case study of the publication 1, ‘Community-based Business Design Model’ written by Tamminen. Data of three first workshops, four planning meetings, field notes, observations and twelve semi-structured interviews were included in the publication 4, ‘Fiskars Village: Exploring Possibilities for Collaboration in a Design-Oriented Community’ written by Tamminen.

3.6 Analysis of the data

All three forms of reasoning - deduction, induction and abduction – can be in use in design research (Kolko, 2010). A deductive argument guarantees logically the truth of its conclusion, if the provided premises are true (Kolko, 2010). It claims that something must be operative. An inductive argument offers sound evidence that something might be true, if it is based on structured experience (ibid.). Deduction predicts something to be tested by induction (Peirce, 1903). If anything needs to be learned or phenomena understood, abduction needs to be used: abduction forms an explanatory hypothesis, ‘it is the only logical operation which introduces any new idea’ (ibid., p.217).

3.6.1 Data analysis of the ways of working and practices in the open design community

The data of the open design community were collected and analyzed in two separate phases because of a time span of about a year between the phases. Reason for the break was practical; data from the first phase were not sufficient for a
rigorous case study related to the ways of working and practices in the open design community, and more data were collected once an appropriate research theme was selected. There were eight informants in the first phase, which included the semi-structured interviews, and 344 in the second one, which was the cross-sectional web survey. Data of the first phase were analysed inductively which provided discoveries of patterns and themes and enabled categorization of the data (Patton, 2002). The transcriptions of the interviews and the sketches made by the informants were analyzed by coding, finding patterns, labelling them and developing different categories for different stages of the design process (Patton, 2002). The stages were compared with conventional design processes (Roozenburg and Eekels, 1995), and both similarities and differences were found.

In the second phase, the earlier collected qualitative data about the ways of working and practices in the open design community were reanalysed with the perspective of the possibility-driven design, and the quantitative data acquired in a web survey were analysed through the lens of the possibility-driven design. The web survey of the second phase was analyzed by calculating the responses of the community members. The analysis was done by counting percentages of the responses in five different categories: strongly agree, agree, don’t know, disagree and strongly disagree. The responses percentages are presented in Table 6. In addition, the positive design framework (Desmet and Pohlmeyer, 2013) was used in the analysis. Responses were categorized into virtue, pleasure and personal significance according to the elements of the positive design framework (ibid.).

**Data analysis in the study of intuition**

Open community members’ use of intuition emerged in the data analysis phase although intuiting was not included in the themes of the case study research. One of the informants mentioned to take an intuitive approach in his design process instead of using a fixed process as he was describing how he creates his designs.

**3.6.2 Data analysis of the ways of working and practices in the design-oriented local community**

Ten workshops and twelve semi-structured interviews in total were conducted in the design-oriented local community. There was an overlap of data collection and data categorization as the first analyses of the workshop outcomes were done already in the workshops by the workshop participants. The future scenario for the local community was developed in three workshops to support the development of the community, and for the purpose of this study, the analyse of the data related to those workshops and the semi-structured interviews focused on affordances. The business model canvas of Osterwalder and Pigneur (2009) was employed in five workshops for the benefit of the community, and for the purpose of this study, the analyses of the data related to those workshops and the semi-structured interviews focused on business design model of Fraser
To illustrate outcomes of the workshops, a part of the business model canvas, customer segments, is presented in Figure 2 in the Appendix I.

**Data analysis in the study of collaborative business design modelling**

A deductive data analysis (Patton, 2002) was conducted for the eight workshops, observations, nine semi-structured interviews and related field notes based on Fraser’s (2007, 2009) business design model by analysing qualitatively the content of the workshops, interviews and field notes. Categorization and naming activities were done in the workshops because they were part of the Opera method (Slåen and Mantere, 2003) used in the workshop. Although categorization and naming of the categories were done already in the workshops by the participants, all elements presented and discussed in the sessions were reviewed and re-categorized later by the researchers, who were also the workshop facilitators. A complete analysis of the workshops was done right after each workshop by taking into account used Post-it® Notes, groupings of the Post-it® Notes, and naming of the groups as well as field notes and observations. Focus of the data analysis was on the interaction between individuals and the local community. Elements linked with interaction were coded, labelled and categorized. The elements, such as customer understanding and shared values, were found in the data as a result of a deductive analysis based on Fraser’s (2007, 2009) business design model. As the work with the business model canvas progressed, elements related to Fraser’s business design model (2007, 2009) could be recognized as second-order concepts in the analysis phase after analyzing the first-order concepts of the workshop sessions (Pratt, 2008). The second-order elements, such as shared values and collaboration, were also introduced and discussed in the workshops as analysis of the workshop outcomes took place while the workshops were still conducted.

An abductive data analysis, which can be seen as a combination of inductive and deductive analysis (Peirce, 1903; Denzin, 1978; Kolko, 2010), of each interview was done by reading through the transcripts, underlining all elements which supported collaboration and design interactions, categorizing and naming them with descriptive names. The emerged themes were compared with Fraser’s business design model (2007, 2009), and some of the themes fitted into Fraser’s model while others did not. Comparison of the data from the workshops and interviews was done in the final stage of the analyses. Interviews strengthened the findings of the workshops by bringing in participants’ personal perspectives because the interviews were more intimate than the workshops, and the discussions were more private. All informants had a possibility to read and comment the manuscript of the publication 4, ‘Fiskars Village: Exploring possibilities for collaboration in a design-oriented community,’ written by Tamminen before its submission to a scientific journal forum.

**Data analysis in the study of affordances**

The purpose of the inductive data analysis is to discover patterns, themes and categories in the data, and findings emerge out of the data (Patton, 2002). An inductive data analysis was conducted for the outcomes of three workshops, twelve semi-structured interviews, related field notes and observations. Data of
the three workshops and nine semi-structured interviews were the same as for the case study related to the business design modelling (Fraser, 2007, 2009). In addition, three new semi-structured interviews were added into the data used in the study of affordances because there were new participants in the workshops, and they were willing to participate in interviews. All data were analysed inductively through the lens of affordances. All the workshops were steered with clear lead questions which are presented in Table 5 in the Appendix I. The available data were viewed as ‘as-is’ situations and ‘post-hoc’ properties, as proposed by Kannengiesser and Gero (2012). Elements which enable and support collaboration in design situations emerged in the conducted qualitative content analysis which refers to data reduction and sense-making effort by attempting to identify core consistencies and meanings (Patton, 2002).

The qualitative content analysis consisted of several steps; first, the parts of the interview transcripts which touched on the conducted workshops were read and elements related to collaboration between individuals of the local community were underlined. Second, grouping and naming of the collaborative actions were done. The collaborative actions acted as ‘a key’ to discover affordances, i.e. opportunities for action (Gibson, 1986; Pols, 2012), in the data. The affordances emerged in the data as the first-order concepts (Pratt, 2008), and their emergence meant that all data were re-analysed as the third step. The re-analysis was conducted by elaborating deeper meanings of the emerged opportunities for action. Fourth, all the data were analyzed at the community and individual levels by a meta-evaluation, i.e. an evaluation of an evaluation (Patton, 2002) of the deeper meanings.

An example of the content analysis conducted at the community level is presented in Figure 3 in the Appendix I. The collaborative actions, e.g. creation of ideas, iteration rounds, and shared constructive feedback, were findings of the content analysis. An evaluation of the deeper meaning of the findings provided themes that support and enable perception of affordances at the community level. The four themes; community thinking, innovating identity, entrepreneurial mind set and recognition of the complexity of a holistic customer experience, were developed during the analysis of the deeper meanings of the data related to the workshops. Community thinking consists of elements related to the local community; therefore, the deeper meanings of living and environment, infrastructure, quality criteria and community can be seen to be part of it. Innovative identity consists of elements related to innovativeness and creativeness; therefore, the deeper meanings of creative village, innovative ‘idea hatchery’, spontaneous village, Fiskars academy, exhibitions and cultural production can be seen to be part of it. Entrepreneurial mind set consists of elements related to running an own company with a profit and loss responsibility; therefore, the deeper meanings of brand of the village, entrepreneurship, marketing communication, productization of services, quality criteria, exhibitions, and communication and marketing can be seen to be part of it. Recognition of the complexity of a holistic customer experience consists of ill-defined elements designers are familiar to work with; therefore, the deeper meanings of ‘weaver’ of the network, history – the future, holistic experience, exhibitions and Fiskars’ four seasons can be seen.
to be part of it. Two collaborative actions, quality criteria and exhibitions, can be seen to have several aspects, and therefore their deeper meanings can be seen as shared between the four themes that were recognized to enable and support perception of affordances.

An example of the content analysis conducted at the individual level is presented in Figure 4 in the Appendix I. The collaborative actions, e.g. freedom to explore new ideas and a recognition of the existence of contradictions between artisans of different subject matter, were findings of the content analysis. An evaluation of the deeper meaning of the possibilities of actions provided themes which individuals perceive as enablers of collaboration in their design situations. An evaluation of the deeper meaning of the findings provided three themes: autonomy, deliberateness and contradictions. The affordances, descriptive quotes related to the affordances from informants, and the themes are presented in Table 8 in the Appendix I.

After analysing the workshops and the interviews separately, a comparison between two sets of data was done to constitute a wider understanding of affordances and the emergent enablers and supporting elements for collaborative design situations at community and individual levels. The deeper meanings of collaborative activities which emerged in the data related to the workshops were reviewed at the community level, and the affordances which emerged in the interviews were reviewed at the individual level. Data of the workshops support the themes which emerged in the interviews although community members’ daily work can be characterized as more concrete activities than the more general discussions that took place in the workshops. The chosen perspective was pragmatic, and it also provided a linkage between the two levels as the findings show. All informants had a possibility to read and comment the manuscript of the publication 1, ‘Community-Based Business Design Model,’ written by Tamminen before its submission to a conference.

Data analysis in the study of intuition

In the analysis phase all the data were reviewed to see if intuition or the use of it were mentioned. The use of intuition in design situations was found in four of the transcriptions of the semi-structured interviews.

3.7 Summary of data collection and data analysis methods

Summary of the used data collection and data analysis methods are presented in Table 5. More detailed descriptions are provided in the previous chapters 3.4 Data collection in the open design community, 3.5 Data collection in the design-oriented local community and 3.6 Analysis of the data. A cross-case analysis could not be conducted across the open design community and the design-oriented local community cases, because the thematic interviews and workshops focused on different issues. Instead, the different approaches to the possibility-driven design revealed similarities between the two design-oriented communities and provided new insights and a better understanding of the concept of the possibility-driven design. Publication 3 by Tamminen and Järvi and publication
5 by Tonetto and Tamminen are conceptual studies, hence they do not include empirical data.

Table 5. Data collection and data analysis methods of this study.

<table>
<thead>
<tr>
<th>Publication 1. Community-Based Business Design Model</th>
<th>Data collection methods</th>
<th>Inductive analysis</th>
<th>Deductive analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Conduction of workshops and semi-structured interviews, field notes and observations</td>
<td>Emergence of patterns based on data from workshops and interviews</td>
<td>Confirmation of the findings based on an existing theoretical framework</td>
</tr>
<tr>
<td>Publication 2. Possibility-Driven Spins in the Open Design Community</td>
<td>I phase: Conduction semi-structured interviews  II phase: Conduction of web survey</td>
<td>I phase: Emergence of patterns from data of interviews  II phase: Confirmation of findings based on a numerical analysis</td>
<td></td>
</tr>
<tr>
<td>Publication 3. The Role of Design in Service-Dominant Logic</td>
<td>Conceptual study, no empirical data</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Publication 4. Fiskars Village: Exploring Possibilities for Collaboration in a Design-Oriented Community</td>
<td>Conduction of workshops and semi-structured interviews, field notes and observations</td>
<td>Emergence of the first order- and the second order concepts from data acquired in workshops and interviews</td>
<td>-</td>
</tr>
<tr>
<td>Publication 5. Understanding the Role of Intuition in Decision Making When Designing for Experiences: Contributions from Cognitive Psychology</td>
<td>Conceptual study, no empirical data</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
4 Summary of the results

Results of the case studies and the conceptual studies are presented in this section. As stated in the chapter 1.3 Positioning and structure of the study, the publications included in this study can provide responses to one or several research questions. Chapter 4.1 Drivers of collaboration in design situations approaches collaborative activities from an individual perspective. Chapter 4.2 Ways of working in the design-oriented communities approaches used practices and ways of working from an individual and a community perspective. The other topics linked with ways of working and practices, business design modelling, communities of practice and communities of interest, apply a community perspective. Chapter 4.3 Affordances in collaborative design activities approaches affordances and perception of them both from a community perspective and an individual perspective. Chapter 4.4 Intuition in design situations approaches intuition from an individual perspective.

4.1 Collaborative working in design-oriented communities

In this study, collaboration is defined as a group of people working together to accomplish an agreed activity or to achieve an agreed goal (Chiu, 2002). Findings from the case study of the open design community are presented in the chapters 4.1.1 Networked personal aspirations and 4.1.2 Motivating factors to participate in design endeavours. Publication 2, ‘Possibility-Driven Spins in the Open Design Community’ presents the main characteristics of the ways of working and practices in the open design community. The other data source of this study, the design-oriented local community, was not approached with exactly the same research thematic, so a proper cross-case analysis regarding the main characteristics in the design-oriented local community was not done. However, found similarities between the two design-oriented communities are presented.

4.1.1 Networked personal aspirations

Members of the 3D printing open design community were asked to draw a picture of their design process and include relevant components in it. One of the informants, a designer, provided an illustrative sketch of his design process (Figure 8) via IRCnet chat. The illustration is simple but informative; it highlights the main elements that constitute the designer’s design situation. The three main elements, esteem, technology and usage, are the designer’s own
terms and he finds them vital in his work. The term esteem on the left lower corner can be regarded as an aesthetic aspect and a virtue of the design. It can also be seen as the designer’s perception of being a morally good person. The term technology on the right lower corner can be regarded as a tool and an enabler with which the designer can pursue his own goals and create needed designs. The term usage on top of the other elements can be regarded to signify the importance of knowing what and how to design through own experience. The usage can be compared to the philosophy of DIY (Do-It-Yourself) community. The usage brings in satisfaction of designing appropriate artefacts for particular situations and needs.

The findings are linked with being a member in the open design community. All three elements of Figure 8 have a communal dimension because the members rarely work alone; ‘the network is part of the solution.... specifically 3D printing is the physical embodiment of a network’ stated one of the informants. The purpose, people and character can vary from one 3D printing project to another, which indicates that the emphasis and weight of the elements can vary as well.

![Figure 8. A personal design framework of an informant, illustration done by a member of the 3D printing open design community (Tamminen and Moilanen, 2016).](image)

Based on the interviews of the members of the design-oriented local community, shared values, aim for high quality design, craftsmanship and art as well as appreciation for self-sustaining and long-term life styles in the local community were seen as the main elements for the personal aspiration. These aspirations are also connected to the community; for example, self-sustaining life style needs to be developed in collaboration with other members of the local community.

### 4.1.2 Motivating factors to participate in design endeavours

A web survey was conducted in the 3D printing open design community. There were 344 respondents in the survey. Findings of the web survey reveal reasons for people to participate in design endeavours of the 3D printing projects (Table
The most significant factors were to have fun (66% of the respondents) and learn new skills (51% of the respondents). Sharing of knowledge and skills with others (62% of the respondents), expressing oneself (61% of the respondents) and helping others (57% of the respondents) were also seen quite important. On the other hand, money was not seen as a reason to participate in the 3D printing projects (36% of the respondents). Based on the findings, members of the 3D printing open design community have a preconception that sharing can conflict with monetary values.

Table 6. Response percentages of the 3D printing open design community members to why they participate in 3D printing projects (Tamminen and Moilanen, 2016).

<table>
<thead>
<tr>
<th>Strongly agree (%)</th>
<th>Agree (%)</th>
<th>Don’t know (%)</th>
<th>Disagree (%)</th>
<th>Strongly disagree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I participate in 3D printing projects because it is fun.</td>
<td>66</td>
<td>12</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>2. I participate in 3D printing projects because I learn new skills.</td>
<td>51</td>
<td>23</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>3. I participate in 3D printing projects because of money.</td>
<td>14</td>
<td>14</td>
<td>22</td>
<td>13</td>
</tr>
<tr>
<td>4. I participate in 3D printing projects because I like to share my knowledge and skills with others.</td>
<td>30</td>
<td>32</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>5. 3D printing projects are a way to express myself.</td>
<td>32</td>
<td>29</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>6. I participate in 3D printing projects because I want to help others.</td>
<td>28</td>
<td>29</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>7. I participate in 3D printing projects because I want to develop 3D printing tools and practices.</td>
<td>29</td>
<td>19</td>
<td>32</td>
<td>9</td>
</tr>
<tr>
<td>8. I develop 3D printing because I need it for doing something else.</td>
<td>29</td>
<td>22</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>9. I participate in 3D printing projects because I like collaborative development.</td>
<td>27</td>
<td>24</td>
<td>24</td>
<td>13</td>
</tr>
<tr>
<td>10. I participate in 3D printing projects because it gives me better job opportunities in the future.</td>
<td>18</td>
<td>24</td>
<td>25</td>
<td>18</td>
</tr>
<tr>
<td>11. I do 3D printing because I think all software and hardware should be free.</td>
<td>18</td>
<td>15</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>12. I participate in 3D printing projects because I want to give back to the community.</td>
<td>19</td>
<td>23</td>
<td>24</td>
<td>19</td>
</tr>
<tr>
<td>13. I participate in 3D printing projects because I get more respect.</td>
<td>12</td>
<td>17</td>
<td>27</td>
<td>21</td>
</tr>
</tbody>
</table>

Responses from the interviews conducted with emails, Skype calls and IRCnet chats indicate that members of the 3D printing open design community accept business-oriented thinking, i.e. aiming at achieving money in the design projects, as long as it is transparent, which means that everybody working in the same project are aware of the business-oriented thinking. A shared philosophy of the community members is that if they participate in the projects and contribute to the shared good of the open design community, they will benefit from their actions.

The interviews conducted in the design-oriented local community indicate that similar results could have been obtained from the data collected there. Social interactions, enjoyment, personal learning as well as provision of trainings inclined towards design, craftsmanship are art to others, even to people outside
of the community, were highly appreciated elements in the design-oriented local community.

4.2 Ways of working in design-oriented communities

Findings related to the ways of working in the open design community are presented in the beginning of this chapter from individual and community perspectives. Results presented in these chapters are included in Publication 2, ‘Possibility-Driven Spins in the Open Design Community’ by Tamminen and Moilanen. Findings related to the ways of working in the design-oriented local community are reviewed through the lens of a business design model. Publication 1, ‘Community-Based Business Design Model’ by Tamminen describes collaborative ways of working in the design-oriented local community, and expands design thinking mind sets across independent organizations while developing a shared business design model for design-oriented communities.

4.2.1 Acts of sharing in the open design community

Sharing in this context means that community members take part in virtual and face-to-face activities in the open design community. Virtual sharing takes place in the Internet and face-to-face sharing happens locally in e.g. hacker spaces and sharing event. Based on the findings of the data from the interviews, members of the 3D printing open design community develop their designs further with the help of acts of sharing. In addition to sharing of 3D models, knowledge and resources can also be shared. A personal design process of one of the informants, a designer specialized in hardware development of an open source driven RepRap 3D printer, was also chosen to be analysed in detail. The designer described his design process with four phases: ‘filling’, ‘deep thinking’, ‘extracting’, and ‘showing’. Terminology used to describe the activities in the acts of sharing are designer’s own terms. In the ‘filling’ phase, the designer collects ideas and reviews the designed model from many perspectives and tries to learn more about it. Work done at the phase of filling is usually done alone, but sketches and other outcomes are published and shared with the community members to inspire them and invite the interested ones to join the development work. At the phase of ‘deep thinking’, ideas and thoughts are mixed to conceive an own creation ‘with own ingredients’. In the ‘extracting’ phase, excess is removed, and only an essential is left. The concluding design is revealed in the ‘showing’ phase. The purpose of the ‘showing’ is to gain, for example, more contributions to and knowledge of on-going projects. The acts can be intertwined; the phases can take place simultaneously or be repeated several times. The designer can see his design as ‘a good virus’ which reflects the ideology and values of spreading a change for the common good of the open design community. Acts of sharing create a link between designs of an individual community member and the open design community. The acts of sharing can also be an opportunity for further development of artefacts as the designer receives comments and ideas for his designs. The acts of sharing are voluntary so only members interested in the topic participate in the design endeavours.
The four phases can be seen as an example of the ways of working in the open design community. The phases can be in constant evolution, and designers can make illustrations, for example they can draw pictures, of a specific iteration phase when needed. One of the insights of the interviews was that designers in the open design community employ similar ways of working as open software developers without knowing it until it is pointed out to them. The quality and variety of designs shared in global platforms, such as Thingiverse, varies and therefore the general attitude of the community members is to ‘collect the pearls of what has already been developed’ and make an artefact that fits for an own purpose. If a user, or a prosumer, develops an artefact herself in the open design community, the development and use functions overlap, but there is no guarantee that the finished artefact is reliable and functions according to specifications. One of the informants, a well known designer in the open design field, raised up a concern about the quality of the artefacts; Iteration rounds of testing and improvements decrease the failure rate but the DIY (Do-It-Yourself) users are still responsible for the quality of the artefacts, and they have to rely on their own sense and judgement.

4.2.2 Derived work in the open design community

Design endeavours of the 3D printing community take place at the global level in the shared digital platforms and discussion forums, and sometimes for example in local hacker spaces whereas the design endeavours of the design-oriented local community take place mainly in face-to-face situation in the local community. Derived work refers to derivative designs done and shared in the open design community under a set of Creative Commons licences (Katz, 2011). Based on the results of the case study conducted in the 3D printing open design community, an intrinsic complexity of the ways of working can emerge from the derived work. One of the informants, a designer, described design endeavours in a shared project as ‘we never start from scratch as we are inspired by all the things we see.’ The results indicate that design endeavours can be categorized into four different phases: ideation, opportunity seeking, sketching and sharing of working designs and prototyping (Figure 9). Names of the phases are commonly used terminology in the 3D printing open design community.

7 Creative Commons is a non-profit organization which has written licences to ensure that anyone making use of the work makes also a fair attribution to the author.
The ideation phase can be triggered from an individual’s personal need and an artefact is first created for the designer and after that to a customer. There can be various idea sources, and the ideation process depends on designer’s abilities and ways of thinking. One of the designers described his ideation process as ‘I look at everything as a possible brick that could be used in something else’, and his innovation methods as ‘synthesize all the good ideas I [sic] seen in things around’. In the opportunity seeking phase, the second phase of the derived work, designers discuss interesting topics with each other and a goal for the derived work can be clarified. The opportunity seeking phase corresponds to the ‘filling’ phase presented in the previous chapter as an individual perspective of the design process. Based on the findings, reflections can take place in online asynchronous discussion channels such as Internet Relay Chat (IRC) or other technology-related peer communities. One of the informants described the discussions as ‘the bleeding edge of the development.’ The topics can vary from being design-related issues to different technical perspectives, and from ideation to implementation techniques and development tools. The third phase, the sketching and sharing of working designs can entail exposure of sketches, digital 3D models and related items to the community. There are several platforms where the designs can be shared, and designers’ have own personal preferences. The fourth phase, the prototyping, refers to printing out a three dimensional model of the digital 3D model. A designer can 3D print the model herself, if she owns a 3D printer. The designer can ask another member of the open design community to 3D print the model, or she can go to a local DIY community if there is a 3D printer. There are also commercial 3D printing services available, and the
cost of the printed 3D model depends on for example material and expected delivery time. The term peer-prototyping stems from an activity in which a member of the open design community 3D prints a physical artefact and even tests it (Menichinelli, 2008). Local DIY communities are outcomes of an evolution; the open design community, local hacker spaces and 3D printing have a common history, and the development of low-cost 3D printers started in hacker spaces.

Based on the findings in the 3D printing open design community, derived work can be seen to utilize previous inventions and models for the shared development of new artefacts. The phases do not have to be consequential or predictable but they can take place simultaneously and iteratively. The development of designed artefacts can happen fast in the 3D printing open design community, because many community members from all over the world can be involved in the same shared project, and the project can be finished in a short period of time.

### 4.2.3 Models of the ways of working in the open design community

A community member can see her way of working in the community from an individual perspective as the act of sharing model, whereas the community perspective to the operations can be seen as the derived work model. The models can be seen as different perspectives to the similar way of working in the open design community; they describe how derivative designs are developed and shared. The four phases of the acts of sharing model, ‘filling’, ‘deep thinking’, ‘extracting’ and ‘showing’, can have counterparts in the derived work model with ideation, opportunity seeking, sketching and sharing of working designs and prototyping (Table 7). The dynamic phases of the models are not sequential but can happen simultaneously or be repeated several times.

**Table 7. The ways of working in the open design community from the perspectives of an individual and a community.**

<table>
<thead>
<tr>
<th>Phases</th>
<th>Acts of sharing: individual perspective</th>
<th>Derived work: community perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>I phase</td>
<td>Filling</td>
<td>Ideation</td>
</tr>
<tr>
<td>II phase</td>
<td>Deep thinking</td>
<td>Opportunity seeking</td>
</tr>
<tr>
<td>III phase</td>
<td>Extracting</td>
<td>Sketching and sharing of working designs</td>
</tr>
<tr>
<td>IV phase</td>
<td>Showing</td>
<td>Prototyping</td>
</tr>
</tbody>
</table>

### 4.2.4 Ways of working in the local design-oriented community

The ways of working were also studied in the design-oriented local community. The focus of the interviews and the workshops in the design-oriented local community was in collaborative design endeavours of the community members. Based on the findings, designerly ways of working are embedded in design endeavours of the design-oriented local community as majority of the community members have design-oriented education or their work has been inclined towards design thinking for years. Sharing of sketches, knowledge and resources for the development and production can also happen in the local community. The findings indicate that the sharing takes place primarily in collaborative projects, which have a common goal and an agreed schedule. On the other hand,
the wildest thinking takes often place in unofficial meetings for example in the local pub and the most unexpected coincidents of finding a synergy between needs of a person and offering of another person can happen in an isle of the local groceries store. The ways of working for reaching high quality artefacts differs in these two design-oriented communities; Members of the 3D printing open design community aim to high quality artefacts through iteration rounds, own usage of 3D printed artefacts as well as trial and error type of approach whereas each member of the design-oriented local community is responsible for producing high quality artefacts in collaborative projects.

4.2.5 Collaboration in design-oriented communities

Collaborative ways of working and practices was the research focus in the design-oriented local community. Findings, based on analysed data from the workshops and the semi-structured interviews, advocate for an enhancement to Fraser’s (2007, 2009) business design model due to the complex environment the multiple small yet independent organizations entail. The enhanced business design model was developed while the community members developed a future scenario of the local community, employed a business model canvas of Osterwalder and Pigneur (2009) and created a concept to support the shared business activities. Fraser’s model, introduced in the chapter 2.3 Business design modelling, includes three elements: user understanding, concept visualization and strategic business design. The original model could be complemented with three additions, a holistic user understanding, collaboration and values, to correspond with the elements in a shared development activity of the design-oriented local community. (Figure 10).

Filling in the business model canvas (Osterwalder and Pigneur, 2009) and creation of concepts based on common understanding turned out to be very challenging in the workshops. For example, definition of a customer and understanding of her needs and desires was done in nearly as many ways as there were participants in the workshop. Therefore, a holistic user understanding is a complicated but essential element in the development of shared strategies, concepts, artefacts and solutions due to numerous organizations involved in the work. Each organization has own perspective to their customers’ needs although a particular customer could even be the same for all the organizations. The holistic user understanding constitutes perspectives of multiple companies, and the created customer experience is a sum of efforts done by all involved parties. Based on the discussions in the workshops and experiences of the local community members, creation of a sustainable customer experience requires creation of a positive memory trail to ensure recollection of the perceived experience. Collaboration was recognized as another important element in the development work for two reasons. First, collaboration is essential in the ideation and design phases of novel artefacts and solutions. Second, due to a lack of resources and a small size of organizations, collaboration becomes a necessary way of working. Fraser’s (2007, 2009) original business design model includes user understanding and concept visualization, which also require close collaboration of all in-
volved parties. An evidence of the well working collaboration in the design-orien-
ted local community is the existence of various projects and bees of the com-
munity. The third element, values, emerged from collaborative and social inter-
actions in the design-oriented local community. Shared values, such as quality,
trust, sustainability and local manufacturing, can produce successful outcomes
and consequently willingness to collaborate again. In the case of design-orien-
ted local community, the values turned out to be fundamental elements on
which the collaboration stands, and which can enable creation of innovative sol-
lutions. It is noteworthy that monetary values were not the identified as the
most important values although the role of money as an enabler and a source
for necessary food and shelter was apparent.

Based on the findings in the 3D printing open design community, collabora-
tion appears to be a fundamental way of working but it appears to have a more
ambiguous nature than in the design-oriented local community. Often anony-
mous members of the 3D printing community participate in shared projects if
they find them interesting enough but they do not commit themselves to the
projects as deeply as in the design-oriented local community. Collaboration in
the design-oriented local community includes more face-to-face interactions,
and people in the shared projects know other project participants. Local com-
munity members are usually also aware of the purpose, schedule and goal of the
project.

Based on the findings of the case studies of the 3D printing open design com-
munity and the local design-oriented local community, shared values seem to
be a driving force behind the collaborative activities. Based on the conducted
interviews, the value of money is recognized in both communities, but it is not
seen as the most essential motivator for the work. The findings also imply that
an enhanced business design model could be used in the 3D printing open de-
sign community in a similar manner as in the design-oriented local community
to boost the market and customer experience value for the members of the open
design community.
4.3 **Affordances in collaborative design situations**

Affordances, opportunities for action (Gibson, 1986; Pols, 2012), and themes that enable and support perception of affordances in collaborative design situations emerged when analyzing data of the semi-structured interviews and the workshops conducted in the design-oriented local community. Publication 4, ‘Fiskars Village: Exploring Possibilities for Collaboration in a Design-Oriented Community’ by Tamminen presents the conducted study and related findings.

### 4.3.1 Perception of affordances at the community level in the design-oriented local community

Data analysis conducted at the community level focused on themes that enable and support perception of affordances in collaborative design situations. The following four themes, obtained as second-order concepts (Pratt, 2008) in the data analysis phase, enable and support design-oriented collaboration at the community level.

1. **Community thinking**

   The shared values, such as trust, sustainability, high quality of the work and local manufacturing, can create a strong bond between members of the local community. The shared practices were found to be based on volunteer activities where bees, social encounters and discussions are normal ways to accomplish or produce a shared artefact such as a forest park, a unique artefact done in collaboration with several parties or a long-term solution such as a continuing education for artisans and crafts teachers. The community thinking appeared to be dynamic and open, also people outside of the local community were welcome to bring in new ideas. Additionally, the community thinking appeared to evolve in conjunction with discussions and activities.

2. **Innovative identity**

   The community members were found to be proud of their continuous ability to innovate. Ideas could be created, rallied and advanced further wherever two or more persons met and discussed the development of any issue at hand. Creativity, spontaneity and a positive drive were present in the discussions. The most promising ideas were piloted and eventually put into production. The respect for competences, skills and working methods as well as the networked nature of stakeholders were taken in use to benefit all involved parties. The community members wanted stay innovative so there was no time to step back and not innovate.

3. **Entrepreneurial mind set**

   Entrepreneurial mentality appeared to dominate everyday activities on the design-oriented local community. The mentality consisted of attributes like proactiveness, accountability and persistency, and community members’ acknowledgement of the importance of their own role in earning enough money to pay the bills. The innovative atmosphere could create possibilities but it could also bring on challenges, which were tackled with unique solutions and high quality work.

4. **Recognition of the complexity of a holistic customer experience**
Small organizations within a local community were found to be aware of the fact that they could not comprehend nor fulfil all the needs of a customer alone. Community members seemed to share a common understanding that creation of a positive customer experience and recollection of their offerings required collaboration between all parties.

4.3.2 Perception of affordances at the individual level in the design-oriented local community

Data analysis done at the individual level focused on community members’ affordances. The progress and outcomes of the workshops were touched on in the interviews so there is a linkage between the data from the workshops and the data from the interviews. Therefore, the affordances identified at the individual level are connected with the themes supporting perception of affordances at the community level. The following three themes, obtained as second-order concepts (Pratt, 2008) in the data analysis phase support perception of affordances in collaborative design situations at individual level in the design-oriented local community.

1. Autonomy
Freedom to explore new and controversial ideas and to make independent decisions related to the time, space and ways of working, democracy and fairness appears to be significant factors which impact community members’ capability to collaborate.

2. Deliberateness
Scarcce resources and frugality can be characteristics of small organizations hence deliberateness of own work and understanding of its impact can be utmost important. Based on the findings, money is needed for basic survival but it does not provide a deeper meaning for work.

3. Contradictions
Contradictions can generate ideas and discussions, and collaboration can create better solutions. When expertise from diversified areas is combined constructively, solutions beyond expectations can be created.

Based on the findings, the individual perspective to affordances is more concretely inclined towards action. It also appears to be executable with a smaller scope. A community level perspective to affordances seems to have a wider scope and be more strategic as more individual realms are included in the community scope.

4.3.3 Affordances in the open design community

Based on the findings, descriptions of the sharing activities at the individual level and the derived work at the community level touch on affordances and perception of them. The results indicate that the ‘filling’ phase at the individual level and the ‘opportunity seeking’ phase at the community level could be considered as perception of affordances. In other phases, the acts of sharing and derived work models, the ‘showing’ phase at the individual level and the ‘sketching and sharing working designs’ phase at the community level, ideas, thoughts
and comments from the other community members are mixed in order to create something new. These two phases could be compared with one of the themes, recognition of the complexity of a holistic customer experience, which appears to enable and support collaboration at the community level in the design-oriented local community. Members in the open design community can be aware of their design limitations; they show their sketches and working designs to other members of the community in the hope of being able to develop better designs. Additionally, derived work taking place in the open design community is usually based on autonomy and deliberateness, because participation in shared projects is voluntary and a new shared project is usually initiated by an encountered problem, which can be personal or customer-originated. Autonomy and deliberateness were found to support perception of affordances at the individual level in the design-oriented local community.

4.4 Intuition in design situations

Publication 5 by Tonetto and Tamminen is a conceptual study about designers’ ability to use intuition when designing for experiences. According to earlier conducted research on intuition (e.g. Sadler-Smith and Shefy, 2004; Raami, 2015), designing, decision-making and judgement are cognitive processes, although individuals are not always aware of all aspects involved in these activities. All actions are not based on rational thinking since human minds have limitations, there can be sparse of information or a limited access to it. Due to ambiguous and uncertain situations, which designers usually face, they are forced to be intuitive and make decisions partially based on their affective responses to the problems. Intuition can be an automatic and personal way of processing information but it is not opposite of rationality. Emotion can even help people to make better decisions. Classifications of design expertise (Lawson 2004; Lawson and Dorst, 2013) describes how skills of a novice designer develop gradually from a layman to a novice designer, to an expert designer and finally to a visionary. The classification suggest that expert designers can handle new design situations with little or no analysis because they use their knowledge, ability to recognize precedents and patterns stored in their memories. The implicit recognition of design situations indicates use of intuition. Based on the classifications (ibid.), the more a novice designer encounters new design situations, the more her ability to see patterns increases.

Although data related to the use of intuition were not explicitly collected in the design-oriented communities, the use of intuition was mentioned in the semi-structured interviews of the 3D printing open design community and the design-oriented local community. Findings in the design-oriented local community indicate that the use of intuition seemed to be very personal as it was only mentioned in the interviews but not in the workshops even though intuiting could have been mentioned there. Based on the findings, it seems that master designers have developed their personal ways to recognize own, genuine intuition, but they can also distinguish intuition from for example wishful thinking or expectations. Findings of the data also indicate that intuition was used in two
ways in design situations: to find a suitable collaboration partner and to make
decisions related to working designs.

4.5 Communities of practice (CoP) and communities of interest (CoI) in the open design community

Communities of practice (CoPs) are formed around shared practices (e.g. Wenger, 1998; Reckwitz, 2002; Hielscher, 2008; Neufeld et al, 2012), and communities of interest (CoIs) are formed around shared interests (e.g. Fischer, 2001; West and Lakhani, 2001). An existence of CoPs and CoIs was identified while analyzing the data of the 3D printing open design community. Based on the findings, the boundary between CoPs and CoIs is not clear, the same persons can be active in both groups. The entire global 3D printing community can be regarded as a CoP because the common interest and shared focus lies around the 3D printing technology and related matters. In addition, local DIY communities, i.e. hacker and maker spaces, can be regarded as CoPs with their own ways of working and practices. Based on the findings, CoIs can be formed around a certain aim or for a specific project at the global and local levels. Dissemination of knowledge and successful working practices takes place both locally and globally. Knowledge can be shared in local DIY communities but as soon as the knowledge is published in the digital discussion forums and working platforms, it becomes global.

Based on the findings of the interviews, there were many on-going projects in different phases in the 3D printing open design community. The projects can have several inputs from the community members. Outcomes of the projects as well as project team members can vary. The outcomes can be seen as possibility-driven spins in the open design community. The collaborative actions can be called possibility-driven spins which indicate fast turns in the practices of the community as the community members seize an opportunity to create an interesting or required design. The development of artefacts is done through collaboration and iteration; existing models are shared with the community members and anybody interested in a particular artefact is allowed to contribute to the project.

The aims of the shared projects are presented in Figure 11. Based on the findings, the designs developed in the projects can be used for personal purposes, term ‘personal use’ in the Figure 11, and not shared with the community as artefacts intended for personal use do not need to be shared. On the other hand, if the designed model pleases its designer, she can share it with the community, add her name to the artefacts’ license and get the recognition of the community. The aim is illustrated with the term ‘shared with community’ in the Figure 11. Additionally, a design can be ‘hijacked’ as a fork, in which case part of the development team, or a third party outside of the development project, starts an independent development of the source code of the design. A fork originates from software development and refers to an incident in a software system when a process generates a copy of itself (Robles and González-Barahona, 2012).
Forks for commercial purposes can cause philosophical conflicts in the community due to possible abuse of designs and lack of respect of the commons licenses under which the designs are usually developed. However, forks can also develop the whole community by disseminating knowledge and offering new opportunities to the community members. The commercial aims are illustrated in the Figure 11 with the term ‘a commercial artefact’.

Figure 11. Illustration of various possibility-driven spins existing in the open design community (Tamminen and Moilanen, 2016). A term spin indicates fast turns in the community practices.

4.6 Communities of practice and communities of interest in the design-oriented local community

Based on the findings, the design-oriented local community consists of several CoPs and CoIs. Based on the results, all community members belong to at least one CoP and active individuals can belong to several CoPs. The CoPs can be formed for example around certain occupations such as goldsmiths, artisans and service designers. Shared interests or constraints as well as common goals can constitute CoIs; conducted ten workshops of this study formed a CoI around a shared interest, the prosperity of the local community. CoPs and CoIs appear to be relatively small and their members are well connected with each other. CoPs appear to be more stable and slower to evolve in changes than CoIs. On the other hand, CoIs appear to be more spontaneous than CoPs as the members can easily foster for example wild thinking. Voluntary-based collaboration, bees and shared practices are part of people’s everyday life in the design-oriented local community.

Based on the findings, ways of working and practices of the design-oriented local community are spontaneous and dynamic. The global dimension of the design-oriented local community does not have as large impact as in the 3D printing open design community although active members of the design-oriented local community have vast international networks. Lack of information related to local events, resources and knowledge about their competences were raised up as challenges in the workshops. Although members of the design-oriented local
community can be interested in for example digitalization and high end technology, based on the results it seems that they appreciate local manufacturing and do not necessarily expand their ways of working to the global level.

### 4.7 Summary

A summary of the results is presented in Table 8. The findings are categorized according to the case studies, the open design community, which is viewed through the lens of the 3D printing open design community, and the design-oriented local community. In addition, the findings are categorized according to the level of analysis, i.e. individual level and community level. Based on the findings, drivers that encourage community members to participate in community activities at the individual level can be personal aspirations, such as shared values, esteem to oneself and the other members of the community, and DIY philosophy. The aspirations are connected to the community which can have an impact on the weight and emphasis of the aspirations. Drivers that encourage community members to participate in the community activities at the community level could be motivational; having fun and learning of new skills were found to be the strongest motivators for the members of the 3D printing open design community to participate in the shared projects. Possibilities to help others and express oneself in the 3D printing open design community were also found significant.

The acts of sharing model was found to describe the ways of working in the 3D printing open design community at the individual level. Counterparty for the individual level model of acts of sharing was found to be the derived work model at the community level. Due to the design, art and craftsmanship-oriented history of the local community, its ways of working are design-oriented. An enhancement to Fraser’s (2007, 2009) business design model was developed to serve the business needs of organizations in the design-oriented communities.

Affordances, opportunities for action (Gibson, 1986; Pols, 2012), were studied mainly in the design-oriented local community. Affordances supporting collaborative activities emerged at the individual level, and themes that enable individuals to perceive affordances emerged at the community level. Affordances were not studied in the 3D printing open design community but some elements of the used ways of working could be recognized to have similar characteristics at the individual and community levels as the affordances and themes enabling perception of affordances found in the design-oriented local community.

This study focused more on the conceptual study of the intuition because publication 5, written by Tonetto and Tamminen, is a conceptual study. However, when analyzing the data from the case studies, intuition and the use of intuition emerged. They were mentioned in the interviews of both the 3D printing open design community members and the design-oriented local community members. Based on the findings, the use of intuition seems to be a natural part of community members’ design processes. In addition, intuition was used in two ways in design situations: to find a suitable collaboration partner and to make decisions related to working designs.
Being a member in CoPs and CoIs can encourage participation in activities in both the 3D printing open design community and the design-oriented local community. Elements, such as shared interest and constraints as well as together agreed goals, seemed to encourage participation in community activities, and made the collaboration more efficient especially in CoIs.

Table 8. Consolidation of the findings of the field research in the open design and local design-oriented communities from the perspectives of an individual and a community.

<table>
<thead>
<tr>
<th>Response to research question</th>
<th>Open design community</th>
<th>Design-oriented local community</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Individual</td>
<td>Community</td>
</tr>
<tr>
<td>Drivers that encourage participation in community activities</td>
<td>Networked personal aspirations</td>
<td>Motivational factors CoPs CoIs</td>
</tr>
<tr>
<td>Ways of working in design-oriented communities</td>
<td>Acts of sharing model</td>
<td>Derived work model</td>
</tr>
<tr>
<td>Affordances in collaboration</td>
<td>Affordance supporting elements in used ways of working</td>
<td>Affordance supporting elements and themes in used ways of working</td>
</tr>
<tr>
<td>Intuition in design situations</td>
<td>Community members find the use of intuition natural</td>
<td>Community members find the use of intuition natural Intuition used to find a suitable partner and to make decisions in working designs</td>
</tr>
</tbody>
</table>
5. Discussion

The aim of this study is to widen and deepen our understanding of the possibility-driven design. The focus of this study is on the ways of working and practices in the design-oriented communities. The possibility-driven design has been studied earlier from the perspectives of subjective well-being, positive design and meaningful positive experiences (Desmet and Hassenzahl, 2012; Hassenzahl et. al, 2013; Jimenez et. al, 2014).

In this study, the possibility-driven design is examined through the conceptual framework of human-centred design, business design modelling, open design, affordances theory and intuition. In this section, the research results are discussed based on the main research question and four sub-questions, which were set to study the concept of possibility-driven design.

5.1 Theoretical contributions

5.1.1 Possibility-driven design as an emerging field of research

Possibility-driven design is an emerging field of research which was introduced to the design research area for less than five years ago. Fraser's business design model (2007, 2009) and Giacomin’s human-centred design model (2014) referred to in this study have not been discussed through the lens of possibility-driven design before. The connection of Fraser’s business design model and possibility-driven design in design-oriented community contexts are discussed, and a modification to Fraser’s business design model is proposed to meet better the needs of several independent organizations of design-oriented communities which share the same goal. According to Fraser (2007, 2009), the business design model is an interactive symbiosis of organizations, and it transfers value of both market and customer experience. Fraser’s model includes three gears, user understanding, concept visualization and strategic business design. This study proposes three additions to the model. First, multiple independent organizations bring more complexity into the user understanding hence the user understanding has to be seen in a more holistic way by taking into account different perspectives of diverse organizations. Second, collaboration between multiple parties is an essential factor to reach shared goals. Third, values, such as trust and sustainability, can produce successful outcomes of the collaborative activities and consequently willingness to work together again. The importance of iteration rounds between the involved parties is emphasized in Fraser’s model,
but it does not take into account the significance of collaboration and values. From the perspective of possibility-driven design and based on the findings of this study, their importance is obvious when building sustainable designs with long-term goals.

This study approaches Giacomin’s (2014) human-centred model with a new perspective; Giacomin focuses on end-users and understanding of their needs and experiences by framing their intended use of artefacts, whereas this study views the human-centred model through different ways of working and practices, which include design thinking and engineering design thinking. A designer starts off with the questions why while working with the meaning-making of the situation. An engineer begins with the question what while defining and evaluating e.g. numerical facts of the situation. Possibility-drive design does not contradict with Giacomin’s human-centred model but enriches it by bringing in a novel perspective to use it.

5.1.1 Drivers that encourage community members to participate in design activities of the community

The development of artefacts through collaboration and iteration is a natural way of working for designers, both in the virtual platforms and forums and in the face-to-face circumstances (Dorst, 2015). Based on the findings of this study, personal aspirations can encourage members of the design-oriented communities to participate in community activities. The personal aspirations can provide a purpose for the participation; they can increase members’ self-esteem and respect for the other community members as well as fulfil the situational needs. This finding can be aligned with the positive design framework of Desmet and Pohlmeyer (2013). The framework consists of three components: design for virtue, design for pleasure and design for personal significance and subjective well-being (Jimenez et al., 2014; Desmet, 2013; Desmet and Pohlmeyer, 2013). Based on the findings of the web survey, the most significant factors that drive participation in community activities are to have fun and learn new skills. Having fun can be regarded as an element of design for pleasure in the positive design framework (Desmet and Pohlmeyer, 2013). In addition, learning new skills can be personally significant to the participating person. Participation in collaborative projects can be justified with a willingness to share own knowledge and skills with others, and because it was perceived as a way to express oneself. Both of these activities can be seen as virtues of the positive design framework (Desmet and Pohlmeyer, 2013). Additionally, sharing of own knowledge and skills with others and expressing oneself can also increase feelings of personal significance and pleasure.

Participation in community activities was found to consist of intentional actions and practices people choose voluntarily to be engaged in. The autonomic and democratic ways of working can enhance subjective well-being and happiness (Lyubomirsky et al., 2005; Ryan and Deci, 2000, 2006). Based on the findings, money was not found to be among the main drivers to encourage participation in community activities although its role as an enabler to cope with everyday needs, such as food and shelter, was undeniable. Based on the findings,
community members accept forking, an independent development work related to a source code of the artefact done by a development team or a third party, for commercial purposes as long as it is done transparently. Acceptance of commercial outbursts of open source projects is also a finding of a research done by O’Mahony and Bechky (2008). Positive experiences related to collaboration can also create positive recollections in participants’ minds which in turn can make them participate in other collaborative activities. Enthusiasm of inspired individuals can breed personal well-being and consequently social welfare in the community (Wenger et al, 2002; Henkel and von Hippel, 2005).

Drivers that encourage participation in community activities of the design-oriented communities are presented in publication 1 and 4, written by Tamminen, in the context of the design-oriented local community, and in publication 2, written by Tamminen and Moilanen, in the context of the open design community.

5.1.2 Ways of working and practices in the design-oriented communities

The findings of the case study conducted in the 3D printing open design community indicate that the nature of the ways of working and practices in the open design community is disruptive as suggested by van der Beek (2012). The intrinsic complexity of the used ways of working stem from many on-going projects in different phases, new inputs, several outcomes and changing roles of project participants. Participation is voluntary, and community members can have multiple purposes why to participate in a project. The amount and variety of designs shared in open, digital platforms is very large; therefore, community members have a possibility to choose projects they prefer to work in, and anybody interested in a particular design is allowed to contribute to the project.

The ways of working and practices in the open design community (Figure 9) resemble a design thinking process (Figure 4), which contains observation, collaboration, visualization of ideas, fast learning, prototyping and concurrent business analysis (Brown, 2009). In addition, the ways of working combine engineering design thinking and design thinking at the practical level; users produce the artefacts themselves based on needs or desired outcomes (Toffler, 1980; von Busch, 2012). The ways of working and practices can also be viewed through human-centred design, which ‘enables many individual or cultural conceptions to unfold into uninterrupted interfaces with technology’ (Krippendorff, 2004, p.48). Human-centred design focuses on questions, insights and activities of people for whom the artefact is intended, not in designer’s creative process or applied technology and material (Giacomin, 2014). The democratic and open character of the open design community blurs the definition of a designer; there is no clear distinction between a master and a novice designer, a phenomenon discussed also by Toffler (1980), Atkinson (2010, 2011) and Stikker (2011). With unconventional ways of working and practices, there is potential for disruptive design because open design perceives changes as new possibilities (Stikker, 2011).
In this study, Fraser’s (2007, 2009) business design model was enhanced to serve multiple parties of design-oriented communities who share the same target group of customers. The development of meaningful impact in users’, or customers’, lives both functionally and emotionally is challenging in projects with multiple independent parties, because the information needed to understand user needs thoroughly can be almost entirely latent or unspoken (Utterback et al., 2006). The aim of the business design model for design-oriented communities is to commit all involved parties to a long-term, win-win solution which can bring in notable benefits. The original elements of the model, user understanding, concept visualization and strategic business design, are vital, but the more clearly defined element, a holistic user understanding, and the new elements, values and collaboration, can enable a more versatile use of the business design model. Due to multiple parties, a user understanding needs to be holistic because the small companies and organizations can have different perspectives to users, for example a goldsmith understands a user differently from a joiner or a furniture manufacturer. In addition to the holistic user understanding, values and collaboration support the use of the model in multiple party contexts. A common goal and smooth transfer of knowledge can be achieved through collaboration and shared values, which are also essential when creating a holistic user understanding.

Based on the findings, knowledge, shared practices and business processes can be transferred effectively in design-oriented communities when carried in person in goal-oriented interactions and ad-hoc discussions. Due to physical closeness and lack of special resources, the organizations of the local community find other organizations of the community potential sources for the needed knowledge and skills (Boutilier and McNaughton, 2006). The findings are also in line with the statements of Utterback et al. (2006) and Sirkin (2011); companies in close proximity to one another benefit most of the flow of tacit and rapidly changing knowledge needed in the creative processes. The strength of locality and physical proximity were found to be noticeable in the immersion of the design activities of the design-oriented local community although the digital networks can enable fast communication and dissemination of trivial information. As Lawson (2004) suggests, experienced designers can be unconsciously aware of the knowledge their colleagues in the design-oriented community possess and therefore communication and sharing of own ideas with a few meaningful words and sketches can be easier and faster.

Based on the findings, the clearest difference between the open design community and the design-oriented local community is the global and local trait of them. The global characteristic of the open design community is reflected in for example communication channels; discussions take place often in digital platforms, such as Thingiverse and IRCnet chat. Members of the design-oriented local community prefer to use face-to-face communication in design situations. Another difference between the two communities is the quality of artefacts. Good enough quality is reached in the open design community through prototyping, iteration rounds and usage, but the main responsibility lies with the user
of the artefact, whereas production of high quality artefacts can be seen as a virtue for the members of the design-oriented local community.

The ways of working and practices in the open design community are presented in publication 2 written by Tamminen and Moilanen, and in the design-oriented local community in publication 1 and 4, written by Tamminen.

5.1.3 Affordances in collaborative design situations

Affordances are intrinsic properties of the environment relative to an actor, i.e. features of the environment directly contribute to particular behaviours or outcomes (Gibson, 1966). Design situation includes all available information of the environment and the past design activities of the designer (Taura et al., 2002). Affordances theory, based on opportunities for action (Gibson, 1986; Pols, 2012), is one of the ways to understand designers’ ability to perceive tacit clues in the environment and blend them with explicit knowledge in order to find possibilities for solutions that fulfil, or even exceed, customer or stakeholder needs. This study identified affordances in design situations and proposes three themes, autonomy, deliberateness and contradictions, which encourage and support individuals’ perception of affordances in the design-oriented local community. In addition, the study proposes four themes, community thinking, innovative identity, entrepreneurial mind set and recognition of the complexity of holistic customer experiences, which encourage and support perception of affordances at the local community level, when people interact with each other. The themes can provide a shared mind set and enable collaboration by adapting to local needs and constraints, and maintaining a common identity in the communities (Fischer, 2001; Fischer, 2004).

The results indicate that there is a complicated relationship between affordances and individuals’ ability to perceive them. Affordances act as ‘messengers of meanings’ to those affected by them (Krippendorff, 2005), but designers commit to their work in various ways and produce diversified designs even with the same brief (Gero and Kannengiesser, 2012). Perceptions of affordances are closely connected with designers’ everyday activities and interactions when for example ideation, design building and manipulation happen in non-verbal and verbal forms (Sirkin, 2011). Based on the findings, physical proximity allows ad-hoc interactions to take place on spurs-of-a-moment. Additionally, the themes that support perceptions of affordances are more abstract at the community level than at the individual level although both levels are tightly coupled together. The findings indicate that an individual devotion to design meaningful artefacts and solutions can be easier if for example shared values are clear and innovative identity is promoted in the community.

The affordances and the perception of affordances in design situations are presented in publication 4, written by Tamminen, in the context of the design-oriented local community. The publication 2, written by Tamminen and Moilanen, touches on affordances in the context of the open design community although the affordances were not part of the research design of the case study of the 3D printing open design community.
5.1.4 Role of intuition in design endeavours

Simon (1996) refers to intuition as an act of recognition, which stems from individual’s personal self-knowledge and ability to perceive and discern an own intuition (Surel, 2007; Raami et al., 2008; Raami, 2015). If design is understood as a sense creating activity, it can indicate that perception, experience and appearance are the fundamental concerns of design (Krippendorff, 2005). The use of intuition is a natural practice of master designers (Lawson, 2004; Lawson and Dorst, 2013), and the use of intuition was brought up in interviews in both the open design community and the design-oriented local community contexts. Based on the findings, it seems that master designers have developed their personal ways to recognize own, genuine intuition, so they can also distinguish intuition from for example wishful thinking or expectations. In addition, intuition was used in two different ways in design situations: to find a suitable collaboration partner and to make decisions related to working designs. Based on observation and field notes, intuition was not mentioned in the conducted workshops in the design-oriented local community although free ideation was one of the methods used in the workshop. The atmosphere in the workshops was friendly, open-minded and trusting, which can indicate that the use of intuition is perceived very personal.

Design-oriented communities can offer an inspiring environment where wild ideation and novel practices are welcome. Building on several researchers’ (Simon, 1996; Lawson, 2004; Surel, 2007; Raami et al., 2008; Lawson and Dorst, 2013; Raami, 2015) description of intuition, the use of intuition can be seen to be related to perception of affordances, which are opportunities for action that an individual is able to pick up in the environment (Gibson, 1986; Pols, 2012). Therefore, intuition and affordances can offer possibilities to find solutions to challenging design situations, but perception of an affordance involves an external component either from the environment or from an artefact while an intuition is an internal and personal process of a designer.

Designers have to make decisions while designing artefacts and that entails complex cognitive processing (Plous, 1993; Tversky and Kahneman, 1981). Both designing and use of intuition are skills that can be learned (Kahneman, 2003; Shefy and Sadler-Smith, 2004; Kautz, 2005; Peirce, 2013; Surel, 2012; Raami, 2015). The design-oriented communities can also offer an environment where the use of intuition can be practiced and learned. According to Shefy and Sadler-Smith (2004) and Raami (2015), proper feedback promotes learning of the ability to use intuition. Learning can be seen as a process of separating patterns in the environment rather than supplementing sensory information which reflects past experiences (McCrenere and Ho, 2000).

The role of intuition in design situations is presented in publication 5, written by Tonetto and Tamminen. The publication contributes to the discussion of the use of intuition in design situations merely from the conceptual perspectives, and suggests that the use of intentional intuiting is a skill that can be learned.
5.1.5 Constitution of possibility-driven design

The possibility-driven design stems from designers’ mind set of finding unforeseen solutions (Desmet and Hassenzahl, 2012). It can be regarded as an open-minded approach to find positive, yet unconventional, solutions to everyday challenges. A connection between the possibility-driven design and the design-inspired innovation, which emphasizes the integration of design to knowledge about user needs, technological opportunities and product language (Utterback et al., 2006), can be found; both notions focus on design and innovative thinking. Based on the findings of this study, the possibility-driven design contains voluntary activities and seemingly random seizing of opportunities to improve a situation for the better without necessarily having a problem, whereas the design-inspired innovation is more structured approach to novel innovations with integrations to design of knowledge (ibid.).

Collaboration as well as contradictions can enhance the development; von Busch (2012) points out that friction in the open design community can be a key motivation for engagement and also necessary for gaining insights and solving problems. The 3D printed artefacts can be regarded to link science based engineering design thinking with design thinking originating from creation of meaning and fit-for-purpose artefacts. Human-centredness can be achieved by shifting attention from assuring that artefacts work as intended to enabling individuals to expand their perception, interaction and use of the artefacts (Krippendorff, 2004).

This study suggests that the concept of the possibility-driven design can be enriched with perspectives gained in the design-oriented communities from individual and community perspectives. The acts of sharing model from the individual perspective and the derived work model from the community perspective widen our understanding of the ways of working and practices in the open design community. These models are developed through synergy; the final designs comprise strengths and diminish or neutralize weaknesses of the competences of engineers and designers of the open design community for only the best designs continue to exist. Artefacts developed in collaboration have to be interesting and good enough to ‘survive’ among tens or hundreds of other competing projects in the global open design community. According to Avital (2011), emerging companies based on open design business models are likely to change the old model of industrial production.

Based on the findings, design-oriented communities can see challenges as possibilities and shift them into meaningful goals rather than constrained problems. Communities of interest (CoIs) of the design-oriented communities, formed temporarily around a certain interest, can be pioneers of unconventional practices which can lead to innovative artefacts. The CoIs can brainstorm wildly, try out various alternatives, and based on own experiences and feedback, end up with the most suitable solution. The members of the CoI are engaged in reaching the common goal, which can consecutively contribute to the success of the involved organizations and enhances knowledge transfer (Wenger et al.; 2002). Based on the findings, communities of practice (CoPs), being slow in
adapting to changes (Norman, 1999), follow the footsteps of CoIs, and once an appropriate practice or solution is found, adopt it slowly but steadily. This study presents affordances, opportunities to action (Gibson, 1986; Pols, 2012), which can provide deeper meanings for collaborative actions in design situations. In addition, themes that support perception of affordances in the design-oriented communities can enhance recognition of potential opportunities to developed appropriate artefacts and solutions. The findings of this study corroborate with Desmet’s (2013) statement of the omnipotence characteristic of design; design can facilitate activities, inspire people to find out who they are and can be, and how they can be meaningful to others.

5.2 Practical implications

Design is a commercial and social imperative and its management is an integral part of what can make organizations successful and effective and societies better and more enjoyable for everyone (Turner, 2013). Since markets and customers generate demand which are potential sources for organizations’ revenues, it is vital to understand strategic possibilities of the organizations based on their realistic capabilities. This study develops Fraser’s (2007, 2009) business design model to suit better for the design-oriented communities. The proposed enhancement to the model includes additional elements, which take into account possible constrains, an interactive symbiosis of small and independent organizations and the long-term goals of the collaborative business design. Collaboration is essential for the organizations due to their small size and lack of resources. Based on the conducted workshops in the design-oriented local community, shared values, a holistic user understanding and an iterative process to create a concept visualization can build strategic business design that delivers both market and customer experience value. The findings indicate that the understanding of current and potential strategic possibilities can prepare organizations to be more creative and able to answer to ambiguous demands of the markets, especially when facing the new challenges of digitalization. Described dynamic ways of working of the open design communities could create a competitive advantage if the recognized weaknesses, such as accountability of the produced artefacts and quality of work, can be tackled.

Based on the results, business-oriented thinking is accepted in the open design community although one of the fundamental ideologies can be sharing for the common good of the community. The rationale behind the acceptance appears to be that the business-oriented activities can develop financial successes to entities applying business-oriented thinking, which in turn can have a positive impact to others in the community.

According to the research of Desmet and Hasselzahl (2012), people want to design artefacts, such as a do-it-yourself football made from adhesive tape (Guixe, 2012 cited in Desmet and Hassenzahl, 2012, p.2) because the design activities and their outcomes generate happiness. Designed artefacts and what users can do with them can focus on meaningful goals, which promote subjective well-being (Desmet and Pohlmyer, 2013), and that in turn can generate social
welfare (von Hippel, 2005). In the light of today’s social challenges, these findings can be valuable to policy makers who try to integrate hundreds of thousands of asylum seekers and immigrants into local societies as well as local people being in the fringe of societies. Based on the results, formation of various communities of practice (CoPs) and communities of interest (CoI) can provide opportunities for people to participate in activities that increase their subjective well-being and subsequently increase social welfare for the entire community. A pursuit towards a common goal can be supported by collaboration, definition of shared values, and definition of the purpose of the work and its’ visualization.

Designing is a collaborative and iterative process, and the ways of working in the open design community can support members’ personal and natural ways of working and practices of designing, although they might be very different from each other (Gero and Kannengiesser, 2012; Dorst, 2015). Findings of this study indicate that the design-oriented communities can be seen as testers of new ways of working and practices. The results imply that the division of designers into master and novice designers is diffusing which can impact the practical roles and relationships of designers, and even cause a dismissal of formal design qualifications. Instead, collaboration skills and successful outcomes can speak on behalf of formal education. One of the strengths of the design-oriented communities appears to be master designers’ willingness to help those who produce and consume what they produce themselves (Toffler, 1980). The findings of this study can also be seen as individual attributes and communal elements which can initiate and enable creations of innovation designs.

5.3 Trustworthiness and limitations of this study

There are no flawless studies because all researchers are social creatures and doing research is human, hence weaknesses and limitations of the studies need to be considered (Denvers, 1999; Mantere and Ketokivi, 2013). High-quality field research can be evaluated with a framework of its methodological fit, which consists of internal consistency of research questions, prior work, research design and theoretical contribution of the research (Edmondson and McManus, 2007). One of the weaknesses of this study is the research design: There is scarce research published explicitly on the possibility-driven design in design-oriented communities, and therefore the topic was approached from scientifically more studied perspectives - human-centred design, business design modelling, open design, affordances and intuition. The topic could have been approached from other angles, such as service innovation, entrepreneurship or well-being, and consequently the theoretical contributions would have been different. Identification of research gaps took place in the interceptions of possibility-driven design and the five different research perspectives; human-centred design, business design modelling, open design, affordances theory and intuition.

Qualitative research was the primary research approach because the intent was to understand prevailing ways of working and practices in the relatively unknown design-oriented communities (Yin, 2009). Additionally, web survey with
quantitative data shed light to the drivers behind the open design community members’ willingness to participate in shared design projects.

Evaluation criteria of a constructivist inquiry with interpretivist perspectives are used in this study (Lincoln and Guba 1984 cited in Patton, 2002, p.546). The quality criteria of this study are presented in Table 9. The criteria include four elements: credibility, transferability, dependability, confirmability (Patton, 2002). These criteria can also be addressed with one term, trustworthiness (ibid.). Trustworthiness of the case study related to the open design community was increased with purposeful sampling in two ways; an opportunistic sampling was used first as invitations to participate in the study were sent to participants of an open design competition, and snowball sampling was used to obtain more informants (Arksey and Knight, 1999; Patton, 2002; Pratt, 2009). Purposeful sampling was used in the design-oriented local community (Stake, 2005; Patton, 2002); Representatives from all key stakeholder groups of the local community were included in the case study.

Credibility, an analogue to internal validity, can be defined as quality of causal relationships and correct mapping of findings (Denvers, 1999; Lincoln and Guba 1986 cited in Patton, 2002, p.546; Yin, 2009). Credibility can be ensured by conducting research of good practice, explaining the researcher’s position in the study and presenting findings to the informants to assure the correct understanding (Patton, 2002). Good scientific practices were applied throughout the research by following the instructions of National Advisory Board on Research Ethics (2009) of Finland. The positions and roles of the researchers were made clear in the email invitations to participate in the survey, and in the beginning of workshops and each interview. There was transparency in data collection and data analysis; first, the interviews were recorded and transcribed word by word. Second, confidentiality of the workshops conducted in the design-oriented local community was agreed in the first workshop, and when a new person participated in a workshop, she was first notified of the agreed terms. Third, progress and outcomes of the previous workshop were discussed in the beginning of each session to refresh the memories of the participants and offer a possibility to correct a possible misunderstanding of the previous session. Fourth, right after each workshop, the progress and outcomes of the session were critically reflected by the two researchers who conducted the workshops. The reflections were first done individually and after that together. The data collection took 15 months, which made it possible to fill in gaps and verify ambiguities found during data analysis, and that way verify the findings.

Transferability as a criterion ensures that results can be applicable in other contexts (Patton, 2002). External validity, an analog to transferability, increases with designating boundaries of generalizability of the findings (Lincoln and Guba 1986 cited in Patton, 2002, p.546; Yin, 2009). The data of the design-oriented local community were collected from a Finnish community with over 350 years old history of local manufacturing (Fiskars Village History, 2015). Therefore, it is possible that a different context would have exhibited a different set of ways of working and practices. Generalization of the results can be debatable as the case study has a problem of being highly localized (Patton, 2002). Guba
(1978 cited in Patton, 2002, p. 583) proposes that conclusions should be treated as hypotheses for future applicability and testing, not as definitive answers. An interesting and possibly also debatable notion is the transferability of the findings in the open design community with its ambiguous boundaries. Although interpretivist perspective of research is more interested in deep understanding of a specific case within a particular context (Patton, 2002), can the findings related to ways of working and practices of the open design community be seen externally valid in other open communities, such as an open innovation community, because the open design community does not have clear boundaries? Transferability of the findings related to categorization of affordances and themes that enable and support perceptions of affordances was improved by the used second-order concepting, which infuses data with the theory (Pratt, 2008). The study related to intuition is more inclined towards conceptual research; hence the results can be applicable in other design contexts.

Dependability as a criterion ensures that results are applicable at other times (Patton, 2002). Dependability is an analog to reliability (Lincoln and Guba 1986 cited in Patton, 2002, p. 546). It was improved in the case study of the open design community by conducting two separate data collection and data analysis phases with different research methods. The findings in the open design community include a description of the design methods: the acts of sharing model from an individual perspective and the derived work model from the community perspective. Although both models were subjective descriptions from two different informants, they are compatible. Dependability was also improved in two ways in the design-oriented local community; first, there was an overlap of the data collection and data analysis, and second, it was possible to verify the preliminary results of the data analysis with the informants.

Conformability refers to the possibility that values of the researcher are entangled with research results (Guba and Lincoln, 1994). Conformability can be considered as an analog to objectivity (Lincoln and Guba 1986 cited in Patton, 2002, p. 546). Conformability of the research was improved by researcher’s reflexivity and critical perspective to try to apply good scientific practices (National Advisory Board on Research Ethics, 2009), maintain a high degree of self-awareness throughout the case studies, and employ open-minded thinking in data collection and data analysis phases. Research themes were not the same in the two cases so it was not possible to do a cross-case analysis (Eisenhardt, 1989; Yin, 2009), but the data were first analysed within a case and subsequently a comparison between the cases was done which improves conformability of this study. In addition, members in the open design community and the design-oriented local community gave an impression of being sincere and honest in the interviews and workshops.
Table 9. Quality criteria used in this study (Guba and Lincoln, 1994; Patton, 2002; Yin, 2009).

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<tr>
<th>Criterion</th>
<th>Definition</th>
<th>Used tactics</th>
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<tr>
<td>Credibility</td>
<td>Quality of causal relationships and correct mapping of findings</td>
<td>1. Research of good practice</td>
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<td>2. Transparency in data collection and analysis</td>
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<td>4. Tape recording and transcripts of interviews</td>
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<td>5. Data analysis of the workshops done by two researchers</td>
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<td>6. Manuscript reviews by informants in the design-oriented local community</td>
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<tr>
<td>Transferability</td>
<td>Ensures that results can be applicable in other contexts</td>
<td>1. Transferability of findings to other open communities, e.g. open innovation community.</td>
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<td></td>
<td></td>
<td>2. Use of the second-order concepting which infuses data with theory</td>
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<td>3. Conceptual studies</td>
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<tr>
<td>Dependability</td>
<td>Ensures that results are applicable at other times</td>
<td>1. Two separate data collection and data analysis phases with different research methods applied in the open design community</td>
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<td></td>
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<td>2. Overlap of data collection and data analysis in design-oriented local community</td>
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<tr>
<td>Confirmability</td>
<td>Possibility that values of the researcher are entangled with research results</td>
<td>1. Open-minded thinking in data collection, e.g. interview questions only guided discussions, and data analysis</td>
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<td></td>
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<td>2. Two case studies, first an analysis within a case and after that a comparison between the cases</td>
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<td>3. Reflexivity, understanding how researcher’s own experiences and background affect what she understands and how she acts in the world</td>
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<td>4. Sincere and honest interaction and communication with informants.</td>
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Edmondson and McManus, (2007) have divided the management field research into three categories, nascent, intermediate and mature theories as a continuum. In this study, traits of both nascent and intermediate theories exist and therefore the research questions were open-ended, and the results present new connections with provisional explanations of the possibility-driven design in design-oriented communities. Additionally, new constructs, such as themes supporting perception of affordances, are suggested. For that reason, there are few traits of mature theories with well-developed constructs and models agreed by many scholars in this study (Edmonson and McManus, 2007).

If a study of possibility-driven design in design-oriented communities were to be done again, it would be done somewhat differently. First, based on the collected data in the open design community, DIY (Do-It-Yourself) philosophy and a membership in the 3D printing open community could be seen as the only common characteristics between the informants. It would have been interesting to follow up a few open design projects from the beginning to the end, and study how they evolve, how project participants perceive their own role and roles of others, and why some projects fail while others become successful. Second, data related to the design-oriented local community could have been collected differently. In this study, active community members with a positive and constructive design attitude participated in the workshops and interviews (Boland Jr. and Collopy, 2004). However, data could be been collected also from local community members who did not want to participate in shared activities but wanted to stay in the fringe of the community. Third, quantitative data of the 3D printing open design community were analysed only by counting percentages of the responses in five categories. The data could have been analysed more thoroughly by quantitative methods. Fourth, outcomes of the workshops in the design-oriented local community were grouped, named and prioritized first by the workshop participants because the Opera methods (Slåen and Mantere, 2003) was used to facilitate the workshops. Analyses done by local community members might have biased the outcome because the data were part of their personal and
work life. If only the researchers had analyzed the data, the findings might have been more objective.

5.4 Implication for the future research

As the complexity of artefacts, social situations, global networks and technology increases, the need for design expertise in a range of different sources increases in a similar fashion (Bruce and Morris, 1998; Dorst, 2015). On the other hand, design can be a key contributor to making organizations successful in what they position to do (Turner, 2013). In addition, boundaries between design expertise and amateurs are changing as digital tools and media provide an infrastructure for creating, sharing and transforming information (Atkinson, 2010, 2011; Stikker, 2011; Hummels, 2011). Some of the potential paths to continue research on the possibility-driven design and design research were revealed during this study.

Impact of Internet of Things (IoT) on the possibility-driven design

A connection of physical things to the Internet creates numerous new possibilities; control of the physical world is possible with access to remote sensor data and that can give rise to new synergistic services that go beyond the services of contemporary everyday life. For example, how smart objects and new services connected to the Internet can be developed with the possibility-driven design approach for an aging society?

Impact of the open design on the future

Designers play a salient role in interpreting the requirements of stakeholders into material and immaterial artefacts, and they also have this key role when designing solutions in collaboration with other parties. In the context of open design, anything in digital format can be stored, shared and used by anyone anywhere. That way users can become more than passive consumers, they can be active originators and contributors of their own design. Open design has a potential to change our understanding and perception of design (Kennedy, 2011) and impact also designed artefacts whether they are products or services. How will open design change conventional design? What is the role of digitalization in the evolution of open design?

Evolution of boundaries between professional and amateur designers

The study focuses on the 3D printing open design community and design-oriented local community, which can be seen as polar cases if approached with a dichotomy of professional designers and amateurs (Atkinsson, 2010, 2011; Stikker, 2011). The 3D printing open design community can be seen as an open arena for anyone to join, and the design-oriented local community as a place for professional designers. The reality is far more nuanced since professional designers are also active in the 3D printing open design community, and contributions of all community members are welcomed in the design-oriented local community. Contrary to traditional predictions that good design can only be created by professionals, the open design movement suggests that opportunities
for both master and novice designers can co-exist in today's societies and markets. Impacts of the on-going transformation make an interesting topic for the future research. Is design expertise needed in the future and if yes, why and in which contexts?

**Intellectual property rights**
Various actors, including designers, investors and manufacturers, operate together to produce innovative solutions but contractual arrangements of the collaboration with technical, social, economical and legal settings remain unclear (Balka et al., 2009). As the amount of work done in various open design communities increases, concerns about the rights of designers, intellectual property (IP) systems, aesthetics and quality of artefacts raise as well. The fair use of IP rights, usability, high enough quality and safety are shared interests of both companies and users. Copyrights, design rights and patents govern the re-use of designs. Open licensing schemes, such as the Creative Commons Licensing ([www.creativecommons.org](http://www.creativecommons.org)), are based on copyrights, but they were not drafted for three-dimensional objects, which does not necessarily mean that open design will fall within the scope of Creative Commons licences. Collaborative projects should have a design right for the objects they create. This can become a barrier especially for international projects because the right for a certain design can be complex, and it can vary from country to country (Katz, 2011). Patents protect an idea itself, but it can become problematic since an invention can be implemented both in the software and hardware of the same solution, and the only way to make sure an invention does not infringe a patent is to do an exhaustive check in patent offices all around the world (ibid.). Open design is still a nascent discipline, and licensing of open design artefacts is a relatively untouched area of research, and there is plenty of room for further research both from national, or country specific, and international perspectives.
References


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Hummels, C. (2011). Teaching Attitudes, Skills, Approaches, Structure and Tools, in B. Van Adel, L. Evers, R. Klaassen and Peter Troxler (Eds.) Open design now, BIS Publishers; Creative Commons, the Netherlands.


Katz, A. (2011). Authors and Owners. In B. Van Adel, L. Evers, R. Klaassen and Peter Troxler (Eds.) Open Design Now, BIS Publishers; Creative Commons, the Netherlands.


Kennedy, G. (2011). Joris Laarman’s Experiments with Open Source Design, in B. Van Adel, L. Evers, R. Klaassen and Peter Troxler (Eds.) Open design now, BIS Publishers; Creative Commons, the Netherlands.


Papanek, V. (1972). *Design for the Real World*. Thames and Hudson Ltd. USA.


Appendix I: Data gathering and analysis

Data collection in the open design community

The first phase
Interview participants are presented in Table 1 below. In addition, 14 other persons were contacted but they did not have time or possibilities to participate in the study.

Table 1. 3D printing open design community: Participants of the first phase of the data collection.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Country of residence</th>
<th>Interview media</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Designer</td>
<td>USA</td>
<td>Email correspondence (pilot &amp; actual interview)</td>
</tr>
<tr>
<td>2. Designer &amp; Maker</td>
<td>USA</td>
<td>Email correspondence (pilot)</td>
</tr>
<tr>
<td>3. Designer</td>
<td>The Netherlands</td>
<td>Email correspondence</td>
</tr>
<tr>
<td>4. Architect</td>
<td>The Netherlands</td>
<td>Email correspondence</td>
</tr>
<tr>
<td>5. Designer</td>
<td>The Netherlands</td>
<td>Skype call</td>
</tr>
<tr>
<td>6. Design researcher</td>
<td>Finland</td>
<td>Skype call</td>
</tr>
<tr>
<td>7. Designer</td>
<td>France</td>
<td>IRCnet chat</td>
</tr>
<tr>
<td>8. Master level engineering student</td>
<td>Finland</td>
<td>IRCnet chat &amp; Skype call</td>
</tr>
</tbody>
</table>

An invitation to participate in the case study was sent to the participants of an open design contest. The invitation included the following research topics (Table 2):

Table 2. Research themes of the first phase of the data collection.

<table>
<thead>
<tr>
<th>Topics:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. We would like you to draw us pictures (or just one) about your design process; what components, tool and phases it includes</td>
</tr>
<tr>
<td>2. How does the design evolve; the first drafts, .... some developing figures, .... the final design</td>
</tr>
<tr>
<td>3. What are the sources for your inspiration?</td>
</tr>
</tbody>
</table>
The second phase
The 3D printing open design community members were asked to answer to the following web survey questions (Table 3). Supplement data of the web survey is available online: http://surveys.peerproduction.net/open-data/longitudinal-survey-data/#3d-manufacturing-community-surveys. The questions are based on earlier research conducted in the open source area (Aalbers; 2004; Mikkonen et al., 2007).

Table 3. Questions of a cross-sectional web survey.

<table>
<thead>
<tr>
<th>1. I participate in 3D printing projects because of money.</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Don’t know</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. I participate in 3D printing projects because I want to develop 3D printing tools and practices.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I participate in 3D printing projects because I learn new skills.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. I participate in 3D printing projects because I like collaborative development.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I participate in 3D printing projects because I like to share my knowledge and skills with others.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. I participate in 3D printing projects because I get more respect.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. I participate in 3D printing projects because it gives me better job opportunities in the future.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I participate in 3D printing projects because it is fun.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. I participate in 3D printing projects because I want to help others.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. 3D printing projects are a way to express myself.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. I do 3D printing because I think all software and hardware should be free.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. I participate in 3D printing projects because I want to give back to the community.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. I develop 3D printing because I need it for doing something else.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Data collection in the design-oriented local community

Participants of the case studies are presented in Table 4.

Table 4. Design-oriented local community: Participants of the interviews and the workshops*). All interviewees participated in the workshops.

| Occupation | |
|------------|----------------|-------------------------------------------------|
| 1.         | Goldsmith and designer in an own company | |
| 2.         | Master goldsmith and designer in an own company | |
| 3.         | Designer and joiner in an own company and representative of the Village club | |
| 4.         | Blacksmith in an own company | |
| 5.         | Director in an own company and representative of the Merchants’ association | |
| 6.         | System designer in an own company | |
| 7.         | Manager in a real estate business unit | |
| 8.         | Museum guide, member in the Society of home and school and founder of a local theater | |
| 9.         | Village guide and a teacher in local schools | |
| 10.        | Manager of a real estate business unit | |
| 11.        | Director of an education society | |
| 12.        | Director of the Co-operative of artisans, designers and artists | |
| 13.        | Apprentice in the real estate business unit*) | |
| 14.        | Real Estate Manager*) | |
| 15.        | Sculptor *) | |
| 16.        | Guide in an own company*) | |
| 17.        | Owner of a restaurant*) | |
| 18.        | Conductor and violinist*) | |
| 19.        | Photographer*) | |

There was a lead question in each workshop to focus the development work. The lead questions of the three first workshops are presented in Table 5. The workshops were conducted in Finnish.

Table 5. Lead questions of the first three workshops.

| Lead question of the workshop | |
|-----------------------------|----------------|-------------------------------------------------|
| The 1st workshop            | 1. How is Fiskars Village in 2020? | |
| The 2nd workshop            | 2. What skills, experiences, competences and passions would I like to share in the Fiskars Village? | |
| The 3rd workshop            | 3. What would I like to get from Fiskars Village? | |

Two samples of interview transcripts are presented in Figure 1 as raw data.
Figure 1. Examples of the raw data from a semi-structured interview.

Questions of the semi-structured interviews are presented in Table 6. The interviews were conducted in Finnish, and the participants were allowed to open up their thoughts and perceptions although the questions steered the discussions.

Table 6. Questions of the semi-structured interviews.

<table>
<thead>
<tr>
<th>Questions related to the conducted workshops</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How did you find the conducted workshops and the agendas?</td>
</tr>
<tr>
<td>2. Several different type of themes emerged in the workshops [list of the themes presented in the interviews]. How do you see the themes and values which enable prosperity and good collaboration in the companies and societies of Fiskars Village?</td>
</tr>
<tr>
<td>3. Do you think something relevant is missing from the themes that emerged in the workshops?</td>
</tr>
<tr>
<td>4. Do you think issues that do not belong to Fiskars Village are part of the themes?</td>
</tr>
<tr>
<td>5. Do you think the workshops can add value and enable the development of Fiskars Village?</td>
</tr>
<tr>
<td>6. How would you like to continue this work and the on-going development in the Village?</td>
</tr>
<tr>
<td>7. How do you find the role of researchers from Aalto University in the development work?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Questions related to the collaboration between companies and societies</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. How do companies and societies find potential collaboration partners in Fiskars Village?</td>
</tr>
<tr>
<td>9. How do you collaborate?</td>
</tr>
<tr>
<td>10. What factors are important in the collaboration?</td>
</tr>
<tr>
<td>11. Could you please describe a collaboration project or projects in which you have been involved with (how did it start, duration, end result, plans for continuation, etc.)</td>
</tr>
<tr>
<td>12. Does everybody know each other from other contexts as well? Which one?</td>
</tr>
<tr>
<td>13. Could you please describe an ideation and product development process from the first idea creation until there is a finished offering available?</td>
</tr>
<tr>
<td>14. How would you describe the nature of the collaboration partners?</td>
</tr>
<tr>
<td>15. Who is the driver of collaboration?</td>
</tr>
<tr>
<td>16. What is an input of each company/person?</td>
</tr>
<tr>
<td>17. How is the collaboration?</td>
</tr>
<tr>
<td>18. How do you communicate with each other or inform others of the coming changes?</td>
</tr>
<tr>
<td>19. What kind of a business model do you have (e.g. reflecting with the business model canvas model built in the workshops)?</td>
</tr>
<tr>
<td>20. What kind of opinions do customers/villagers have and how do they impact the product/service development work?</td>
</tr>
<tr>
<td>21. How important is the consistency of the developed products when there are many parties involved in the development work?</td>
</tr>
<tr>
<td>22. What have you learned during the collaboration projects?</td>
</tr>
<tr>
<td>23. How do you follow up the success of the collaboration projects?</td>
</tr>
<tr>
<td>24. What plans with various collaboration partners do you have for the future?</td>
</tr>
</tbody>
</table>
A part of Osterwalder and Pigneur’s (2009) business model canvas, the customer segments, is presented in Figure 2 to illustrate activities of the workshops. The workshops were conducted in Finnish.

![Figure 2](image)

**Figure 2.** Osterwalder and Pigneur’s (2009) business model canvas was used as the framework in the workshops. Identification of the customer segments, a part of the business model canvas, was an activity in the workshops.

Progress and outcomes of the workshops were discussed in the semi-structured interviews. An example of the qualitative content analysis related to affordances at the community level is presented in Figure 3.

![Figure 3](image)

**Figure 3.** An example of the qualitative data analysis of a semi-structured interview. The quote refers to two themes, innovative identity and community thinking, which emerged in the data.

Semi-structured interviews touched on informant’s own work. An example of the qualitative content analysis related to affordances at the individual level is presented in Figure 4.
Figure 4. An example of the qualitative data analysis of a semi-structured interview. The quote includes two themes, contradictions and autonomy, which emerged in the data.
The collaborative actions and their deeper meanings which enable and support perception of affordances are presented in the Table 7. The data were collected in the workshops, and the collaborative action and the themes emerged in the content data analysis as the first-order and the second-order concepts (Pratt, 2008).

Table 7. Collaborative actions and their deeper meanings emerged as themes which enable and support perception of affordances at the community level.

<table>
<thead>
<tr>
<th>The first workshop</th>
<th>The second workshop</th>
<th>The third workshop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborative actions</td>
<td>Themes</td>
<td>Collaborative actions</td>
</tr>
</tbody>
</table>
| 1. Creative Village  
  • Factor impacting all activities | Innovative identity | 1. Infrastructure  
  • Information of what happens in the Village | Community thinking | 1. Quality criteria  
  • Consistent look and feel of the Village  
  • Brand book | Community thinking, Entrepreneurial mind set |
| 2. Living and environment  
  • Sustainably attractive Village  
  • Affluent community and living environment  
  • The best place for children  
  • Nature in the number one (and the neighbours) | Innovative thinking | 2. ‘Weaver’ of the network  
  • Gatherer-mediator role | Recognition of the complexity of a holistic customer experience | 2. Holistic experience  
  • Done in collaboration  
  • Competence bank as an asset | Recognition of the complexity of a holistic customer experience |
| 3. Brand of the Village  
  • Significant actor in the world  
  • Holistic thinking | Entrepreneurial mind set | 3. History – the future  
  • 3D world to preserve the heritage  
  • Product development | Recognition of the complexity of a holistic customer experience | 3. Fiskars nature  
  • Potential area to be developed | Community thinking |
| 4. Innovative ‘idea hatchery’  
  • Education  
  • Manual skills  
  • Doing together  
  • Fiskars Academy | Innovative identity | 4. Spontaneous Village  
  • Utilization of spontaneity  
  • ‘Spoofing’ around | Innovative identity | 4. Exhibitions  
  • Emphasis on the locality | Community thinking, Innovative identity, Entrepreneurial mind set |
| 5. Entrepreneurship  
  • New jobs | Entrepreneurial mind set | 5. Marketing communication  
  • Annual clock – a shared story  
  • Marketing assistance | Entrepreneurial mind set | 5. Cultural production  
  • Concerts  
  • Theatre | Innovative identity |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>World leading unit of design, craftsmanship and art education</td>
<td></td>
<td>Customers for everyone</td>
<td></td>
</tr>
<tr>
<td>7. Productization of services</td>
<td>Entrepreneurial mind set</td>
<td>8. Community</td>
<td>Community thinking</td>
</tr>
<tr>
<td>Cultural production</td>
<td></td>
<td>Pleasant living environment</td>
<td></td>
</tr>
<tr>
<td>A hybrid of products, services and experiences</td>
<td></td>
<td>Themes as ‘a spa’ not as ‘a circus’</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Possibility to influence on the development work</td>
<td></td>
</tr>
<tr>
<td>9. Communication and marketing</td>
<td>Entrepreneurial mind set</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Centralized sales and marketing</td>
<td></td>
<td>Digitalized services</td>
<td></td>
</tr>
</tbody>
</table>
Themes that enable and support perception of affordances at the individual level emerged as secondary-order concepts (Pratt, 2008) from the data collected in the interviews. The affordances are presented in Table 8. Similar affordances occurred in many interviews, but they are mentioned only once in the table.

**Table 8.** List of affordances emerged in the interviews. Grouping of the affordances into themes was done in the content analysis phase.

<table>
<thead>
<tr>
<th>Affordances related to collaboration in the community</th>
<th>Thoughts of the interview participants</th>
<th>Themes</th>
</tr>
</thead>
</table>
| 1. Exploitation of local competences  
   High quality craftsmanship  
   Experience based reliability, timeliness and cost consciousness  
   Effectiveness of grapevines | ‘There is a family here who makes the best casting and silver plating in Finland.’ | Autonomy |
| 2. Network of experts and artists  
   Enthusiasm and positive experience of collaboration with local actors  
   Potential to create a hybrid of products, services and experiences provided by several organizations  
   Wild ideas, exploring of new ways of working | ‘The sculptor had the idea... the model was so cumbersome that it was impossible to carve it on gypsum so I modelled it with my computer. The person [name removed] sat next to me and told me to move it [the cursor] in this and that direction, and we created it together that way. And then I cut the models for him...He won the competition... the customer wanted to have a wooden case and I contacted another person in the Village...it was a brilliant case... We made quite a big batch, about thirty thousand of them.’ | Autonomy |
| 3. Vast array of business opportunities  
   Creative atmosphere  
   The rest of the world is interested in the Village  
   Development towards more sustainable activities  
   Villagers’ share a similar story of the Village at a certain level but operationalization of it differs | ‘...[T]he atmosphere, people perceive there is something on-going in the Village, like it’s alive, and that affects the villagers and that way it affects of course the whole community, and the visitors.’  
‘I believe that this community is together more.’ | Deliberateness |
| 4. Spontaneity  
   Possibility for a solitary work | ‘Collaboration is also about the awareness that there are many other similar types of human beings in here.’  
‘There needs to be peace, you curl up into yourself. Surely you can ask somebody how they would do it.’ | Contradictions |
| 5. Local hand making  
   Sustainable brand with meaningful stories  
   Collaboration with international design –oriented universities  
   Support of the nature and well-being of the villagers | ‘...[T]op quality by hand, and in this kind of environment, and of this kind of wood. With the story, starting from our first customer Alvar Aalto, and after him came Kaj Franck...’  
‘There are two things in the background: You have to be good, and you have to have credibility.’ | Autonomy |
| 6. Expansion of traditional product design thinking towards experience design  
   Possibilities to offer university level education  
   ‘Competences bank’ of the villagers exists in local discussions | ‘...[E]xpansion of creativity. Sort of towards fresh waters. And also towards education is a really good idea... I heard the concept of Fiskars Academy today for the first time but that would be magnificent. And I would like to be involved.’ | Autonomy |
<table>
<thead>
<tr>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Possibilities to develop ideas in 'an intelligent fast failure’ mode</strong></td>
<td><strong>Combining a living place and a destination for visitors</strong></td>
<td><strong>Humbleness and thankfulness vs. narcissism and selfishness</strong></td>
<td><strong>Heritage in providing education</strong></td>
<td><strong>Resources and space to practice and find own area of expertise</strong></td>
<td><strong>Bees as a working mode</strong></td>
</tr>
<tr>
<td><strong>Built framework for craftsmanship education and apprenticeships for children, adults and business visitors</strong></td>
<td><strong>Holistic experience</strong></td>
<td><strong>Philanthropic elements, e.g. funding, entrepreneurship forum</strong></td>
<td><strong>Enhanced learning environment</strong></td>
<td><strong>Master-apprentice relationships</strong></td>
<td><strong>Plethora of small activities</strong></td>
</tr>
<tr>
<td><strong>Shared values</strong></td>
<td><strong>Evolvement of openness and closeness over the years</strong></td>
<td><strong>Democratic and debating environment</strong></td>
<td><strong>Balance between commercialism and local well-being</strong></td>
<td><strong>Synchronicity (an occurrence of events that appear to be meaningfully related but not causally)</strong></td>
<td><strong>Physical space for brooding ideas</strong></td>
</tr>
<tr>
<td><strong>Pride of local craftsmanship</strong></td>
<td><strong>Fundamental idea from the 1980’s: bring your own work with you when you move to the Village</strong></td>
<td><strong>Internationality</strong></td>
<td><strong>Continuous development with experts and creative people from a local artist in residence program</strong></td>
<td><strong>Physical space for brooding ideas</strong></td>
<td><strong>Unique environment for the basic education</strong></td>
</tr>
</tbody>
</table>

### Contradictions

- **Humbleness and thankfulness vs. narcissism and selfishness**
- **Philanthropic elements, e.g. funding, entrepreneurship forum**
- **Democratic and debating environment**
- **Enhanced learning environment**
- **Balance between commercialism and local well-being**
- **Internationality**
- **Synchronicity (an occurrence of events that appear to be meaningfully related but not causally)**
- **Physical space for brooding ideas**
- **Continuous development with experts and creative people from a local artist in residence program**

### Autonomous

- **Possibilities to develop ideas in 'an intelligent fast failure’ mode**
- **Built framework for craftsmanship education and apprenticeships for children, adults and business visitors**
- **Combining a living place and a destination for visitors**
- **Holistic experience**
- **Shared values**
- **Pride of local craftsmanship**
- **Humbleness and thankfulness vs. narcissism and selfishness**
- **Philanthropic elements, e.g. funding, entrepreneurship forum**
- **Democratic and debating environment**
- **Heritage in providing education**
- **Enhanced learning environment**
- **Balance between commercialism and local well-being**
- **Internationality**
- **Synchronicity (an occurrence of events that appear to be meaningfully related but not causally)**
- **Physical space for brooding ideas**
- **Continuous development with experts and creative people from a local artist in residence program**
- **Resources and space to practice and find own area of expertise**
- **Master-apprentice relationships**
- **Problem solving**
- **Unique environment for the basic education**
- **Bees as a working mode**
- **Plethora of small activities**

---

‘...[T]his is really a place where people live. It is not only a tourist attraction.’

‘Each shop or entrepreneur here acts also as a travel advisor.’

‘... [I]f I don’t know who to ask, I know somebody who knows who to ask.’

‘There is this atmosphere that we want this to be a good place. It is quite evident.’

‘I don’t know if it needs some prodigious collaboration, but it is just that we feel at home here.’

‘...[T]his is our place. It is obvious because there are not tags on the walls of the buildings.’

‘The value of debating is that we understand each other and the parties we represent in a smarter way and then, implicitly, it enables us to make shortcuts when needed and agree on things without contracts because we have worked together before.’

‘There are projects that last a certain period of time and the turnover is created through them. The wholesomeness is renewed in a way through them, too.’

‘I am grocery shopping and bump into a person [name removed] in the aisle of the local market. We start talking and discover that what the person needs is a perfect match with what we are doing in our project.’

‘The creativity is part of our everyday life and it is part of the brand and everything else.’

‘If a child has skills of a smith or an artisan already when going to upper secondary school, it’s quite interesting.’

‘...[H]is knowledge is as valuable as gold... and he has this kind of willingness to share that with hobbyists, and I think that is really awesome and brilliant.’
<table>
<thead>
<tr>
<th>Participative culture</th>
<th>'We thought of organizing the work as a bee because it is fun and the villagers can meet and with low threshold share news and whatever they want to talk about.'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic development through dialogue, networking by talking</td>
<td></td>
</tr>
<tr>
<td>Feeling of freedom, possibility to try out things and do anything without a fear</td>
<td></td>
</tr>
<tr>
<td>Hopefulness</td>
<td></td>
</tr>
<tr>
<td>Deliberateness</td>
<td></td>
</tr>
</tbody>
</table>
Interdisciplinary research, such as this study, acts in boundary areas of different schools of thought and tackles paradoxes. Polanyi (1966) encountered contradictions when pondering about the existence of tacit knowledge within frontiers of physical and social sciences and referred to Meno’s paradox discussed by Plato (c. 428/427 – c. 348/347 BC) in those situations. Meno’s paradox deals with the absurdity of gaining knowledge; ’either you know what you are looking for, in which case no search is needed as there is no problem, or you do not know what to look for, in which case you cannot expect to find anything’ (Polanyi, 1966). This study approaches paradoxes presented in this study with an open mind and reflection.