

You, Xinya

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REVIEW

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Applying design thinking for business model innovation

Xinya You* 

*Correspondence:
youxy429@hotmail.com

University of Dundee,
Nethergate, Dundee DD1 4HN,
Scotland, UK

Abstract

In recent years, there has been an increasing interest in using design thinking for business model innovation. However, few studies have explored the application, potential and challenges of design thinking from a comprehensive perspective. In order to better understand how design thinking can contribute to business model innovation, this paper regards business model innovation as a subject of design research and provides a critical review of researchers' explorations of how to apply design thinking for business model innovation. In light of the literature review, this paper distils seven key design research themes: (1) design thinking as a mindset and a methodology; (2) designers of business models; (3) design activities for business model innovation; (4) design tools for business model innovation; (5) design approaches for business model innovation; (6) co-creation of new products, services and business models, and (7) evaluating and measuring the impact of design thinking. The themes not only highlight the potential of applying design thinking as a necessary mindset and methodology to business model innovation, but also emphasise the nature of designing as a social process.

Keywords: Design thinking, Business model innovation, Mindset, Design methodology, Design processes

Introduction

Over the past two decades, researchers and managers have become increasingly aware of the importance of business models. In the management literature, the business model has become an increasingly important concept in technology and innovation management (Massa et al., 2017). The applicability of business models has expanded from focal companies to other types of companies in the ecosystem of the value network (Zott & Amit, 2013). The potential to analyse business models from the industry, sector, regional, national, cluster and company levels has been explored (Saebi et al., 2017; Zott & Amit, 2013). Moreover, researchers' understanding of business models extends to their sustainability, i.e. their contribution to economic, cultural and social dimensions (Joyce & Paquin, 2016). Some researchers have identified the need to build business models for organisations in the non-profit sector, such as social businesses (Seelos & Mair, 2005; Yunus et al., 2010), and many researchers have collected empirical data to demonstrate the impact of business models on company performance (Morris et al., 2013; Saebi et al.,

2017; Zott & Amit, 2007). Successful business practices suggest that continuing business model innovation can bring companies the ultimate competitive advantage (Mitchell & Coles, 2003).

Business model innovation requires design knowledge and skills that traditional business schools and management schools do not teach. As a strategic management researcher, McGrath (2010) pointed out, ‘unlike conventional strategies that [emphasise] analysis, strategies that aim to discover and exploit new models must engage in significant experimentation and learning—a [“discovery driven”], rather than analytical approach’ (p. 247). Some researchers (Amano, 2014; Simonse, 2014) believe that design thinking can provide managers with a discovery-driven design approach for business model innovation. In the past decade, researchers have explored the methodological value of design thinking for business model innovation from a variety of perspectives (Amano, 2014; Simonse & Badke-Schaub, 2014). Many business model design tools, such as the business model canvas, have been developed for entrepreneurs and managers to use (Bocken et al., 2013; Osterwalder & Pigneur, 2010).

Although a number of studies have been carried out on exploring the potential of design thinking, few studies provide a comprehensive view on how to apply design thinking for business model innovation. In addition, the application of design thinking faces some challenges. For example, design thinking as a concept is under-theorised and is often over-simplified as a linear and clear process that can be easily followed (Kimbell, 2011; McCullagh, 2010). This paper aims to provide a comprehensive perspective to help unleash the potential of design thinking and resolve some of the challenges it faces in its application. It is divided into four sections. Section 2 gives a brief overview of business model innovation as a subject of design research. Section 3 discusses the application, potential and challenges of design thinking in business model innovation. Section 4 introduces the research methodology used in this study and presents the descriptive results of this paper. Section 5 identifies several key themes of applying design thinking to business model innovation. These themes point out some directions for future interdisciplinary research on design thinking and business model innovation.

Business model innovation: a subject of design research

Business model innovation is a popular topic in business model research. Researchers suggest that innovation must include business models because a business model describes the design of a company’s value creation and value capture mechanisms, which together generate profit (Chesbrough, 2007; Gay, 2014). In general, business model innovation describes the creation of a new business model or a process of transformation from one model to another (Chesbrough, 2010; Geissdoerfer et al., 2016; Mitchell & Coles, 2004). Recent research suggests that business model innovation ‘can comprise the development of entirely new business models, the diversification into additional business models, the acquisition of new business models, or the transformation from one business model to another’ (Geissdoerfer et al., 2018, p. 406). Learning from a successful business model is also considered valuable for stimulating innovation. For instance, Giesen et al.’s (2007) research identified three main types of business model innovation based on 35 best practice cases: the innovations in industry model, the revenue model and the enterprise model.

Researchers have proposed many definitions for business model innovation (Geissdoerfer et al., 2018). These definitions have several focuses, including making better value configuration (Chesbrough, 2007), providing novel product or service offerings to customers and end-users (Mitchell & Coles, 2004), experimenting with new business model elements and building blocks (Osterwalder et al., 2005), and leveraging a company's internal capabilities and resources (Amit & Zott, 2010). According to these definitions, business model innovations should include the design and implementation of new business models. However, researchers have yet to reach a consensus on the definition of business model innovation. In recent research, Foss and Saebi (2018) proposed a clear direction for defining business models and business model innovation from a theoretical construction perspective. As they put it: 'the ... [business model] ... and ... [business model innovation] ... constructs are fundamentally about the architecture of the firm's value creation, delivery and capture mechanism; theoretically the key aspects of ... [business models] ... is complementarity between activities underlying these mechanisms; ... [business model innovation] means novel changes of such complementary relations' (Foss & Saebi, 2018, p. 9). Foss and Saebi's intention is to establish a pre-existing agreement on the nature of the units of analysis (i.e. the business model and business model innovation).

In the business model innovation literature, business model design is described as a source of innovation as well as a key task for entrepreneurs and executives (Chesbrough, 2007; Zott & Amit, 2007). From this perspective, business model innovation is a design research topic. The literature shows some considerations for the design and implementation of new business models:

- The tool attributes of the business model itself, e.g. as a tool for systemic analysis, planning and communication (Doganova & Eyquem-Renault, 2009; Geissdoerfer et al., 2018);
- The interrelationship between the different components of the business model, e.g. the value proposition, the market segment, the offering and complementary assets of the cost structure, the revenue generation mechanism, the value chain structure and the value network (Chesbrough, 2010; Geissdoerfer et al., 2018);
- The relationship between product market strategy, the business model and organisational design (DaSilva & Trkman, 2014; Osterwalder et al., 2005; Richardson, 2008; Zott & Amit, 2013);
- The design elements that describe the architecture of an activity system and the design themes that describe the sources of the system's value creation (Amit & Zott, 2010);
- The relationship and conflicts between the new business model and the existing business model (Aspara et al., 2010; Massa et al., 2017);
- Business model innovation and sustainability (Carayannis et al., 2014);
- Managers as designers and executives of business models (Chesbrough, 2007; DaSilva & Trkman, 2014; Eckhardt, 2013; Massa et al., 2017; Zott & Amit, 2013; Zott et al., 2011).

Companies' capability to create, implement, iterate and evolve business models to adapt to changing market conditions is critical to their business success (Geissdoerfer et al., 2018; Lindgardt et al., 2012; Romero & Molina, 2009; Wirtz et al., 2016). As Wirtz et al. (2016) pointed out, '... a current business model should always be critically regarded from a dynamic perspective, thus within the consciousness that there may be the need for business model evolution or business model innovation, due to internal or external changes over time' (p. 41).

In this regard, many design approaches and tools have been created for managers to use. For example, Zott and Amit (2010) developed a conceptual toolkit for helping managers analyse and improve the current designs to adapt them to the future and to enable entrepreneurial managers to design future models. Similarly, after considering the components of the business model, the process of business model innovation, as well as the competitive strategy of the innovating company, Chesbrough and Rosenbloom (2002) and Chesbrough (2010) provide an integrated approach for business model innovation. There are also some researchers trying to design measurement models for business model innovation. One example is Chesbrough's (2007) business model framework. It sequences possible business models from basic models to far more advanced models and can be used by companies to advance their business models. Attempts to develop a business model innovation typology through empirical studies have also been made (Cavalcante et al., 2011; Koen et al., 2011; Taran et al., 2015).

Application, potential and challenges of design thinking in business model innovation

Since business model innovation can be regarded as a design research topic, it has attracted the attention of many researchers in the design discipline. One of the reasons is Osterwalder and Pigneur's (2010) *Business model generation: a handbook for visionaries, game changers, and challengers*. This popular book introduces its readers to some design thinking methods (e.g. customer insights, ideation, visual thinking, prototyping and scenarios) and tools (e.g. empathy maps and brainstorming) created and used by design practitioners. It also mentions Roger Martin's opinion on managers as designers, Fred Collopy and Richard Boland's (2004) book *Managing as Designing* and Tom Kelly's (2001) book *The Art of Innovation: Lessons in Creativity from IDEO, American's Leading Design Firm*. These scholars and design practitioners are famous 'design thinking' advocates in the management field. Their publications are frequently cited by management and design researchers who are interested in design thinking.

From the perspective of design researchers, the applicability of design thinking has expanded from product design to product-service systems and is now extended to business model design (Simonse & Badke-Schaub, 2014). Many researchers (Amano et al., 2017; Lehmann et al., 2015) have explored the value of design thinking to business model design and innovation. Some topics are frequently mentioned in research papers, such as 'prototypes', 'visualisation', 'co-design', 'participatory design', 'value propositions', 'product and service innovations', 'problem solving', 'modelling and mapping process', 'iteration' and 'activity system architecture' (Amano, 2014; Amano et al., 2017; Buur et al., 2013; Ceschin et al., 2014; Geissdoerfer et al., 2016; Gilbert et al., 2012; Gudiksen et al., 2014; Joyce & Paquin, 2016; Simonse et al., 2012).

It has been argued that design thinking can play a strategic role in business model innovation. For example, Gilbert et al. (2012) described design thinking as ‘an effective means in democratizing innovation’ and ‘a key catalyst in linking strategy to action’. They illustrated how design thinking tools and approaches could be used to drive product and service innovation from a business model innovation perspective. Another researcher, Amano (2014), described design thinking as ‘the strategic role of design’. He discussed five key elements of design thinking—human centredness/field research, collaboration, learning through iterative processes, visual storytelling and concurrency with business analysis—to illustrate its potential impact on business model innovation. Moreover, Simonse and Badke-Schaub (2014) proposed a concept of strategic design thinking from the perspective of business model innovation:

[Strategic design thinking is] a series of cognitive activities (such as reasoning, creative problem solving, decision-making), which are directed to the understanding of the business problems, its network structure and value exchange possibilities to co-create a design process and outcome which are meant to provide a strategic direction and communication of a shared vision and commitment.

Although researchers have a positive attitude towards the application of design thinking in business model innovation, some of them (Amano, 2014; Amano et al., 2017) pointed out that the lack of a general definition of design thinking may be a problem of applying it to business model innovation. Many definitions have been proposed to try to describe its nature and application potential, such as ‘a formal creative problem-solving method with the intent to foster innovation’ (Dell’Era et al., 2020, p. 324), ‘a cognitive style’ (Kimbell, 2011, p. 297) and ‘Design thinking is a human-centered approach to innovation that draws from the designer’s toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success’ (IDEO, 2021).

One of the reasons that so many definitions were created is that the term design thinking is derived from Herbert Simon’s thoughts on the cognitive way of problem-solving (Simon, 1969), but challenged by Nigel Cross’ ‘designerly ways of knowing’ (it focuses on design practitioners’ ways of problem-solving) (Cross, 1982), and used by a famous design consultancy IDEO to name its company methodology (it was frequently mentioned by popular business publications and taught at business schools) (Brown, 2009). In addition, in the early days when design thinking became popular, influenced by IDEO’s practice-based company methodology, ‘many disparate, vaguely creative activities are combined under the label of [“Design Thinking”]’ (Dorst, 2011, p. 531) and design thinking was sometimes over-simplified as ‘as a clear and codified process of methods, tools, and steps that can be learned by nondesigners’ (McCullagh, 2010, p. 38). This further increased the difficulty of conceptualising and theorising design thinking.

Nowadays, more and more researchers have realised the importance of clarifying the origins of design thinking (Micheli et al., 2019; Oxman, 2017). Attempts have been made to distinguish design thinking in management and design research paradigms. For example, Johansson-Sköldberg et al. (2013) suggest using the term ‘design thinking’ in the management discourse and a new term ‘designerly thinking’ in the design discourse. Nevertheless, as Lucy Kimbell pointed out in her paper ‘Rethinking Design Thinking’ published in 2011, ‘[design] thinking ... remain undertheorized and understudied;

indeed, the critical rethinking of design thinking has only just begun' (2011, p. 301). In this regard, some researchers who attempt to use design thinking as a methodology for business model innovation have recognised that it is under-theorised (Amano, 2014; Simonse et al., 2012). In recent years, many design researchers have tried to better understand design thinking from multiple perspectives, such as revisiting the most influential design thinking publications (Huppatz, 2015), mapping out the design cognition landscape (Hay et al., 2020) and further conceptualising design thinking (Micheli et al., 2019).

Since the theorisation of design thinking is still in progress, researchers have not yet reached a consensus on how to define it. The lack of a unified definition of design thinking has increased the difficulty of knowledge creation and accumulation. For instance, in practice, many organisations had different understandings of what design thinking is and found that it is difficult to measure its impacts on innovation (Schmiedgen et al., 2016). Nevertheless, it is unwise to unify the definition of design thinking in the early stages of theorisation—embracing the existence of multiple definitions can help explore its potential. A practical approach is to emphasise the context of research and application when exploring design thinking and ensure that its academic roots are clear. It also applies to the application of design thinking in business model innovation.

In order to provide a comprehensive perspective to help unlock the potential of design thinking and address some of the challenges it faces in its application, a thorough literature review is needed. The next section reviews existing research on applying design thinking for business model innovation, exploring how researchers have defined the role of design thinking in business model innovation, their research and practice on applying design thinking for business model innovation, and how the impact of design thinking on business model innovation can be measured or evaluated. The researcher also seeks to distil some key research themes of applying design thinking for business model innovation from the literature review for future exploration.

Literature review

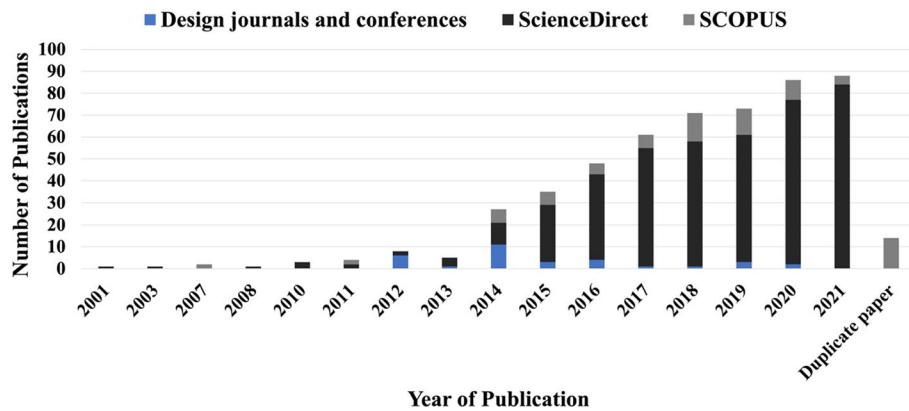
Research methodology

The researcher used ScienceDirect and Scopus databases for the literature searching and “business model”, “design thinking” and “innovation” as keywords for Boolean searches (Boolean search: TITLE-ABS-KEY [“business model” AND “design thinking” AND “innovation”] for journal and conference papers). The researcher divided “business model innovation” into two keywords “business model” and “innovation” because in some literature, the creation of new business models is not directly described as business model innovation (Bason, 2012; Emili et al., 2016). Using business model and innovation as two search keywords can reduce the omission of relevant literature. The Boolean search returned 417 papers from ScienceDirect and 79 papers from Scopus (search date: December 20, 2021; only papers written in English were considered).

The researcher noted that some design research papers do not use the term “design thinking” when discussing how to design business models (Bason, 2012). Broadly speaking, the use of design methods to solve management problems can be seen as an application of design thinking (Johansson-Sköldberg et al., 2013). Therefore, the researcher directly searched the websites of some top design journals (searching journals

Table 1 Search term, directory and results

Search term	Directory	Results
"business model" AND "design thinking" AND "innovation"	ScienceDirect	417
"business model" AND "design thinking" AND "innovation" (search within Article title, Abstract, Keywords; document type: Article, Conference paper, Review)	Scopus	79 (14 papers of these papers also appear in ScienceDirect's search results)
"business model"	Design journals and conferences	32

**Fig. 1** Timeline of publications by directory

with article titles) and conference proceedings using “business model” as a keyword and included the search results in the review (search date: December 20, 2021). A total of 32 papers were found—all of which were published after 2010. The search results for design journals are (number of papers in brackets): Design Issues (1), The Design Journal (1), Design Management Review (0), International Journal of Design (0), and CoDesign (2). The results for design conferences are (the number of papers is shown in brackets): DRS (3), DRS Learn Xdesign (0), EAD (2), DMI: Academic Design Management Conference (19), ADIM (4) (Note: proceedings for DMI: Academic Design Management Conference published prior to 2012 are not available).

Table 1 shows the search results for ScienceDirect, Scopus and Design Journals and conferences (see Additional file 1: Appendix A: Sheet 1 for the complete dataset). The search identified a total of 514 papers for review.

As shown in Fig. 1, publications on the link between design thinking/methods, business models and innovation have grown significantly since 2014, and this trend continues (see Additional file 1: Appendix A: Sheet 2 tab for more information on the number of publications).

The researcher conducted an initial review of the 514 papers and found that most of them could not be used for analysis (see Additional file 2: Appendix B: Data analysis tab). The reasons were as follows: not relevant to applying design thinking for business model innovation ($n = 451$), not available ($n = 17$), not an English-language paper ($n = 1$) and not a conference or journal paper ($n = 2$) (see Additional file 2: Appendix B: Data analysis tab/column B). The final number of papers used for analysis is 44, including 36 empirical studies, 7 conceptual studies and 2 literature review studies (1 of which is also

a conceptual study) (see Additional file 2: Appendix B: Data analysis tab/column X to column AC).

The analysis of the papers applied a structured content analysis method. Content analysis can be used as a quantitative and qualitative method: quantitative content analysis uses a deductive approach “*based on previous research, which allows for formulating hypothesis about relationships among variables*”, while qualitative analysis adopts an inductive approach, using “*research questions to guide data collection and analysis but potential themes and other questions may arise from careful reading of data*” (White & Marsh, 2006, p. 35). The analysis approach for this study was to read each paper to answer the following research questions:

- How do researchers define design thinking in their papers?
- What design thinking publications, scholars and thoughts are mentioned in the paper?
- Why is design thinking valuable for business model innovation?
- How can design thinking be used for business model innovation?
- How can the impact of design thinking be measured and evaluated?

The researcher conducted a descriptive statistical analysis to answer the first and second questions. Given the exploratory nature of the next three questions, content analysis was used as a qualitative method. As explained by Hsieh and Shannon (2005, p. 1278), qualitative content analysis is “*a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns*”. Table 2 shows the list of code categories created by the researcher in the course of reading the 44 papers to answer these questions.

Results

How do researchers define design thinking in their papers?

The review found that of these 44 papers, 40 mention the term design thinking and 18 provided one or more definition(s) of design thinking ($n=14$) or attempted to define design thinking ($n=4$) (see Additional file 2: Appendix B: Data analysis tab/column D and E and Definitions tab). Table 3 shows the definitions of design thinking in the 18 papers and the sources of the definitions (where applicable). The academic roots

Table 2 Research questions and code categories

Research questions	Code categories
Why design thinking (or design approaches) is valuable to business model innovation?	Methodology Ways of thinking
Research question: How can design thinking be used for business model innovation?	Designers Design activities Design artefacts: design tools Design artefacts: design approaches Design artefacts: design outputs
How can the impact of design thinking be measured?	Impact Measurement/evaluation methods

Table 3 Papers, definitions of design thinking and sources of definitions

Paper	Definition	Source(s)
Innovating business models with pinball designs	"the process by which we devise courses of action aimed at changing existing situations into preferred ones"	Simon, H., "The sciences of the artificial" (1969)
Co-designing business models: reframing problems	"In the future, the most successful businesses will balance analytical mastery and intuitive originality in a dynamic interplay that I call design thinking"	Martin, R., "The design of business: Why design thinking is the next competitive advantage" (2009)
Prototyping in business model innovation: exploring the role of design thinking in business model development	"If we try to demystify the core of design thinking in falls into four major categories: types of reasoning, the type of the design problem, learning approaches and design making essentials."	N/A
Designing an innovative networked business model	"everyone designs who devises courses of action aimed at changing current situations into preferred ones"	Simon, H., "The sciences of the artificial" (1969)
Rethinking the prototyping process for applying design thinking to business model innovation	"... links Design Thinking and the way designers work to a specific way designers solve problems: the use of abductive logic as opposed to inductive or deductive reasoning."	Dorst, K., "The core of design thinking and its application" (2011), Dorst, K., "The nature of design thinking" (2010)
Sustainable business modeling: The need for innovative design thinking	"a human centered innovation process that emphasizes observation, collaboration, fast learning, visualization of ideas, rapid concept prototyping, and concurrent business analysis"	Lockwood, T., "Design thinking: integrating innovation, customer experience and brand value" (2010)
Design thinking to enhance the sustainable business modelling process – A workshop based on a value mapping process	"we define design thinking as a human centered approach, following a gradual and iterative process, presenting a solution of complex problems by collaborating in multidisciplinary teams"	N/A
Bridging sustainable business model innovation and user-driven innovation: A process for sustainable value proposition design	"Design thinking is a method for developing innovative solutions for complex problems, by deliberately incorporating the concerns, interests, and values of humans into the design process"	Brown, T., "Change by design" (2009), Meinel, C., Leifer, L., Plattner, H., (Eds.), "Design thinking: understand—improve—apply" (2011)
A tool for collaborative circular proposition design	"Design thinking is defined as a user-centred innovation approach based on problem solving and a process of repeated iterations between the three creative phases of inspiration, ideation and implementation..."	Brown, T. and Katz, B., "Change by design" (2011)
Sustainable mining development with community using design thinking and multi-criteria decision analysis	"Design thinking is seen as a way to ideate (the process of forming new abstract or concrete ideas and concepts) within contexts of high uncertainty or even wicked problems (Micheli et al., 2019; Von Thienen, Meinel and Nicolai, 2014)."	Micheli, P., Wilner, S.J.S., Bhatti, S., Mura, M. & Beverland, M., "Doing design thinking: conceptual review, synthesis, and research agenda" (2019), Von Thienen, J., Meinel, C. & Nicolai C., "How design thinking tools help to solve wicked problems" (2014)
Transforming a Traditional Product Offer into PSS: A Practical Application	"The key concept of design thinking prescribes a human-centered approach which factors in human behavior, needs and preferences"	N/A
	"It is an effective user-centered approach"	Brown, T., "Design thinking" (2008), Liedtka, J. and Ogilvie, T., "Designing for growth: A design thinking toolkit for managers" (2011)

Table 3 (continued)

Paper	Definition	Source(s)
The reDesign canvas: Fashion design as a tool for sustainability	"Design thinking can be described as a 'practice ... associated with having a human-centered approach to problem solving in contrast to being technology- or organization-centered. [Designers] are seen as using an iterative process that moves from generating insights about end users, to idea generation and testing, to implementation' (Kimbell, 2011)."	Kimbell, L., "Rethinking design thinking: Part I" (Kimbell, 2011)
Industrial Digital Environments in Action: The OMILAB Innovation Corner	"Design Thinking as a systematic, human-centred approach to solving complex problems ... [where] ... user needs and requirements as well as user-oriented invention are central ..."	Hasso-Plattner-Institut, "What is design thinking?" (2020)
Navigating market opportunity: traditional market research and deep customer insight methods	"design thinking can describe cognitive processes of designers, particularly the way designers solve problems"	Kimbell, L., "Rethinking design thinking: Part I" (2011), Kimbell, L., "Rethinking design thinking: Part II" (2012)
Promoting user-centricity in short-term ideation workshops	"Design thinking can be described as the interplay between diverging phases of exploring problem and solution spaces, and converging phases of synthesizing and selecting"	Lindberg, T., Meinel, C. & Wagner, R., "Design thinking: A fruitful concept for IT development?" (2011)
Open business model innovation: Literature review and agenda for future research	"... design thinking as the overlapping spaces of inspiration, ideation, and implementation rather than a sequence of orderly process steps."	Brown, T. and Wyatt, J., "Design thinking for social innovation" (2010)
Application of design thinking towards a PSS concept definition: A case study	"... 'human-centric methodology [that ...] blends an end-user focus with multidisciplinary collaboration and iterative improvement to produce innovative products."	Meinel, C. and Leifer, L., "Design thinking research, design thinking: understand—improve—apply" (2011)
Design LED innovation: Shifting from smart follower to digital strategy leader in the Australian airport sector	"Design thinking describes different participatory innovation methods involving experimentation, tangible resources and game-like innovation activities to stimulate the creative exploration of innovative solutions ..."	Burr, J., Guriksen S., "Interactive pinball business" (2012)
	"Design thinking (DT) is a human-centered design approach composed by particular mindsets and interrelated methods."	N/A
	"Design thinking describes the way in which designers think, and the approaches and processes utilised in solving problems that may be wicked in nature ..."	Kimbell, L., "Rethinking design thinking: Part I" (2011)

of design thinking and the practical value of design thinking in the business world are reflected in the cited literature (e.g. Simon, H., “The sciences of the artificial” (1969) and Martin, R., “The design of business: Why design thinking is the next competitive advantage” (2009)).

What design thinking publications, scholars and thoughts are mentioned in the paper?

The researcher calculated the number of citations to design thinking publications describing what design thinking is in the 44 papers. In total, 88 publications were found. Some of these ($n=25$) were cited more than 1 time ((see Additional file 2: Appendix B: Pivot tables tab/column A and B). Table 4 shows the publications that were cited more than 2 times ($n=13$). Publications that focused on the practical value of design thinking to the business world and social innovation ($n=5$) were cited most often (e.g. “Change by design”, “Design thinking” and “The design of business: Why design thinking is the next competitive advantage”). Academic publications ($n=8$) that contributed to the conceptualisation of design thinking were also cited several times (e.g. “The core of design thinking and its application”, “Rethinking design thinking: Part I” and “Wicked problems in design thinking”). These citations reveal the equally important impact of the practical value of design thinking and the conceptualisation of design thinking in the application of design thinking for business model innovation.

In addition to the number of citations, the researcher analysed the thoughts from these 88 publications that were cited by the papers reviewed (see Additional file 2: Appendix B: Pivot tables tab/column D and E). The researcher analysed all the thoughts by using NVivo 12 to generate a word cloud based on word frequency (see Fig. 2). As shown in Fig. 2, the most frequently used words highlight the application of design thinking as a human-centred problem-solving process or approach.

Why is design thinking valuable for business model innovation?

The analysis of the 44 papers shows that the value of design thinking (or designers’ way of problem-solving) for business model innovation has been widely explored (see

Table 4 Design thinking publications and count of citations

Publications	Count of citations
Brown, T., “Change by design” (2009)	12
Brown, T., “Design thinking” (2008)	10
Dorst, K., “The core of design thinking and its application” (2011)	9
Martin, R., “The design of business: Why design thinking is the next competitive advantage” (2009)	9
Kimbell, L., “Rethinking design thinking: Part I” (2011)	5
Verganti, R., “Design-driven innovation” (2009)	4
Buchanan, R., “Wicked problems in design thinking” (1992)	4
Simon, H., “The sciences of the artificial” (1969)	4
Brown, T. and Wyatt, J., “Design thinking for social innovation” (2010)	3
Cross, N., “Designerly ways of knowing” (1982)	3
Rittel, H. and Webber, M., “Dilemmas in a general theory of planning” (1973)	3
Buchanan, R., “Wicked problems in design thinking” (1990)	3
Schön, D., “The reflective practitioner: How professionals think in action” (2017)	3



Fig. 2 Word cloud created based on word frequency

Additional file 2: Appendix B: Data analysis tab/column H and I). Table 5 shows the categories and codes generated during the data analysis process, as well as examples of the values identified (for more details, see Additional file 2: Appendix B: Value of DT tab). The numbers in brackets indicate the number of papers that include relevant data. The results show that all the papers examined explored the methodological value of design thinking for business model innovation, and 2 of them also explored design thinking as a way of thinking.

How can design thinking be used for business model innovation?

Table 6 shows the categories and codes created during the data analysis process to understand how design thinking can be used for business model innovation. Five categories were created: designers, design activities, design artefacts: design tools, design artefacts: design approaches, and design artefacts: design outputs. Numbers in brackets indicate the number of papers containing relevant data (see Additional file 2: Appendix B: Data analysis tab/column J to S for model details).

The main results of the data analysis are as follows:

- *Designers.* The majority of the 44 papers show that companies or organisational users are the main designers of their business models (e.g. senior managers, business case representatives, managers, CEOs, CSOs, organisational leaders, social innovators, senior staff, design entrepreneurs, the strategic planning and development groups) ($n=32$), design researchers/experts are the business model design facilitators ($n=28$) and multiple stakeholders are participants ($n=36$). Seven papers show that multidisciplinary teams are the main designers of business models.

Table 5 Results of coding on the value of design thinking for business model innovation

Categories	Codes	Examples
Methodology ($n=44$)	Methodologies ($n=2$)	The application of the design methodology can be effective for business model innovation, such as using prototyping to facilitate disruption (Amano et al., 2017)
	Tools ($n=8$)	Design tools can lead to quality dialogues over (re)framing of problems and future business scenarios, followed by qualitative judgment on the most promising scenario (Gudiksen et al., 2014)
	Approaches ($n=25$)	Design thinking approach can be used to develop design opportunities (innovations) and projects/solutions based on problem solving in context (Blois, 2015)
	Methods ($n=6$)	Design thinking methods can be used to create a design-driven innovation methodology to create business model prototypes (Wang et al., 2021)
	Ways ($n=6$)	Designers' way of generative modelling and visual thinking can be used to make new discoveries of business model inventions (Simonse, 2014)
	Processes ($n=2$)	"The 'design thinking' elements stimulate the ideation process and help to harmonise often conflicting stakeholder interests" (Geissdoerfer et al., 2016, p. 1218)
	Activities ($n=2$)	The tangible business modelling activities can be seen as design thinking with hands and body (Buur & Gudiksen, 2012)
	Learning styles ($n=1$)	Design processes, activities and learning styles can improve dialogues on business model development and get participants to work with 'future state' alternatives for approaching business model development (Gudiksen, 2012)
	Learning processes ($n=1$)	The iterative learning process (i.e. prototyping) in design thinking plays a vital role in identifying a right direction among a wide range of directions business model innovation can possibly take (Amano, 2014)
	Principles ($n=1$)	Design thinking principles can be used to increase the innovation capability of companies in the early development phase of new business models (Heck et al., 2018)
Ways of thinking ($n=2$)	Ways of thinking ($n=2$)	Designers' way of generative modelling and visual thinking can be used to make new discoveries of business model inventions (Simonse, 2014)

- *Design activities.* Three types of design activities were identified in the data analysis—participatory design activities ($n=37$), design research activities ($n=25$) and design activities ($n=41$). Most papers describe design activities conducted by the main designers of the business model ($n=41$), as well as participatory design activities involving multiple stakeholders, such as workshops ($n=37$). In addition, 25 papers demonstrate the importance of design research activities for business model innovation, such as participant observation, shadowing and open-ended qualitative interviews. (For more details on participatory design activities and design research activities, see Additional file 2: Appendix B: Data analysis tab/column L)
- *Design artefacts: design tools.* The results show that the majority of papers ($n=40$) describe the use of design tools to facilitate business model innovation (see Additional file 2: Appendix B: Data analysis tab/column N). Of these, 29 papers describe the use of existing tools for business model innovation (e.g. Business Model Canvas and Customer Journey), 18 papers show the application of new business model design tools (e.g. Free Format Sketching and Value Transaction

Table 6 Coding results on applying design thinking for business model innovation

Categories	Codes
Designers ($n=42$)	<ul style="list-style-type: none"> • Design researchers/experts as facilitators ($n=28$) • Design researchers/experts as main designers ($n=3$) • Company or organisation users as main designers ($n=32$) • Company or organisation users as participants ($n=1$) • Multiple stakeholders as participants ($n=36$) • Multiple stakeholders as main designers ($n=1$) • External multi-disciplinary teams as main designers ($n=2$) • Multi-disciplinary teams as main designers ($n=5$) • Multi-disciplinary teams as participants ($n=1$)
Design activities ($n=41$)	<ul style="list-style-type: none"> • Participatory design activities ($n=37$) • Design research activities ($n=25$) • Design activities ($n=41$)
Design artefacts: design tools ($n=40$)	<ul style="list-style-type: none"> • Applying new business model design tools ($n=18$) • Using existing tools for business model innovation ($n=29$) • Applying new tools to enable business model innovation ($n=2$) • Using existing tools to enable business model innovation ($n=1$) • Using tools of business analytics to support business model innovation ($n=5$)
Design artefacts: design approaches ($n=41$)	<ul style="list-style-type: none"> • New business model design approaches ($n=31$) • New product and service design approaches ($n=1$) • Existing product and service design approaches ($n=1$) • New design thinking and innovation approaches ($n=2$) • Existing design thinking and innovation approaches ($n=3$) • New design approaches to make business modelling tools ($n=1$) • New frameworks of using design approaches for business model innovation ($n=2$)
Design artefacts: design outputs ($n=44$)	<ul style="list-style-type: none"> • Prototypes of new products and services ($n=35$) • Prototypes of value propositions ($n=1$) • Prototypes of new business models ($n=34$) • New products and services ($n=23$) • New business models ($n=23$) • Opportunities for the transition to new business models ($n=15$)

Mapping) (for more details, see Additional file 2: Appendix B: Using existing tools for BMI tab and New BMD tools tab), and 5 papers mention the use of business analytics tools to support business model innovation (e.g. SWOT analysis, Benchmarking, Logical Model, Social Reporting Standard). There are also 2 papers describing the application of new tools for enabling business model innovation and 1 paper shows the use the existing tools for enabling business model innovation—these tools were not used directly for business model innovation, but for creating new products and services.

- *Design artefacts: design approaches.* Of the 44 papers, 41 describe design approaches for business model innovation (see Additional file 2: Appendix B: Data analysis tab/column P). 31 papers describe the use of new business model design approaches, of which 18 describe general approaches to business model design and 13 describe user case-specific approaches, such as those for developing sustainability and product-service systems (see Additional file 2: Appendix B: New BM design approaches tab). The results also revealed several other new approaches to business model innovation: new frameworks of using design approaches for business model innovation ($n=2$), new design approaches to make business modelling tools ($n=1$) and new design thinking and innovation approaches ($n=2$) and new product and service design approaches ($n=1$). Existing design thinking and

innovation approaches ($n = 3$) and existing product and service design approaches ($n = 1$) were also used to enable business model innovation.

- *Design artefacts: design outputs.* All 44 papers describe the design outputs of business model innovation (see Additional file 2: Appendix B: Data analysis tab/column R). Most of them emphasise the importance of prototypes in business model innovation—35 papers mention prototypes of new products and services, 34 describe prototypes of new business models and 1 mention prototypes of value propositions. About half of the papers describe the creation of new products and services ($n = 23$) and business models ($n = 23$). Fifteen papers notes that design activities can lead to opportunities for transition to new business models. The data analysis also provides an overview of how new products, services and business models can be co-created:
 - 27 papers show that new products and services can be prototyped in the process of business modelling;
 - 4 papers indicate that new business models can be devised around the new products/services;
 - 1 paper gives an example of how new business models can be devised around a new way of co-producing new products/services;
 - 1 paper suggests that the creation of new business model can empower the development of new products and services;
 - 1 paper suggests giving shape to new products/services together with new business model and using new business models as a framework to direct the development of new products/services.

How can the impact of design thinking be measured and evaluated?

Table 7 shows the results of coding on how the impact of design thinking (or designers' way of problem-solving) to business model innovation can be measured or evaluated (see Additional file 2: Appendix B: Data analysis tab/column T to W for details). All the 44 papers describe the impact of design thinking (or designers' way of problem-solving). 33 papers measured or evaluated the impact—design thinking or designers'

Table 7 Coding results on the impact of design thinking

Categories	Codes
Impact (44)	Impact (measured/evaluated) (33) Impact (not measured/evaluated) (11) No impact (0)
Measurement/evaluation methods (35)	Case studies (29) Experiments (5) Reflections (3) Feedback collection (9) Informal interviews (follow-ups) (1) Observations (32) Documentary analysis (4) Literature review (1)

way of problem-solving can help create new products and services ($n=29$) and new business models ($n=33$), and by applying design thinking or designers' way of problem-solving, companies and related stakeholders can learn new knowledge and skills for business model innovation ($n=6$). The measurement and evaluation methods used are observations ($n=32$), case studies ($n=29$), feedback collection ($n=9$), experiments ($n=5$), documentary analysis ($n=4$), reflections ($n=3$), informal interviews (follow-ups) ($n=1$) and literature review ($n=1$). The other 11 papers identified the potential positive impact of design thinking (or designers' way of problem-solving) on new product and service development and business model innovation, but did not provide evidence to measure or evaluate this impact.

Discussion

Key theme 1: Design thinking as a mindset and a methodology

The review shows that in the context of business model innovation, design thinking is often regarded as a valuable methodology and/or a way of thinking. In fact, design thinking is often regarded as a mindset characterised by a series of important design principles that are useful for enhancing design processes (e.g. reflective practice, communication through visualisation, empathy, fail quickly and cheaply, and structuring the problem-solving process) (Brenner et al., 2016; Gudiksen et al., 2014; Lehmann et al., 2015). However, the boundaries between design thinking as a way of thinking and as a methodology has not always been well described by researchers. For example, Simonse (2014) notes that designers' approach to generative modelling and visual thinking (i.e. communication through visualisation—as part of the design thinking mindset) can be used to make new discoveries about business model inventions.

A promising future research direction could be to explore the value of design thinking as a mindset for business model innovation. Jenkins and Fife (2014) indicate that design thinking, as a synthetic, holistic and heuristic mode of thinking, complements the analytical thinking that managers rely on when solving problems and making decisions. Wrigley et al.'s (2016) research points out that design thinking is a necessary mindset for business model innovation and represents the willingness to explore future possibilities. It is worth noting that in recent years, design researchers have expanded their understanding of 'design thinking as a way of thinking' (Howard et al., 2015; Schweitzer et al., 2016). For example, a recent study showed that there are as many as 22 constructs of design thinking mindset (e.g. tolerance for—being comfortable with ambiguity—uncertainty, embracing risk, human centredness, empathy/mindfulness and awareness of process, holistic view [considering the problem as a whole] and problem reframing) (Dosi et al., 2018). These constructs of design thinking as a mindset can be further explored in business model innovation research.

The review shows that researchers have extensively explored the methodological value of design thinking for business model innovation. Gudiksen's (2012) categories of design thinking—design reasoning, design problems, design learning approaches and design making essentials—can be used to organise some of the key findings, as shown below.

- Design reasoning: Applying abductive reasoning (e.g. switching between divergent and convergent reasoning) can lead to the emergence of new business scenarios in

the business model design process (Geissdoerfer et al., 2016; Gilbert et al., 2012). The knowledge funnel is also considered valuable for business model innovations. For example, it has been used by Deloitte to create the Deloitte Digital Business Model Mind Map (Gilbert et al., 2012).

- Design problems: Several researchers (Bason, 2012; Buur & Gudiksen, 2012; Gudiksen, 2012) pointed out that business model design problems are ill-structured problems or wicked problems. Reflection-in-action can lead to the co-evolution of solutions (various future scenarios and business model prototypes) and problems (business model design problems) (Amano et al., 2017; Bucolo & Wrigley, 2012; Geissdoerfer et al., 2016; Simonse & Badke-Schaub, 2014).
- Design learning approaches: Designers' 'learning through doing' strategy and material culture are useful for business model innovation. The designers of business models can apply some learning approaches by using specific design methods, design tools and play design games, such as: (1) visual learning through sketches and drawings, e.g. using the Business Model Canvas (Buur et al., 2013); (2) tangible learning through materials, e.g. playing design games such as the Distribution Channel Sand-play and Pinball Flow Game (Buur et al., 2013); (3) embodied learning or bodystorming, e.g. the design methods of tangible value network mapping and staging business relations (Geissdoerfer et al., 2016).
- Design making essentials: In terms of design making essentials, designers can use certain mechanisms (e.g. design games and prototyping) to create 'what-if scenarios' or 'future scenarios' dialogues among stakeholders (Amano et al., 2017; Buur & Gudiksen, 2012; Gudiksen, 2012; Gudiksen et al., 2014; Jenkins & Fife, 2014). Business model prototyping is a key mechanism throughout the business model design process. Prototypes can be used as learning tools in business model development (including implementation), characterised by an iterative process (Amano et al., 2017). Adopting an evolutionary perspective is necessary for the iteration of prototypes—it can deconstruct and rebuild the organisational situation to identify new opportunities for business model innovation (Amano et al., 2017). There are many other benefits to using a business model prototype. For example, low-cost business model prototypes allow companies to test and improve them before implementation (Jenkins & Fife, 2014).

Key theme 2: Designers of business models

In recent years, design researchers have also paid more attention to investigating the capabilities of designers as the primary agents of design activities (Kimbell, 2011; Pandza & Thorpe, 2010), to understand the socialised, situated, contextual and contingent nature of design activities (Adams et al., 2011; Pandza & Thorpe, 2010; Smulders et al., 2014), and to explore the roles of design artefacts in the design process and different ways artefacts emerge (Kimbell, 2009, 2011; Pandza & Thorpe, 2010). This trend is also reflected in the literature applying design thinking for business model innovation (Bason, 2012; Buur & Gudiksen, 2012; Gilbert et al., 2012; Jenkins & Fife, 2014).

Most of the papers reviewed have shown that CEOs and senior managers, design researchers and experts, and the company's key stakeholders all play an important role

in the design of business models. CEOs and senior managers who are the key decision-makers in their businesses can be the primary designers of their business models (Bason, 2012; Buur & Gudiksen, 2012; Gilbert et al., 2012; Jenkins & Fife, 2014). The facilitation of design experts can help them to apply design thinking for business model innovation (Buur & Gudiksen, 2012; Geissdoerfer et al., 2016; Gilbert et al., 2012; Gudiksen, 2012; Jenkins & Fife, 2014; Komatsu et al., 2016). The design process could engage multiple stakeholders as they can provide various perspectives of value proposition, creation, capture, delivery and exchange, and contribute their knowledge, skills and resources networks for business model innovation (Cautela et al., 2014; Geissdoerfer et al., 2016; Gilbert et al., 2012; Gudiksen, 2012; Gudiksen et al., 2014; Simonse et al., 2012). Multi-disciplinary team collaborations are also valuable for business model innovation (Bryant et al., 2020b; Unterberger et al., 2018).

Key theme 3: Design activities for business model innovation

The review has shown that participatory design activities and design research activities can promote business model design and innovation. Participatory design activities can help design business models by creating settings and activities and developing and using design tools that lead to quality dialogues among participants (Blois, 2015; Buur & Gudiksen, 2012; Geissdoerfer et al., 2016; Gudiksen, 2012; Gudiksen et al., 2014; Suteu & Perondi, 2016). In participatory design activities, professional designers can play the role of facilitator and observer (Gudiksen, 2014; Suteu & Perondi, 2016). Well-designed workshop protocols can encourage synergy between disciplines and knowledge domains (Blois, 2015). Feedback can be collected from participants to improve workshop frameworks and design tools (Bryant et al., 2020b; Chen et al., 2016; Price et al., 2013).

Moreover, managers can initiate design research activities to trigger new product and service provisions and business model innovations and to address challenges facing their organisations (Gilbert et al., 2012). Various design approaches and methods can be used in research activities (e.g. qualitative and ethnographically inspired design research, user research, co-design processes, rapid prototyping, visualisation, experimentation, and interactive and tangible workshop formats) (Bason, 2012; Gilbert et al., 2012; Gudiksen, 2012; Simonse et al., 2012). In design activities, traditional market research tools and the tools of business analytics can be used to support business model innovation, such as collecting and analysing customer data, identifying target markets, conducting future competitor analysis, exploring revenue potential, describing potential cost profile, and developing progression pathway for developing new business models (Garrett & Wrigley, 2019; Jenkins & Fife, 2014).

Key theme 4: Design tools for business model innovation

The review has shown that a variety of new design tools can be created for business model innovation. The main research findings of new design tools are as follows:

- Design tools can be developed and applied to explore and deal with business model problems and to uncover, create and advance perspectives on new business models (Buur & Gudiksen, 2012; Ceschin et al., 2014; Geissdoerfer et al., 2016; Gudiksen et al., 2014; Simonse & Badke-Schaub, 2014).

- Design tools can also be developed for connecting a company's strategies, business model(s) and operational activities (Bucolo & Wrigley, 2012; De Reuver et al., 2013; Gilbert et al., 2012), or, in other words, market product strategy, business model and organisation design (Gudiksen, 2012; Jenkins & Fife, 2014).
- Design tools can be created based on designerly adaptation and reinvention of methods from other fields. For example, ethnographic methods can be transformed into cultural probes and context mapping tools (Simonse et al., 2012).
- Many design tools have been proposed and developed for managers to use, such as Business Model Canvas, Actor Maps, Role Perspectives, Activity Maps, Distribution Channel Sandplay, the Partnership Game, the Pinball Flow Game, the Design Led Innovation Integrated Business Model Prototype, the Value Mapping Tool and Business Model Roadmapping (Bocken et al., 2013; Bucolo & Wrigley, 2012; De Reuver et al., 2013; Emili et al., 2016; Garrett et al., 2016; Gudiksen et al., 2014; Komatsu et al., 2016; Osterwalder & Pigneur, 2010; Short et al., 2012; Simonse, 2014; Simonse & Badke-Schaub, 2014). Some specific design tools were also proposed for non-profit organisations to use, such as Komatsu et al.'s (2016) Adapted Social Innovation Business Model Canvas and Suteu and Perondi's (2016) Business Model Canvas for Non-profit (BM4NP).
- The users of design tools can also contribute to the creation and improvement of design tools (Emili et al., 2016; Gudiksen, 2014; Suteu & Perondi, 2016).

Key theme 5: Design approaches for business model innovation

As aforementioned (Sect. 4.2.4), researchers created and tested many new generalised or customised design approaches for business model innovation. In addition, researchers have tried different approaches to create design approaches. Some researchers have explored design-led approaches, such as Buur and Gudiksens' (2012) design thinking approach with hands and body, which can innovate business models through using design materials to engage cross-disciplinary stakeholders to play with hypotheses and experiment with scenarios; and Bryant et al.'s (2020a) replicable, reflective design-led approach, which uses key tools to implement business model innovation. Jenkins and Fife (2014) proposed a customer insight-led business model innovation approach and a futures-led business model innovation approach. Some researchers have combined traditional analytical and designerly approaches. For example, Simonse et al. (2012) adopted the business model concepts from the strategic management fields and adapted the accompanied analytical approach to a designerly modelling approach. Similarly, Komatsu et al. (2016) made a business model design approach that combines the traditional analytical perspective with a designerly approach through a toolbox. Some researchers have created transdisciplinary research approaches for business model innovation, such as Unterberger et al.'s approach (2018), which includes the following three phases Co-Design, Co-Production, Co-Communication and Transdisciplinary Re-Integration. The different directions explored by researchers suggest that creating design approaches for business model innovation is an interesting topic that can be further explored.

Key theme 6: Co-creation of new products, services and business models

The review has shown that new business models, new products and new services can be co-created in five different ways: (1) new products and services can be prototyped in the process of business modelling; (2) new business models can be devised around the new products/services; (3) new business models can be devised around new ways of co-producing new products/services; (4) new business model can empower the development of new products and services, and (5) new products/services can be given shape together with new business models, and new business models can be used as a framework to direct the development of new products/services. Each approach is proposed in a specific context and has its own application scenario; for example, some researchers demonstrated that new approaches of product and service development, production, marketing and distribution (e.g. open business models and stakeholder engagement) could lead to business model innovation (Cautela et al., 2014; Pisano et al., 2014). The review also shows that researchers tend to explore opportunities to create new products and services as a starting point for business model innovation (Bason, 2012; Blois, 2015; Ceschin et al., 2014; Emili et al., 2016; Gilbert et al., 2012). Since business model innovation often involves the development of new products and services and the creation of business models, it is valuable to further explore how design thinking can support the co-creation of new products, services, and business models in design activities and in the real business worlds.

Key theme 7: Evaluating and measuring the impact of design thinking

Finally, the review shows a number of methods, such as case studies and feedback collection, that can be used to measure and evaluate the impact of design thinking (or designers' way of problem-solving) on business model innovation. Instead of directly measuring the impact of design thinking, most papers provide case studies of using design thinking (or designers' way of problem-solving) for business model innovation and describe how design tools, design activities and participatory design activities support the development of new products, services and business models based on observations (Buur & Gudiksen, 2012; Simonse et al., 2012). Researchers sometimes collect quantitative and qualitative data through questionnaires and interviews to assess the impact of design workshops, approaches, methods and tools on business model innovation (Bucolo & Wrigley, 2012; Buur & Gudiksen, 2012; Geissdoerfer et al., 2016). In the future, evaluation and measurement frameworks can be developed to support the development and improvement of design approaches and tools that use design thinking as a methodology and mindset for business model innovation.

Summary

This paper has argued that business model innovation can be regarded as a subject of design research and has discussed the extensive application value, the strategic role and the application challenges of design thinking in business model innovation. It has also provided a comprehensive overview on applying design thinking for business model innovation, based on a literature review. The literature review has revealed how researchers define and describe design thinking in their papers, why they believe design

thinking is valuable for business model innovation, how design thinking has been and can be used for business model innovation and how the impact of design thinking can be measured and evaluated. Based on the literature review, this paper has also identified seven key research themes on applying design thinking for business model innovation: (1) design thinking as a mindset and a methodology; (2) designers of business models; (3) design activities for business model innovation; (4) design tools for business model innovation; (5) design approaches for business model innovation; (6) co-creation of new products, services and business models, and (7) evaluating and measuring the impact of design thinking. The seven research themes can be further explored in future research. A special attention can be paid to the socialised, situated, contextual and contingent nature of design activities and extend the application of design thinking to the co-evolution of products, services and business models. Overall, this paper will benefit researchers and practitioners who are interested in applying design thinking for business model innovation, whether they have a background in design, organisational research or management.

Supplementary Information

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Additional file 1. Literature Search Results.

Additional file 2. Data Analysis.

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Authors' information

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