Electronic Markets
https://doi.org/10.1007/s12525-018-0326-1

RESEARCH PAPER

Software tools for business model innovation: current state and future challenges

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Received: 24 May 2018 / Accepted: 12 December 2018

Abstract

Software tools for business model development hold great promise for supporting business model innovation, but nonetheless, virtually no design-relevant knowledge exists concerning the functions that such tools should possess. As a result, practitioners lack guidance for choosing software tools, and researchers lack a foundation for advancing knowledge on these tools in a cumulative way. To address these issues, we synthesize knowledge from research on software tools for business model development and adjacent fields with the results of an analysis of 24 software tools from practice. Our contribution is threefold. First, we provide a comprehensive taxonomy that identifies 43 characteristic functions of software-based business model development tools. Second, we provide a classification of existing software tools for the taxonomy and, on this basis, third, we derive an agenda for future research. We thus support practitioners' decision making on tool (re-)design and investment, and provide the foundation for a cumulative stream of research on software tools for business model development.

Keywords Business model · Business model development tool · Business model innovation · Taxonomy · Research agenda

JEL classification O3 · L86 · M15

Introduction

A business model describes the mechanisms of how a firm creates, delivers, and captures value (Teece 2010), and as such is akin to a detailed description of a firm's strategy (Adner et al. 2014; Casadesus-Masanell and Ricart 2010). The interest in business models and business model innovation is intense and growing – from researchers and practitioners alike. For example, a survey of some 3000 executives in 26 countries finds that a majority of 60% consider "defin[ing] an effective business model" a major challenge for their innovation activities (GE 2014, p. 40). Likewise, researchers in fields as diverse as information systems (IS) (Al-Debei and Avison 2010), entrepreneurship (George and Bock 2011), and strategy (Massa et al. 2017) emphasize the importance of business model innovation for the competitiveness of firms.

Business model innovation is a creative as well as a collaborative task (Ebel et al. 2016; Eppler et al. 2011), because it relies on the generation of creative business model ideas and often requires people from various disciplines (e.g., sales, marketing, IS, and research & development) working together. Prior research in a variety of fields has found that tasks that are creative and collaborative can benefit from the support of software tools (e.g., through facilitated exploration, analysis, communication, and documentation). Research on process modeling, for example, acknowledges it as a creative as well as collaborative task (Figl and Recker 2016), and that software tools for process modeling have a profound impact on the quality of the resulting process models (Recker 2012). Likewise, research on creativity support systems (e.g., Seidel et al. 2010), group support systems (e.g., Nunamaker et al. 2015), and new product development (e.g., Mauerhoefer et al. 2017) acknowledges that software tools can substantially affect their users' performance in generating creative outcomes. Consequently,

This article is part of the Topical Collection on Business model innovation: Tools and Innovation patterns

Responsible Editor: Harry Bouwman

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Published online: 15 January 2019

given the collaborative and creative nature of business model innovation, software-based business model development tools (BMDTs) are said to have great potential to support their users in innovating business models (e.g., Ebel et al. 2016; Osterwalder and Pigneur 2013; Veit et al. 2014). This potential is reflected not only in recent calls for BMDTs in the IS discipline, but also in adjunct disciplines (e.g., Schneider and Spieth 2013), in which the introduction of software-based tools has already successfully contributed to an improvement of the development of strategies and products, for example. Software-based tools for strategy making, for example, enable to easily integrate and document information from various sources during the process of ideating and progressing such strategies. Furthermore, such tools also enable to easily document which facts are (de-)legitimized to be taken into account for developing strategies (Kaplan 2011). Software-based tools for new product development, for example, have a positive effect with regard to the use frequency (i.e., how often users employ such tools) and the replacement (i.e., how often existing functions advance or new ones are added) (Kawakami et al. 2015). A demand for BMDTs can also be observed among practitioners, who notice that having "no tools [...] is a big problem" and consistently agree in that "software support would be a key additional value" for innovating their firm's business models (Terrenghi et al. 2017, p. 981).

A number of BMDTs have been developed in research (e.g., Akkermans and Gordijn 2003; Ebel et al. 2016) and practice (e.g., *RealtimeBoard*, *Strategyzer*; for an overview of all BMDTs see Appendix Table 3). These tools have functions that, among others, allow to represent, share, annotate, and version business models. Some of these tools have already gained considerable popularity in practice, as indicated by, for example, more than 100,000 downloads for the app *Business Model Canvas & SWOT*, and more than 1,000,000 business model projects in the browser application *Canvanizer*. Furthermore, some BMDTs show a strong growth in the number of registered users (e.g., more than 1000 new users sign up for *Business Model Fiddle* every month) and others already have a solid base of registered users (e.g., more than 20,000 registered users of *Insight Maker* and Strategyzer as well as more than 1,700,000 registered users of *RealtimeBoard*).[1] Moreover, prior research has proposed that certain functions of BMDTs are particularly conducive to the utility of these tools (e.g., messaging functionality and profile pages, Ebel et al. 2016). Nonetheless, researchers lack comprehensive knowledge concerning which functions BMDTs should have in order to provide the best possible support to their users for innovating business models.

From a practical perspective, this lack of knowledge is problematic because it inhibits tool users making informed tool investment decisions and tool designers in their efforts to (re-)design BMDTs (an argument made similarly by researchers of process modeling tools, see Recker 2012). The lack of knowledge is also problematic from a theoretical perspective, because knowledge concerning the usefulness of the various functions of BMDTs would contribute to a better understanding of business model innovation in general, while these processes are still rather ill-understood (Schneider and Spieth 2013). There is no evidence yet on the usefulness of different functions of BMDTs. The goal of this study is to enable such research to be conducted and to prepare the ground for evaluating the usefulness of different functions of BMDTs in specific use contexts. Accordingly, IS researchers have called for more research to derive prescriptive, design-relevant knowledge for BMDTs (e.g., Alt and Zimmermann 2014; Osterwalder and Pigneur 2013; Veit et al. 2014). Therefore, the goal of this study is to respond to these calls by addressing the following research question: *What are characteristic functions of software tools for business model development?*

As a first step towards answering this question, we draw on and synthesize research on BMDTs and adjacent domains, as well as the results of an analysis of 24 BMDTs from practice. The rationale for analyzing these BMDTs lies in the concept of technology inscription, which assumes that technological artifacts (such as software-based tools) are sources of knowledge about a domain (for more details, see Cozzens et al. 1989). In this way, we explicitly take a technical perspective of these functions to be affordances in the sense of "possibilities for action that [a software-based tool] offers" (Hutchby 2001, p. 49). For our synthesis, we employ the taxonomy building approach by Nickerson et al. (2013) and evaluate the resulting taxonomy through a series of user studies. In our tool analysis, we follow prior research by adopting the view that the Business Model Canvas (Osterwalder and Pigneur 2010) has become the quasi-standard for representing business models (e.g., Massa et al. 2017; Spieth et al. 2014; Strategyzer 2015), and therefore we analyze software tools that allow to develop business models using the Business Model Canvas. In so doing, we make three contributions. First, we provide a taxonomy of functions for BMDTs. Such a taxonomy is an important prerequisite for describing the context of a software and subsequent empirical studies on this software (e.g., for evaluating the usefulness of certain functions) (Kitchenham et al. 2002). We thereby provide a *theory for analyzing*, which according to Gregor's classification of theory types is the most basic form of theory, and as such is the necessary foundation for theories that are more advanced (i.e., theories of explanation and prediction) (Gregor 2006). For our

[1] *Business Model Canvas & SWOT:* play.google.com; *Canvanizer:* canvanizer.com (the number of projects, admittedly, only provides a very rough estimate of the popularity, as one user can start multiple projects and as it is unclear what effort was devoted to each project); *Business Model Fiddle*: bmfiddle.com; *InsightMaker*: insightmaker.com; *Strategyzer*: strategyzer.com; *RealtimeBoard*: realtimeboard.com; figures retrieved on October 24th, 2018.

second contribution, we provide a classification of the currently available Canvas-based BMDTs for the taxonomy we have developed (and evaluated). Third, based on contributions from business model research and adjacent domains as well as from the insights gained from the classification of existing tools, we derive an agenda for future research on the functions of BMDTs. With these contributions, we support practitioners in their tool (re-)design and investment decisions. For researchers, our theory for analyzing (i.e., the taxonomy) and our research agenda lays the foundation for a cumulative stream of research on software tools for business model development, and for theories that are more advanced and go beyond our theory for analyzing.

Background

As we seek to identify the characteristic functions of BMDTs, two streams of studies are relevant for our research. First and foremost, studies are obviously relevant if they address software tools for developing business models. Second, studies are also relevant if they address software tools for tasks that share similarities with the task of business model development (e.g., innovation tasks in contexts other than business model innovation), as such studies promise to yield insights that could fruitfully augment our knowledge on BMDTs. In the following, we briefly review both types of previous studies.

Software support for business model development

In order to support the design of business models with software, it is a prerequisite to have an agreed upon and rigorously defined understanding of what constitutes a business model (Osterwalder et al. 2005). For this purpose, a number of modeling languages have been proposed, which provide a vocabulary for capturing information on business models and a visual notation for presenting this information (e.g., e^3value, Akkermans and Gordijn 2003; the strategic business model ontology, Samavi et al. 2009; for a review see John et al. (2017). Of these modeling languages, the Business Model Canvas (Osterwalder and Pigneur 2010) has become the quasi-standard (e.g., Massa et al. 2017; Spieth et al. 2014; Strategyzer 2015). The Business Model Canvas defines a business model as consisting of nine *components* (e.g., value proposition, customer segments, revenue streams), whose instantiations (or *elements*) serve to describe a concrete business model (e.g., the element 'retail stores' for the component 'channel', see Fig. 1). Its relevance is evident, for example, in that the book that presented the Business Model Canvas (Osterwalder and Pigneur 2010) has sold about one million copies (Strategyzer 2015), and has received more than 6000 citations (according to Google Scholar).

Various software tools have been proposed for supporting the application of the existing modeling languages (e.g., Gordijn et al. 2000; Peinel et al. 2010). These tools allow to digitally represent and change business models. As such, these tools have the potential to support their users in performing certain actions more efficiently than with the 'pen & paper' versions of the modeling languages (e.g., annotating and versioning business models). In addition, these software tools allow their users to perform actions that are not even possible with 'pen & paper' tools (e.g., collaborative business model development in distributed teams, Ebel et al. 2016). Therefore, numerous authors have emphasized that such software tools can meaningfully support innovating business models and that further research on such tools is necessary (Ebel et al. 2016; Osterwalder and Pigneur 2013; Veit et al. 2014). However, to the best of our knowledge only very few studies have sought

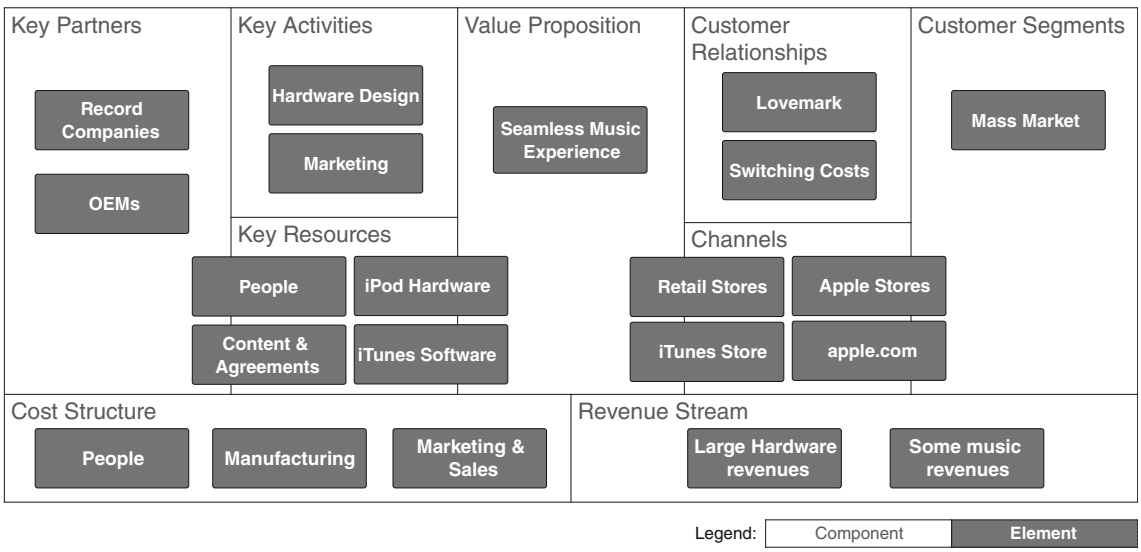

Fig. 1 Illustration of the Business Model Canvas using Apple's iPod/iTunes business model (adapted from Osterwalder and Pigneur 2010, p. 46)

to identify the functions BMDTs that should be able to perform. Ebel et al. (2016) identified in their action design research 20 functions that they consider conducive to innovating business models (e.g., sharing various types of documents and tagging competencies in community profiles). Other previous attempts seek to replicate the sticky note experience from paper-based business model development and investigate the extent to which the (necessary) compromise between creativity and constraints for business model development can, if at all, be reproduced in software-based tools (Fritscher and Pigneur 2010, 2014a, b). These studies can provide a valuable starting point for our attempt to develop a comprehensive overview of the functions of BMDTs. Moreover, a literature review of over 1500 business model papers found that users of the Business Model Canvas perform a number of customizations of the components comprised in the Business Model Canvas in order to overcome certain limitations (i.e., by (1) adding new, (2) dividing, (3) linking, or (4) renaming components, and (5) changing the arrangement of the components, Schoormann et al. 2016). It seems reasonable to expect that such customizations should also be possible in BMDTs.

Software support in adjacent disciplines

A number of disciplines address tasks that share similarities with the task of business model innovation and, at the same time, explore the extent to which tasks in these domains can be supported by software. These disciplines include research on creativity support systems (e.g., Wang and Nickerson 2017, as the task of business model innovation can be seen as a special case of creative tasks, Eppler et al. 2011), research on tools for new product development (e.g., Mauerhoefer et al. 2017, as product innovation and business model innovation share a number of similarities, Bucherer et al. 2012), research on tools for process modeling (e.g., Recker 2012, as process modeling and business model development likewise rely on (semi-)formal modeling languages, John et al. 2017), and research on tools for strategy development (e.g., Jarzabkowski and Kaplan 2015, as business models and strategies are highly similar concepts, Massa et al. 2017). However, only in process modeling research could we identify a contribution that seeks to comprehensively identify (i.e., in the form of a taxonomy, typology, classification framework, or the like) the functions that software tools in that discipline should possess. Hence, in the following we briefly sketch the researchers' perspective on software tools for process modeling.

The role that BMDTs have for business model modeling languages shares some similarities with the role that process modeling tools have for process modeling languages: both kinds of tools facilitate creating and changing models whose semantics and visual notation are defined by a modeling language (thus, business models as well as process models are forms of conceptual modeling that aim to represent a phenomenon of interest, Wand and Weber 2002), and in both cases the modeling task is collaborative and creative in nature.

Similarities can also be found if one considers the (past) course of the more evolved business process research with the comparatively more recent business model research: Business process research has already taken development steps that (may) still lie ahead for business model research. In particular, the maturity and the fuzziness of the underlying concept (i.e., business processes and business models) that modeling tools in each of the two fields intend to facilitate is different. Furthermore, the underpinnings of business processes are already comprehensively investigated for several decades, whereas the concept of business models is about to grow out of its infancy (Massa et al. 2017). In addition, the solution space of possible business model alternatives is broader. The inherent (necessary) fuzziness of the business model concept, unlike for business processes, makes it more difficult to determine whether a business model is correctly represented through a modeling language for business models and when a business model is of high quality. Furthermore, business model research suggests to make use of creativity techniques to properly explore the solution space of possible business model alternatives. This developmental step has already been taken by business process research (Paper 1997; Kettinger et al. 1997). Likewise, the developmental step of employing software-based tools to facilitate the development of such models has already been started in business process research (Kettinger et al. 1997; Recker 2012). Thus, research on BMDTs may benefit from past development stages of research on process modeling tools.

Hence, while the domain of the modeling object is different (for process vs. business model, see Gordijn et al. 2000), given the similarities, research on the functions of process modeling tools promises to be relevant also for the functions of BMDTs. However, the major part of research on process modeling addresses process modeling languages, and only a few studies address the corresponding modeling tools (Recker 2012; Riemer et al. 2011). To the best of our knowledge, only one attempt has been made to systematically assess the functions that a process modeling tool should provide. In their study, Riemer et al. (2011) develop a taxonomy that offers a comprehensive overview of process modeling tool functions. Given the outlined similarities between developing process models and developing business models, we conjecture that the functions identified in that taxonomy are a valuable starting point for our attempt to develop a comprehensive overview of functions of BMDTs. For building a taxonomy of functions for BMDTs, we draw on literature that is concerned with software support for business model development (Ebel et al. 2016, Fritscher and Pigneur 2010, 2014a, b, and Schoormann et al. 2016) and literature from adjacent disciplines in which experience has been gained in designing

functions of software that facilitate collaborative and creative tasks (Riemer et al. 2011) (see Appendix Table 1 for an overview of which functions origins from which line of inquiry in previous literature). Thereby, this study seeks to systemize and build upon existing research and promote more cumulative research for BMDTs in this still new line of inquiry.

Taxonomy building

Taxonomies are artifacts that describe and classify existing or future objects of a domain and help researchers and practitioners to understand and analyze a domain. For developing our taxonomy, we follow the method proposed by Nickerson et al. (2013). This method is widely accepted in IS research and has been used for developing taxonomies in fields as diverse as IS artifact evaluation methods (Prat et al. 2015), crowdsourcing (Geiger and Schader 2014), and internet of things (Püschel et al. 2016). Furthermore, it has also been used for developing taxonomies for business models in various domains such as carsharing (Remane et al. 2016), telemedicine (Peters et al. 2015), cloud computing (Labes et al. 2013), FinTech start-ups (Gimpel et al. 2017), and crowdfunding (Haas et al. 2014).

The method proposed by Nickerson et al. (2013) allows to systematically develop a taxonomy and is rigorous as it clearly defines the necessary seven steps: First, the purpose and the target group of the taxonomy is defined (step 1 "Determine Meta-Characteristic") for directing the development of the characteristics (i.e., properties) and dimensions (i.e., groups of properties) of the taxonomy. Second, conditions must be defined that describe when the taxonomy development is successfully completed (step 2 "Determine Ending Conditions"). Third, the method continues with iterations through two distinct approaches (step 3 "Approach?"). In each of usually multiple iterations one of the two approaches is pursued. The first is conceptual-to-empirical (i.e., deductive, step 4c-6c), which means that the characteristics and dimensions are derived from relevant literature. The second is empirical-to-conceptual (i.e., inductive, step 4e-6e), which means that objects are evaluated for common characteristics and dimensions. New characteristics and dimensions are added to the taxonomy. Finally, the taxonomy development is successfully completed when the ending conditions are met (step 7 "Ending Conditions Met?").

In the following, we describe how we arrived at our taxonomy of functions for BMDTs by applying the seven steps of Nickerson's method (see Fig. 2).

Determine meta-characteristics (1) There are two potential target groups for our taxonomy: (1) Researchers who are interested in business models and (2) practitioners with the same interest. The purpose of the taxonomy is to describe BMDTs in order to assist researchers and practitioners with the analysis and future development of BMDTs, and assist practitioners with the selection of such tools. To do so, the functions that these tools offer to their users are particularly relevant, because these functions determine what users can achieve by using these tools. Therefore, we choose 'functions of BMDT' as the meta-characteristic. All characteristics and dimensions must comply with this meta-characteristic. To illustrate, when choosing this meta-characteristic, the programming language used to implement a BMDT would not be relevant for the taxonomy. In characterizing BMDTs, the target groups are interested in the similarities and differences of the functions of such tools.

Determine ending conditions (2) For determining when to stop the iterative buildup of the taxonomy, we adopted the ending conditions from Nickerson et al. (2013), with one exception[2]: Following Gimpel et al. (2017), we did not apply the condition whereby "at least one object is classified under every characteristic of every dimension" (Nickerson et al. 2013, p. 344) – as this would have hindered us from retaining functions in the taxonomy that are not yet available in BMDTs (but that are potentially useful as suggested by previous research, see Background).

Select approach (3) We ran through one conceptual-to-empirical iteration and five empirical-to-empirical iterations. In the following we describe the nature of both approaches.

Conceptual-to-empirical (4c, 5c, 6c) In the first iteration, we integrated relevant characteristics from the existing literature (see Background). The sources we drew on were (1) suggestions by previous research (Ebel et al. 2016; Fritscher and Pigneur 2010, 2014a, b), (2) a taxonomy of possible adaptations of the components that the Business Model Canvas consists of (Schoormann et al. 2016), and (3) a taxonomy for describing the functions of process modeling tools (Riemer et al. 2011) (see Appendix Table 1).

Empirical-to-conceptual (4e, 5e, 6e) In further iterations, we classified BMDTs. In each of these, we subsequently complemented the taxonomy by analyzing a maximum of five BMDTs with regard to their functions. To systematically

[2] We adopted the following ending conditions from Nickerson et al. (2013, p. 344):

*Objective ending conditions: All objects or a representative sample of objects have been examined; No object was merged with a similar object or split into multiple objects in the last iteration; No new dimensions or characteristics were added in the last iteration; No dimensions or characteristics were merged or split in the last iteration; Every dimension is unique and not repeated (*i.e., *there is no dimension duplication); Every characteristic is unique within its dimension (*i.e., *there is no characteristic duplication within a dimension); Each cell (combination of characteristics) is unique and is not repeated (*i.e., *there is no cell duplication).*

Subjective ending condition: Concise, Robust, Comprehensive, Extendible, Explanatory.

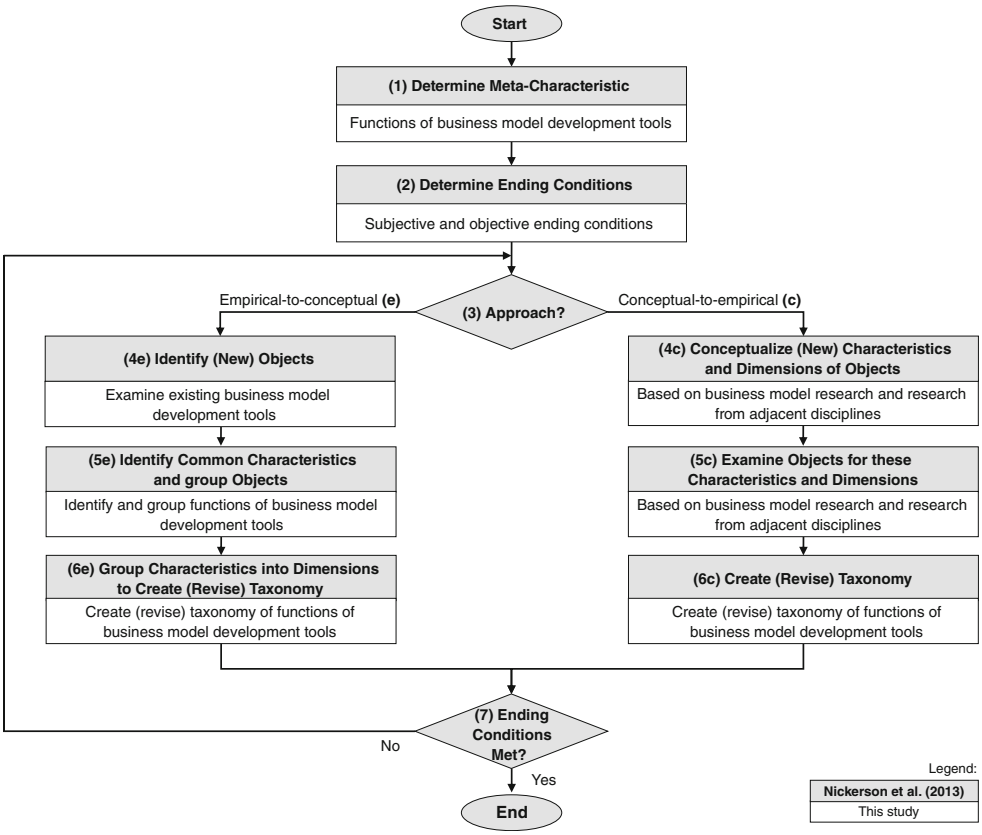

Fig. 2 Taxonomy building (according to Nickerson et al. 2013)

identify the relevant objects (i.e., BMDTs) for the inductive iterations, we adopted the rigorous procedure that Vom Brocke et al. (2009) propose for identifying relevant articles in literature reviews.

- *Selection of sources*: to increase the probability of identifying as many relevant tools as possible, we searched for tools through the most widely used search engines for scholarly and non-scholarly search (Google Scholar and Google) as well as the most widely used app stores (Apple Store and Google Play Store). For Google and Google Scholar, we manually screened the first 300 search engine results (we stopped screening at that number because we did not find any relevant results from number 200 onwards, which made finding further relevant results highly unlikely). For Apple Store and Google Play Store, we screened all results.
- *Identification of keywords*: based on the widespread proliferation of the Business Model Canvas (see Background) our search phrase was: "*business model canvas*" *AND (tool OR software)*. In app stores we searched for "*business model canvas*" only (i.e., without adding *tool OR software*) because the app stores by definition contain only software applications.
- *Inclusion/exclusion criteria*: we included BMDTs that comply with the following criteria: (a) based on the Business Model Canvas; (b) available in English.
- *Tool search*: the search requests for Google, Google Scholar, Apple Store and Google Play Store were run independently by two authors in the browser's incognito mode to avoid the search results being corrupted by previous search requests or the location. A total of 24 BMDTs was identified (see Appendix Tables 2 and 3), of which 14 are web-browser applications, and the other 10 BMDTs are for use on a tablet or computer. Some BMDTs are available in multiple versions that differ in the functions they provide. For developing the taxonomy of any tool with multiple versions, we used the version with the largest range of functions.

To achieve a robust taxonomy from the early iterations, we started the iterations with the BMDTs that we expected to have the widest range of functions. Thus we analyzed fee-based before free BMDTs and browser-based BMDTs before client-based ones (i.e., BMDTs that require an installation on a tablet or a computer). The iterations were carried out in a full-day workshop. Two authors independently identified the functions of the BMDTs in the iterations. For this, both authors individually investigated each BMDT. To allow a

consistent and exhaustive identification of functions, both authors reproduced Apple's iPod/iTunes business model (see Fig. 1) in each BMDT. The third author assumed the role of a devil's advocate by raising critical questions and then suggesting alternative explanations (Eisenhardt 1989). His primary task was to uncover deficiencies and to question assessments. In addition, the devil's advocate was required to provide a different, possibly more objective view thus improving the quality of the taxonomy.

Check ending conditions (7) As a result of the deductive and inductive iterations, all objective and subjective ending conditions of step 2 "*Determine ending conditions*" were indeed met. For each of the characteristics we created a short description (see Appendix Table 4) that allows to assign BMDTs functions more easily and objectively.

Following Gregor and Hevner (2013), to test and revise the descriptions of the taxonomy and its functions, we exposed preliminary versions to four graduate students (i.e., people who were not involved in the taxonomy building) during the taxonomy development. All four students are familiar with developing business models both through university courses they attend and through working as student assistants in a group that analyzes business models. Their experience includes the development of several business model ideas, including with software-based tools. We particularly asked for feedback regarding the understandability of the functions' descriptions. Overall, understandability was high (6.54 on a Likert scale from 1 (strongly disagree) to 7 (strongly agree), see Appendix 5). Based on additional feedback, we sharpened the examples in the descriptions of the functions. In order to avoid social desirability and ensure unbiased responses, feedback was anonymous and we explicitly encouraged them to make a note of anything they found difficult to understand.

Taxonomy description

In the following, we describe our taxonomy of BMDTs, which comprises 43 functions across eleven dimensions (see Fig. 3 and Appendix Table 6). For overview purposes (and thus following Riemer et al. (2011)), these dimensions are structured along the three perspectives of *modeling* (which contains functions for constructing, commenting and assessing a business model), *collaboration* (which contains functions for working on a business model in a team), and *technical* (for describing the architecture and the data exchange functions of BMDTs). Furthermore, we specify for each dimension whether it was derived by deduction (i.e., conceptual-to-empirical) or by induction (i.e., empirical-to-conceptual).

Modeling

The first perspective refers to functions of BMDTs that can be used in particular during the creation of a business model. It comprises five dimensions, namely customization, development,

	Dimension	Characteristics							Approach
Modeling	Customization	Add	Divide	Link	Rename	Change arrangement			Deductive
	Development	Element		Element connection		Template			Inductive, Deductive
	Commenting and linking	Textual comments on element-level	Textual comments on business model-level	Graphical comments (predefined)	Graphical comments (freeform)	Link files	Link web-resources	Glossary support	Inductive, Deductive
	Assessment	Financial		Non-financial		Assessment status		Correctness checker	Inductive, Deductive
	Navigation and filtering	Model comparison	Element filter	Phase management		Element clipboard	Link to business models	Framework support	Inductive, Deductive
Collaboration	Communication	Chat		Discussion board		User list			Deductive
	Synchronization	Asynchronous modeling		Concurrent modeling		Synchronous modeling			Deductive
	User and role management	User management		Role management		Support of task sharing		Workspace awareness	Deductive
	Repository and conflict management	Version control		Local repository		Remote repository			Deductive
Technical	Architecture	Client/Server		Client only		Web-based			Deductive
	Data exchange	Export				Import			Deductive

Approach: Deductive (i.e., conceptual-to empirical), Inductive (i.e., empirical-to-conceptual)

Fig. 3 Taxonomy of functions for business model development tools

commenting and linking, assessment, as well as navigation and filtering.

As a first step, users might want to customize the business model understanding of a BMDT to best fit a certain context. Therefore, the **customization** dimension differentiates between *adding* new components, *dividing*, *linking* and *renaming* existing components as well as *changing the arrangement* of the components. Next, to represent a business model, the **development** dimension comprises functions for describing a business model. This dimension distinguishes between *elements* that describe components of a business model by using sticky notes (which can be moved around freely; while tools without this function only allow entering information in one free text field for every component), *element connections* to make the connection between elements explicit, and *templates* which, to facilitate the idea generation, suggest predefined elements for a certain component (e.g., in the form of lists with elements such as 'retail stores' for the component 'channels') or the entire business model (e.g., in the form of business model patterns). The **commenting and linking** dimension entails functions enabling users to document additional thoughts, questions and ideas to increase the understanding among the involved users while collaboratively developing business models. Commenting distinguishes between *textual comments at element-level* to describe a certain element in more detail, *textual comments at business model-level* to describe the entire business model, *graphical comments (predefined)* to make use of existing shapes and symbols, and *graphical comments (freeform)* to add own drawings. In order to integrate further sources, *link files* denotes functions for the integration of own files (e.g., protocols of customer interviews) and *web-resources* for the integration of files available online (e.g., press releases). For ensuring a consistent use of terms, *glossary support* allows to define specific terms relevant to the domain for which users would like to develop a business model (e.g., the term 'Original Equipment Manufacturer' as a 'key partner' in a computer manufacturer's business model). The **assessment** dimension contains functions for evaluating a business model. While *financial assessment* documents quantitative information such as prices, costs and quantities, *non-financial assessment* refers to qualitative evaluations (e.g., in the form of ratings or likes). In addition, for example to trace whether different assumptions are verified or not, *assessment status* documents the status of certain parts of a business model (e.g., has a hypothesis already been tested?). Lastly, *correctness checker* analyzes the syntax of a business model (e.g., does each component have at least one element?). For facilitating the handling of a business model, the **navigation and filtering** dimension distinguishes between six supporting functions: *Link to business models* (or parts of them) and *framework support* describe the embedding and linkage with further business models or architectures (e.g., TOGAF), *element clipboard* stores elements that have not yet been assigned to a component of a business model, *element filter* shows and hides elements, and *model comparison* identifies commonalities and differences between two or more business models. For guiding the users, *phase management* displays functions that are relevant in a given phase of business model development (e.g., idea generation templates in the phase of business model idea generation).

Collaboration

The second perspective comprises functions for collaboratively developing business models. It consists of four dimensions, i.e., communication, synchronization, user and role management as well as repository and conflict management.

The **communication** dimension captures functions through which a user can interact with other users. While *chat* describes synchronous communication (e.g., via text chat, video calls or screen sharing), *discussion board* supports asynchronous communication. To check with whom a user can actually communicate, *user list* indicates which other users work on the same business model as well as which users are currently online. The **synchronization** dimension differentiates three types of working on a business model. *Asynchronous modeling* allows for working with multiple users on a business model and making changes successively (e.g., through exporting and importing business models). In *concurrent modeling* multiple users are able to work on a business model simultaneously, but changes are only visible to other users after they have been released. Finally, *synchronous modeling* supports the work with multiple users in a simultaneous manner, and thus, changes are visible to other users in real-time. To coordinate the collaborative work on a business model, the **user and role management** dimension distinguishes between *user management* (to add, change and remove users), *role management* (to assign roles and permissions to users), *task sharing* (to assign tasks to certain users) as well as *workspace awareness* (to notify users about changes made by other users). Moreover, the **repository and conflict management** dimension refers to functions for *version control* that documents changes between successive versions of a business model and distinguishes between *local repository* that stores data on the user's device and *remote repository* that stores data on a server.

Technical

The third perspective describes technical attributes of a BMDT and comprises two dimensions, i.e., architecture and data exchange.

The **architecture** dimension differentiates three types of applications. First of all, *client/server* distributes the tool's functions to a client and a server application (i.e., a client

application needs to be installed). Second, *client only* enables the tool's functions solely in a client application (i.e., installation required; offline use supported). Third, *web-based* distributes the tool's functions among a client and a server application in which the web browser acts as the client (i.e., no installation is required). Finally, **data exchange** captures functions for the *import* or *export* of a business model, for example to continue working on a business model developed by another user or developed with another tool.

Taxonomy application

In the following, to determine the current state of the practice, we classified all 24 BMDTs by using our taxonomy (i.e., assign the functions of BMDTs to each of the taxonomy's characteristics) and analyzed their functions from two perspectives, namely frequency of occurrence (i.e., which functions are available?) and co-occurrences (i.e., which functions usually occur together?).

Frequency analysis

First, we investigated the BMDTs with regard to the distribution of functions. For this, we counted the BMDTs that provide a particular function and thereby indicate how often a function is implemented in the BMDTs. In so doing, we aim to identify which functions are provided more or less frequently in such tools. We summarize the results of the frequency analysis in Fig. 4 by depicting the percentage of BMDTs that provide a function (the more frequently BMDTs implement a function, the darker the color-coding).

Despite some overlap, the overall distribution of the functions is quite heterogeneous, and the following four main observations emerge: First, none of the BMDTs provide all of the functions, and only 8 out of 43 functions are provided by more than half of the BMDTs. Second, the greatest consensus regarding the functions that a BMDT should have, can be found for the development dimension in which, for instance, all BMDTs except one allow to use elements to describe business model components (this one BMDT only provides functions for entering information in a free text field). As the tools in our analysis intend to facilitate the development of business models in particular, this is not surprising. Third, there is apparently no consensus regarding the functions that a tool should *not* have. For instance, all dimensions comprise characteristics (i.e., functions) that are supported by some of the BMDTs, and there are only three characteristics across three dimensions that are implemented by none of the BMDTs (i.e., commenting and linking, communication, and architecture).

Co-occurrence analysis

Besides exploring the frequency of single functions, we aim to investigate which functions in BMDTs usually occur together, by performing a cluster analysis. We seek to spot whether

	Dimension	Characteristics						
Modeling	Customization	Add (12.5%)	Divide (12.5%)	Link (12.5%)	Rename (20.8%)	Change arrangement (12.5%)		
	Development	Element (95.8%)		Element connection (83.4%)		Template (4.2%)		
	Commenting and linking	Textual comments on element-level (62.5%)	Textual comments on business model-level (33.3%)	Graphical comments (predefined) (29.1%)	Graphical comments (freeform) (12.5%)	Link files (20.8%)	Link web-resources (12.5%)	Glossary Support (0%)
	Assessment	Financial (20.8%)		Non-financial (33.3%)		Assessment status (4.2%)	Correctness checker (0%)	
	Navigation and filtering	Model comparison (4.2%)	Element filter (25%)	Phase management (4.2%)	Element clipboard (45.8%)	Link to business models (16.7%)	Framework support (4.2%)	
Collaboration	Communication	Chat (16.7%)		Discussion board (0%)		User list (12.5%)		
	Synchronization	Asynchronous modeling (58.4%)		Concurrent modeling (4.2%)		Synchronous modeling (37.5%)		
	User and role management	User management (50%)		Role management (41.7%)		Support of task sharing (12.5%)	Workspace awareness (16.7%)	
	Repository and conflict management	Version control (25%)		Local repository (41.7%)		Remote repository (62.5%)		
Technical	Architecture	Client/Server (0%)		Client only (41.7%)		Web-based (58.3%)		
	Data exchange	Export (54.1%)				Import (25%)		

Legend: 0% | 1-33% | 34-66% | >67%

Fig. 4 Frequency analysis of functions for business model development tools

there are clusters of functions which indicate certain archetypes of BMDTs and whether there is already a tacit consensus of functions that BMDTs should possess (see Research agenda for a discussion on standardization of BMDTs). A combination of Ward's method (to identify the number of clusters) and K-means (to assign the BMDTs to the clusters) is widely accepted in IS research and has been applied to samples of similar size compared to ours (Balijepally et al. 2011). Consequently, we adopted this approach to cluster our sample of 24 BMDTs (see Appendix Table 7).

Following Balijepally et al. (2011), we first carried out Ward's method to identify the number of clusters by forming groups based on their similarity (Ward 1963). In order to examine similarities between each pair of two of the BMDTs, their numbers of equal characteristics (i.e., functions of BMDTs) were calculated and the Squared Euclidean Distance was measured, which is suitable for binary data (analyses were conducted in SPSS). The analysis of the resulting dendrogram indicated that one solution with three clusters and one with six clusters would be most useful to interpret. Afterwards, we used K-means, an iterative partitioning algorithm, to minimize the variance within each cluster for both of the cluster solutions and manually evaluated the outcomes (i.e., assignment of BMDTs to a specific cluster) according to their explanatory power (e.g., Remane et al. 2016).

The results of K-means constitute a three-cluster solution because it can be interpreted better than the six-cluster solution and provides more distinctions between the clusters identified (i.e., with regard to their functions: BMDTs within a cluster are homogeneous, BMDTs of different clusters are heterogeneous). The first cluster (10 out of 24 BMDTs) refers in particular to the collaboration functions of BMDTs (i.e., synchronous modeling, user management, role management, and textual commenting on element level). This cluster consists of web-based BMDTs as well as BMDTs that allow using remote repositories and exporting business models. As supported by all of the clusters in this three-cluster solution, functions for *elements* and *element connections* are implemented. The second cluster (13 out of 24 BMDTs) captures five describing functions: *asynchronous modeling*, *elements*, *element connections*, *repository local*, and *client only*. Accordingly, this cluster comprises BMDTs that are used by individual users (and do not allow interacting or modeling with other users). The third cluster (1 out of 24 BMDTs) consists of a client application that allows for storing data in a *remote repository*, and thus, is from a technical perspective a hybrid form of individual and collaborative use. The following functions are exclusively supported by this cluster solution: *concurrent modeling*, *model comparison* and *framework support*.

In summary, the results point out that only a few functions characterize a cluster. In general, we identified one cluster of BMDTs that tends to focus on collaboration, and in contrast, another cluster that focuses on more stand-alone BMDTs (i.e., non-collaborative), which is a distinction that is well-known from other classes of tools such as creativity support systems, which likewise distinguish between individual and group creativity support systems (Wang and Nickerson 2017). Furthermore, observations from both the frequency analysis and the co-occurrence analysis indicate that there is still substantial ambiguity among the functions.

Taxonomy evaluation

Inspired by Nickerson et al. (2013) proposal to "query users about their potential use of [a] taxonomy" (Nickerson et al. 2013, p. 347), for the purpose of evaluating the taxonomy we sought to answer three questions:

(1) Do users understand the descriptions of the taxonomy's characteristics (i.e., the descriptions of the functions of BMDTs)? A positive answer would be an indication for the taxonomy's usefulness because understandability is a prerequisite for the correct application of a taxonomy.
(2) Can users correctly apply the taxonomy to the tools that were used for building the taxonomy (i.e., correctly classify BMDTs following the taxonomy by indicating which functions a BMDT has and which not)? A positive answer would lend additional credibility to the taxonomy's usefulness, because enabling users to correctly classify objects is the main purpose of any taxonomy.
(3) Can users correctly apply the taxonomy to tools that were *not* used for building the taxonomy? A positive answer would further corroborate the taxonomy's usefulness since the purpose of a taxonomy is not only to classify the specific objects on which it was built but, rather, to classify any relevant objects that might not even have existed when the taxonomy was built.

To answer questions (1) and (2), we followed Gregor and Hevner (2013) and asked potential users to evaluate the taxonomy. We conducted a workshop with 11 participants, recruited in their capacity as students attending a bachelor level university course, 'Methods for developing IT-based business models'. As part of their course, students had gained considerable knowledge and experience of business model innovation not only theoretically but also practically, having developed, analyzed, and innovated (including with the help of software-based tools) at least three business models with the Business Model Canvas in multiple assignments, each lasting several weeks. The age of the workshop participants ranges from 19 to 26 years, and three participants were female. Workshop participation was voluntary, unpaid and questionnaires anonymous, to ensure unbiased task completion and

responses during the workshop. All participants were introduced to BMDTs and the purpose of the taxonomy.

For (1) evaluating the understandability of the taxonomy's descriptions we asked participants to rate each description's understandability on a Likert-scale ('I fully understand the description of the function. ') from 1 (strongly disagree) to 7 (strongly agree). The results indicated that users understood the descriptions for the functions of BMDTs very well, with 42 out of 43 descriptions being rated 6 or above (the average across all functions and participants was 6.84). Only the description of the function *framework support* was below 6 (5.55). A possible reason for this was that the description was both comparatively long and abstract. Accordingly, we revised the description to improve its understandability.

For (2) evaluating the applicability of the taxonomy to tools used during taxonomy building, we asked the participants to classify the functions of the BMDT *RealtimeBoard* according to the taxonomy. *RealtimeBoard* was well-suited for this purpose because it covers a wide range of functions from the taxonomy. For each of the taxonomy's characteristic participants had to determine whether the BMDT provides that function (or whether they were not sure, in which case we did not consider a participant's indication for further interpretation). To encourage an exhaustive exploration of *RealtimeBoard's* functions, participants were asked to reproduce a sample business model in the BMDT. This business model (see Fig. 1) spans all nine components of the Business Model Canvas, which makes exploring a BMDT comprehensively easier. We considered a function to have been assigned correctly if the assignment was the same as that made by the authors during taxonomy building (where two authors and a devil's advocate jointly determined which functions are available in which BMDT, see Taxonomy building). The result was that for 37 out of 43 functions (86%) a majority of more than two-thirds of the participants correctly assigned the functions of the BMDT to the taxonomy, with 14 functions even being correctly assigned by all participants. For the remaining six functions (14%), which, as noted, all had very high understandability ratings (greater than 6.00), the following applied: Four functions (*template*, *client/server, element clipboard*, and *discussion board*) were apparently not precise enough for correctly assigning the functions. Accordingly, we revised the descriptions based on feedback from the participants. For the remaining two functions (*divide* and *link* components), the discrepancy between the very high understandability ratings and the wrong assignment was difficult to interpret. The reason for the discrepancy might be that the two functions in *RealtimeBoard* were simply 'too obvious' to identify for the participants—as both functions in the BMDT are available in the main screen via 'drag & drop', without the need to push a button or enter any (context) menu.

Following Nickerson et al. (2013), the taxonomy development also involves finding a meaningful level of abstraction for the taxonomy's dimensions and characteristics. This level is achieved by identifying and (re-)grouping characteristics as part of the iterations (see step 5e and 6e as well as 5c and 6c of Taxonomy building) as well as by evaluating the taxonomy's applicability. With regard to the subjective ending conditions this includes balancing, for example, conciseness (i.e., not being unwieldy or overwhelming), robustness (i.e., allow for differentiation among objects), and explanatory power (i.e., allow for explaining an object) of the taxonomy. Applied to the taxonomy of functions for BMDTs, the level of abstraction is oriented towards the meta-characteristic, and thus, focused on 'functions of BMDTs'. In so doing, we generalize the many possible implementations in order to focus on the actual task that can be facilitated by a BMDT. The following three examples of functions for BMDTs from our taxonomy illustrate this abstraction: (1) *Export*, (2) *Graphical comments (predefined)*, and (3) *Non-financial assessment*.

(1) Export: This function for BMDTs is implemented in ways as diverse as exporting into formats such as PDF, XML, HTML, JPEG etc. In some contexts exporting is a function of particular importance. The individual formats naturally also strongly depend on the application environment. Furthermore, exporting business models can be pursued for various reasons, such as for further processing business model data in other software-based tools than BMDTs or for visually communicating business models through graphics.
(2) Graphical comments (predefined): This function for BMDTs is implemented in ways as diverse as shapes, symbols, and emoticons. The implementations differ with regard to the quantity of available *(predefined) graphical comments* and properties of the functions such as color, size, and typical customizations. We can imagine that this wide range of implementations is relevant to BMDTs that intend to serve large groups of users who require this function in order to access a common base of (possibly company- or industry-specific) *(predefined) graphical comments*.
(3) Non-financial assessment: This function of BMDTs is implemented in forms as diverse as star ratings, likes, and smileys. *Non-financial assessment* mechanisms may be conceived that do not only allow to assess the economic viability of a business model, but also other potential success factors (i.e., to get information on how innovative a business model idea is perceived and how likely it is that potential customers actually become customers of a business model before it is launched).

For (3) evaluating the applicability of the taxonomy to tools *not* used during taxonomy building, we applied the taxonomy to five additional BMDTs, which we selected based on the following grounds. First, while it is acknowledged that taxonomies

may change over time (Nickerson et al. 2013), a taxonomy's ability to classify objects that have been created after the taxonomy was created lends credibility to a taxonomy. Therefore, when performing the evaluation, we repeated the tool search we had performed when building the taxonomy, and thereby identified one new tool (i.e., the *CanvasPlanner*), which we could use for additional evaluation. Furthermore, we manually browsed and searched the websites *BusinessMakeOver* and *Business Model Toolbox*[3] which provide a variety of tools that support individual activities in business model development. In this way, we identified one new tool which is also based on the Business Model Canvas (i.e., *BusinessMakeover's BMC*) and is both software-based and aimed at capturing a business model comprehensibly (in contrast to focusing on dedicated parts of a business model, such as the entrepreneurial skills of individuals or the financial viability of a business model). Second, as noted, the Business Model Canvas is the standard for describing business models. However, our focus on tools that draw on the business model understanding of the Business Model Canvas might limit the taxonomy's capacity of being applied to a wider range of BMDTs. Therefore, we sought to apply the taxonomy to a tool with a business model understanding that was substantially different from that of the Business Model Canvas. The tool we selected was the *e*^{3}*editor*, which is based on the modeling language e^{3}value (Akkermans and Gordijn 2003). We selected this tool because its underlying business model understanding differs substantially from that of the Business Model Canvas (as e^{3}value defines a business model through actors and their relationship) and because it has received considerable recognition in research (Massa et al. 2017). For the same reasons, we also repeated the tool search we had performed when building the taxonomy with a modified search phrase which allows to identify tools that are not based on the Business Model Canvas ("*business model*" *AND (tool OR software)*). The adapted tool search reveals three additional tools which are based on the Lean Canvas (i.e., *Leanstack, Office Opettaja*'s *Lean Canvas*, and *Bytesize*'s *Lean Canvas*). The Lean Canvas is an adaptation of the Business Model Canvas and exchanges four new components (problem, solution, key metrics, and unfair advantage) which are intended to capture uncertainty and risk while innovating business models.

For all six additional BMDTs with which we evaluate our taxonomy (*e*^{3}*editor*, *CanvasPlanner*, *BusinessMakeOver's BMC*, *Leanstack*, *Office Opettaja*'s *Lean Canvas*, and *Bytesize*'s *Lean Canvas*), the first and second author independently identified the functions and assigned them to the taxonomy. The first and second author consistently agreed which functions were implemented in each of the two BMDTs. The classification of both additional BMDTs did not reveal any function that is not already covered by the developed taxonomy. Reassuringly, the taxonomy remains robust. Hence, in summary, the evaluations of the taxonomy's understandability and of its applicability provide evidence for the usefulness of the developed taxonomy.

Research agenda

BMDTs have advanced considerably since the early calls for more work on software support for business model development and innovation (e.g., by Osterwalder et al. 2005; Osterwalder and Pigneur 2013; Veit et al. 2014): A great number of BMDTs have been proposed. However, as our frequency and co-occurrence analyses have made evident, there is no consensus yet as to which functions a BMDT should have. Hence, the logical next step for maturing the field is to more thoroughly evaluate the usefulness of a BMDTs' existing and possible future functions—and to identify the theoretical mechanisms underlying their usefulness. This would involve determining the relative importance of these functions as well as to possibly determine their absolute importance (e.g., in terms of 'must have' and 'nice to have' functions). Therefore, in the following we derive a research agenda that outlines the challenges that researchers need to consider when evaluating BMDTs and their functions. We derive these challenges by drawing on business model research as well as research from adjacent disciplines, namely research on tools for creativity support, process modeling, new product development, and strategy development (see Background).

Inspired by Wand and Weber's (2002) seminal research agenda on modeling languages, we structure our agenda around five themes (see Fig. 5): Themes (1) and (2) represent the core relationship of interest, namely how (1) the *(future) functions* of BMDTs affect (2) the *performance* of their users. This core relationship is moderated by a variety of factors, whose discussion we distinguish into (3) *user characteristics* (Who uses a BMDT?), (4) *task characteristics* (What purpose is a BMDT used for?), and (5) *method* (How is a BMDT used?).

(1) *(Future) functions:* Regarding functions, results from business model research and adjacent disciplines suggest that researchers should explore to what extent additional functions, which are not yet available in BMDTs, could be a useful complement to the existing functions. Concerning the *development* dimension of the taxonomy, the quality of the business model ideas captured in the BMDTs currently depends solely on the intrinsic creativity of the user (i.e., the user is not given any assistance in being creative). In this regard, BMDTs could, for example, incorporate functions for exploring business model patterns (i.e., abstract descriptions of existing business models), given that such patterns have

[3] We would like to thank the review team for suggesting additional websites as potential sources for BMDTs. The websites BusinessMakeOver (www.businessmakeover.eu) and Business Model Toolbox (www.bmtoolbox.net) provide, alongside a wide range of paper-based tools across all phases of business model development, some tools which are implemented in software.

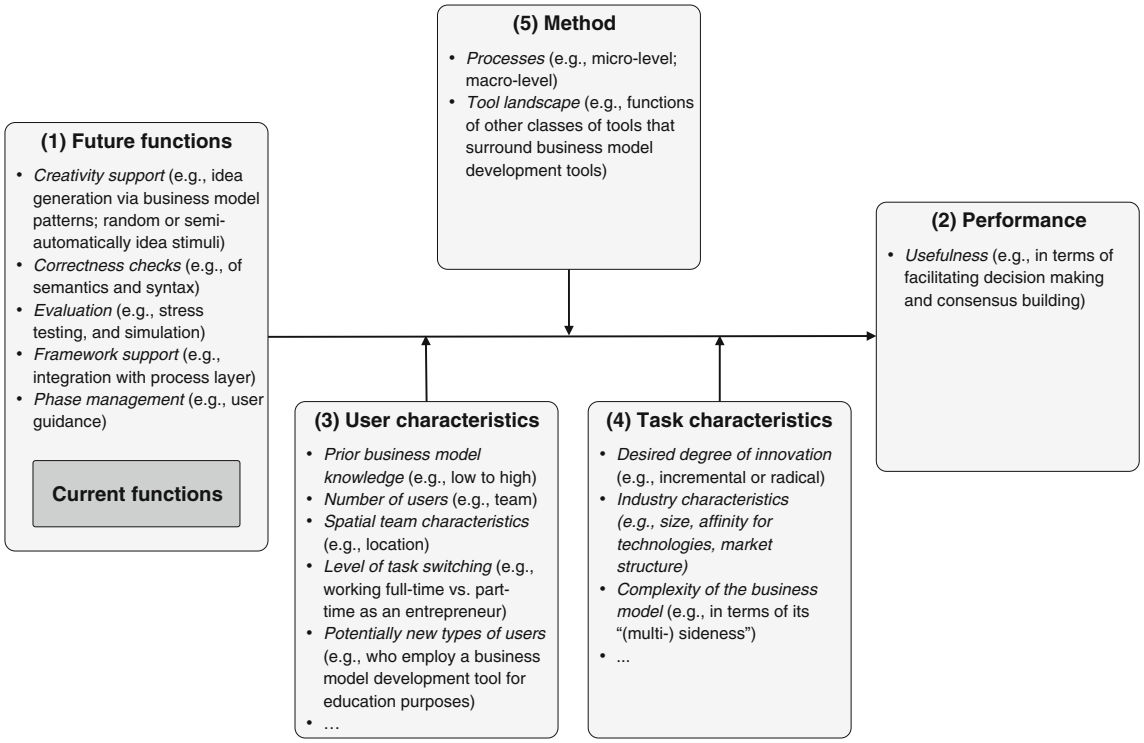

Fig. 5 Research agenda

achieved considerable popularity for promoting idea generation (e.g., Eickhoff et al. 2017; Gassmann et al. 2014; Remane et al. 2016). Additional utility could be achieved by incorporating functions for providing random idea stimuli (e.g., Althuizen and Reichel 2016) or semi-automatically selected idea stimuli (e.g., John 2016), which each have recently been proposed in IS research. Concerning the *assessment* dimension of the taxonomy, BMDT researchers could, for example, draw inspiration from research on process modeling (e.g., Leopold et al. 2014) for checking the semantic and syntactic correctness of a business model (e.g., in terms of completeness or consistent use of terms). Moreover, as business models are dynamic in nature, system dynamics-based approaches promise to help design better business models. This is because system dynamics can facilitate with understanding the cause-effect relationships within business models concerning their profitability as well as their sustainability (e.g., Moellers et al. 2017; Cosenz and Noto 2018). In addition, a data-driven, machine learning-based approach has been proposed for semi-automatically evaluating business models (Dellermann et al. 2017), which might be fruitfully integrated with BMDTs. Also, business model stress testing (Bouwman et al. 2017; Haaker et al. 2017) and business model simulation (Daas et al. 2013) have been proposed as specific software-based approaches for supporting the assessment of business models, but have not yet been incorporated into BMDTs. Concerning the implementation of business models, further research is needed on how to narrow the gap between the business model and the IS/process layer (as defined, e.g., by Al-Debei and Avison 2010). In this regard, there is a pressing need to explore which functions BMDTs would need to better support their users in deriving the IS required to execute a business model. Such functions could pertain to a better semi-automatic integration with code management and issue tracking tools (e.g., GitHub) or, in the very long-term, could pertain to the quasi-automatic derivation of processes and (parts of) the underlying IS (as suggested, e.g., by research on model-driven development, see Czarnecki and Helsen 2006). Moreover, business model roadmapping (De Reuver et al. 2013) can aid in planning the transition from a current to a future business model, but has not yet been integrated into BMDTs (accordingly, in the taxonomy the characteristic *phase management* is absent in all tools but one).

As part of the maturation of the new type of software-based tools for business model development, the further evaluation and advancement of functions for BMDTs may occur alongside standardization. Standardization per se is neither good nor bad and there are different pros and cons attached to it (Jakobs 2008; Van Wessel 2010). Standardization is helpful, for example, if properly defining terminology and

promoting the accessibility of a field towards academics and practitioners. It also helps to save time, money, and effort as well as to ensure a certain level of quality. On the other hand, standardization can hinder or even prevent the further advancement of a field. Timing and consensus of standardization endeavors are important prerequisites to avoid premature standardization. Timing, because too early standardization may lead to erroneous standards or standards that are difficult to interpret as well as hampering individual attempts to advance a field of interest. Consensus, because premature standardization often fails to properly consider all minority opinions in an exhaustive and reasonable manner (Titze 1994). The emerging field of BMDTs may learn from other fields of technological progress, for example, by not "[cutting] of desirable future development paths" (Robson 2000, p. 5), "[balancing] the need for integration, dissemination, and application" (Boose and Gaines 1990, p. 378), and not "risk killing innovation" (Blackstock and Lea 2013, p. 1). Applied to this study's context, the extent to which standardization of BMDTs may or may not inhibit innovation of business models (by investigating the trade-off between the advantages and disadvantages of) is a subject for future research. Standardization of BMDTs may help, because it allows to connect the different disciplines involved in researching the business model concept (and thus also the corresponding software-based tools that intend to facilitate working with this concept). By contrast, standardization of BMDTs may be undesirable, since standardization can stifle creativity and interfere with the declared objective to leverage business model innovation as a source for a firm's competitive advantages. Thus, the uniqueness of a BMDT may help to develop unique (i.e., creative) business models. The taxonomy of functions for BMDTs may help to consensus on the nature of BMDTs and may help determine whether standardization for BMDTs is useful at all and if so, when. It is also conceivable that standardizing BMDTs will never make sense. For the reasons stated above, the taxonomy seeks to, first, systematically review functions and provide definitions for these functions (i.e., define terminology) as well as, second, abstract functions from the available implementations of BMDTs (i.e., promote accessibility). Since a taxonomy is supposed to describe existing and future objects of a domain (Nickerson et al. 2013), the taxonomy of functions for BMDTs is extensible by design. We ensure this by adhering to the subjective ending condition of extensibility, which is suggested by Nickerson et al. (2013) (see Taxonomy building). In the end, it is not the declared aim of the taxonomy to standardize BMDTs, and the cluster analysis reveals that BMDTs are far from being standardized. Nevertheless, the taxonomy can help decide whether (if at all), when (timing) and how (consensus building) standardization of BMDTs is desirable and thereby contributes to leveraging the potential of BMDTs.

(2) *Performance:* When evaluating the usefulness of (sets of) functions of BMDTs, obviously there is the need to determine what usefulness actually means. The gold standard would be to evaluate whether using a certain function leads to higher firm performance (through a better performing business model). However, this gold standard is virtually impossible to achieve, because the corresponding outcome can only be known in the long term and even if it were known, it would be virtually impossible to causally link that outcome to the usage of a BMDT (or one of its functions). Research on strategy tools faces the same challenge and has proposed to use more immediate outcomes, such as the degree to which a tool provokes exploration, facilitates decisions, or facilitates consensus building among its users (Jarzabkowski and Kaplan 2015). Likewise, BMDT researchers need to derive a set of outcomes that can form the foundation for measuring performance when evaluating BMDTs.

BMDTs can be used by a diverse range of users, in a variety of contexts, and in various ways—all of which potentially impact (i.e., moderate) the relationship between functions and performance. Therefore, when determining the usefulness of functions, there is the need to be aware of the relevant moderators, which accordingly need to be determined in future research. In the following, we outline a number of factors that should be considered.

(3) *User characteristics:* Which functions users benefit from is likely to depend on factors such as: The level of prior business model knowledge (e.g., if low, then the user would likely benefit from guidance within a BMDT, while an experienced user is likely to feel constrained by such guidance); the number of users (e.g., a team of users is likely to benefit more from communication and collaboration functions than a sole entrepreneur); spatial team characteristics (e.g., a co-located team is likely to benefit less from communication and collaboration function than a distributed team); the level of task switching users need to make (e.g., an entrepreneur working full-time on a project is likely to benefit less from knowledge management functions compared to a corporate user working on a large variety of projects run in parallel). Researchers conducting evaluation studies should be aware of such factors and, in the long term, should aspire to identifying a comprehensive set of relevant factors to guide further research. Apart from that, research could seek to identify whole new user groups. Given the importance of business models in entrepreneurship and innovation education (Lima and Baudier 2017), researchers could, for example, explore what characteristics BMDTs should have to effectively support student education (e.g., comparable to the simulation games that are popular in marketing education, Vos 2015).

(4) *Task characteristics:* Business model innovation projects can be distinguished especially with regard to the degree of desired innovation (incremental or radical), which is likely to affect the usefulness of different functions. For example, the more radical the business model innovation that is being sought, the more a tool should provide functions to support generating innovative business model ideas (which is less of an issue if only incremental innovations are sought). In addition, characteristics of the industry and specific business model can impact the usefulness of functions. There are, for example, industries that lend themselves to analyzing (simulating) business models quantitatively (e.g., in the energy domain, Lombardi and Schwabe 2017), while others less so (e.g., mobile apps). Also, the complexity of a business model (e.g., in terms of its 'sidedness'—multi-sided or not) is likely to impact the usefulness of various functions of BMDTs, such as filtering or linking business models.

(5) *Method:* Every BMDT can be used in a variety of ways, starting from the micro-level processes within a team (e.g., is there a team member that is dedicated to moderating/facilitating discussions or not?) to macro-level processes within a firm (e.g., does a firm follow specific processes for developing business models, such as the lean startup/customer development process, Blank 2013; and processes for developing the corresponding IS, such as SCRUM, Schwaber and Beedle 2002). These processes can impact the way that a BMDT is used and, as a consequence, the usefulness that specific functions have. Moreover, intertwined with the processes, unless a BMDT is only used for very early-stage idea generation, a BMDT is likely used along with a number of other classes of tools (as innovation typically depends on a whole set of tools, Mannucci 2017). Such tools include knowledge management tools such as Confluence, desktop sharing tools such as Skype, and project management tools such as Microsoft Project (Mauerhoefer et al. 2017). Hence there is the need to explore how BMDTs could be designed to best possibly integrate with the functions that these classes of tools offer. The reason is that in practice the utility of a BMDT is likely to depend on the effectiveness with which a BMDT is used in concert with other tools.

Conclusion

The current high level of interest in business models in research and practice is undisputed. However, the research on how business model development can best be supported by software is just at the beginning (Osterwalder and Pigneur 2013; Veit et al. 2014). To address this problem and prepare the ground for further research, our contribution is threefold:

First, we propose a taxonomy of functions of software tools for business model development which consists of 43 characteristics (i.e., functions). To develop the taxonomy, we followed a rigorous taxonomy development method (Nickerson et al. 2013) and identified as well as consolidated knowledge on BMDT functions from the business model domain (in research and practice) and from adjacent domains such as process modeling. We provide detailed descriptions for the characteristics of the taxonomy and provide evidence for its usefulness by evaluating the taxonomy's understandability and applicability. As taxonomies bring structure to the knowledge of a field (Nickerson et al. 2013), they are especially important in nascent areas of research (Gregor 2006) – an attribute that arguably applies to research on BMDTs (Osterwalder and Pigneur 2013; Veit et al. 2014). In such areas, the descriptive knowledge that taxonomies provide is the foundation for theories that go beyond mere description, but are able to explain and predict (Gregor 2006). In that sense, taxonomies are the necessary foundation for maturing a field (Nickerson et al. 2013), and our taxonomy can fulfill that purpose for research on software tools for business model development.

Second, we provide a structured overview of the currently available BMDTs that are based on the Business Model Canvas. For this overview, we comprehensively identify the currently available BMDTs (following Vom Brocke et al. 2009) and classify these tools using the taxonomy. An important insight from this overview is that there is a huge discrepancy between the numbers of tools being proposed in research and practice. This is somewhat surprising, given that BMDTs have repeatedly been termed an important area for future IS research (Osterwalder and Pigneur 2013; Veit et al. 2014). Given the imbalance between the knowledge on BMDTs generated in research and practice, it seems hardly possible for IS researchers to make contributions that are relevant to practitioners unless they have a profound understanding of the state of the practice—and our structured overview of BMDTs supports researchers in building such understanding. For practitioners, our overview serves a similar purpose, and thereby for them facilitates making informed tool (re-)design and investment decisions.

Third, we derive a research agenda concerning BMDTs that is anchored in business model research and adjacent domains (e.g., new product development, strategy development). An insight from the research agenda is that there seem to be a number of gaps between what researchers propose to facilitate business model innovation and the functions that BMDTs currently provide. For example, researchers have proposed business model patterns as a valuable starting point for developing and innovating business models (e.g., Martins et al. 2015; Remane et al. 2016). This notwithstanding, such patterns have not yet been incorporated into BMDTs. Consequently, the research agenda makes a number of suggestions concerning additional functions whose usefulness researchers should explore, suggestions

concerning the measurement of the resulting usefulness, and concerning factors that moderate the relationship between functions and performance (i.e., task characteristics, user characteristics, and method). As such, the research agenda has the potential to catalyze future research on BMDTs by providing a framework for thinking about future studies on BMDTs, by highlighting important areas for research, and potentially facilitating empirical studies by hinting at important moderating factors.

From a methodological perspective, we contribute to a better understanding of how taxonomies can be evaluated. While the taxonomy building procedure is well-researched (Nickerson et al. 2013), there is virtually no guidance on how to best evaluate a taxonomy, and thus, the selection of appropriate evaluation methods is left open for researchers (Chasin et al. 2017). This study provides an example of how potential users can be employed for evaluating taxonomies. In our case, we evaluated a taxonomy of software functions or, more generally, a taxonomy of objects that can be classified only through an in-depth interaction of users with the objects. For this purpose, inviting potential users to a workshop where they could actually use the software in a standardized way was very helpful. In addition, distinguishing the evaluation into understandability and applicability tasks gave us an indication for where and how to sharpen our results in a targeted way. We would expect this to be a reasonable choice for other researchers too.

As with all studies, our study pertains limitations: First, limitations may arise from the fact that the majority of the existing BMDTs have only been available for a few years (usually less than five), which may cause their functions to be subject to change. However, we were able to ground parts of our taxonomy in previous research on process modeling tools, which uses tools that have been available for a long time and have demonstrated already a sufficient degree of stability. Second, limitations may also arise from our selection of BMDTs, which we have based on the business model understanding of the Business Model Canvas. However, the Business Model Canvas' significant impact is widely recognized. Moreover, in the taxonomy evaluation we showed that our taxonomy could also be applied to a BMDT with a completely different business model understanding.

In conclusion, through its theoretical foundation (i.e., anchoring in previous research) and empirical grounding (i.e., analysis of existing BMDTs), this study combines the current state of research and practice on BMDTs. In this way, our study provides a potential leverage point for future research and the further development of BMDTs in a cumulative fashion and as a discipline in its own right.

Acknowledgements This work was partially supported by the German Research Foundation (DFG) within the Collaborative Research Center "On-The-Fly Computing" (CRC 901, project number 160364472SFB901) and the European Regional Development Fund (ERDF) within the research project "SmartHybrid – Process Engineering" (ZW 6-85003451).

Appendix 1

Table 1 Functions of business model development tools in literature

Function	Riemer et al. 2011	Schoormann et al. 2016	Ebel et al. 2016	Fritscher and Pigneur 2010	Fritscher and Pigneur 2014a	Fritscher and Pigneur 2014b	This study
F1	–	Adding	Collaborative editor that provides a business model template	–	Create own semantic meaning	Options that customize the look of any displayed information	Add
F2	–	Dividing		–			Divide
F3	–	Linking		–			Link
F4	–	Modifying the content		–			Rename
F5	–	Modifying the structure		–			Change arrangement
F6	–	–		Element (sticky note)	Elements (instances of a block)	Elements	Elements
F7	–	–		Link elements	Links between elements	A link connects two elements	Element connections
F8	Templates definable	–	–	–	–	–	Templates definable
F9	Comments: Element level	–	Comment section	Commenting; Annotations	–	–	Textual comments on element-level
F10	Comments: Process level	–		Annotations	–	–	Textual comments on business model-level
F11	–	–	–	–	–	–	Graphical comments (predefined graphic)

Table 1 (continued)

Function	Riemer et al. 2011	Schoormann et al. 2016	Ebel et al. 2016	Fritscher and Pigneur 2010	Fritscher and Pigneur 2014a	Fritscher and Pigneur 2014b	This study
F12	–	–	–	–	–	–	Graphical comments (freeform graphic)
F13	Link files	–	Attachment of external documents and shared material	–	–	–	Link files
F14	Link web-resources	–		–	–	–	Link web-resources
F15	–	–	–	–	–	–	Glossary support
F16	–	–	–	–	–	–	Financial assessment
F17	–	–	–	–	–	–	Non-financial assessment
F18	–	–	–	–	–	–	Assessment status
F19	Correctness checker	–	–	Ensure meta-model of the canvas	–	Consistency of model	Correctness checker
F20	Model comparison	–	–	–	–	–	Model comparison
F21	–	–	–	Layer feature	Color grouping	Digital layers	Element filter
F22	Phase management	–	–	Wizard to guide the user	–	–	Phase management
F23	–	–	–	–	–	–	Element clipboard
F24	Links processes	–	–	–	–	–	Link to business models (or parts of them)
F25	Framework support	–	–	–	–	–	Framework support
F26	Chat functionality	–	Messaging function	Basic interaction features	–	–	Chat
F27	Discussion board	–	Discussion board		–	–	Discussion board
F28	Member list	–	Community (profile page, friendships, tagging and searching for competencies of users)		–	–	User list
F29	Asynchronous modeling	–	–	–	–	–	Asynchronous modeling
F30	Concurrent modeling	–	–	–	–	–	Concurrent modeling
F31	Synchronous modeling	–	–	–	–	–	Synchronous modeling
F32	User management	–	Integration of domain experts	–	–	–	User management
F33	Role management	–		–	–	–	Role management
F34	Support of task sharing	–	–	–	–	–	Support of task sharing
F35	Workspace awareness	–	Push notifications	–	–	–	Workspace awareness
F36	Version control	–	Versions	Versioning	–	Previous state of business model	Version control
F37	Repository local	–	–	–	–	–	Repository local
F38	Repository remote	–	Collaborative editor	–	–	–	Repository remote
F39	Client/Server	–	–	–	–	–	Client/Server
F40	Desktop-based	–	–	–	–	–	Client only
F41	Web-based	–	–	–	–	–	Web-based
F42	Export File: own, pdf, xpdl, ppt, html, word/rtf, xls, bmp, jpeg, png	–	–	–	–	–	Export
F43	Import File: own	–	–	–	–	–	Import
*	Process Modeling Notation EPC	–	–	–	–	–	–
*	Process Modeling Notation BPMN	–	–	–	–	–	–
*	Process Modeling Notation IDEF	–	–	–	–	–	–
*	Process Modeling Notation UML	–	–	–	–	–	–

*These functions refer to process models rather than business models and hence do not fit our study. Similar, these functions would be in this study's context research on or business model development tools with more than one underlying business model understanding

Appendix 2

Table 2 Sources of business model development tools (Fritscher and Pigneur 2010; Alt and Zimmermann 2014; Fritscher and Pigneur 2014; Zec et al. 2014)

Business model development tool	Source			
	Google	Apple Store	Google Play Store	Google Scholar
(1) Abizmo	●	–	–	–
(2) Archi	●	–	–	–
(3) Biz Canvas	–	●	–	–
(4) BiZZDesign	●	–	–	●
(5) Blank Canvas	●	–	–	–
(6) BMCanvas	●	–	–	–
(7) BM|Desig|ner	–	–	–	●
(8) Business Model Fiddle	●	–	–	●
(9) Business Model Canvas	–	●	–	–
(10) Business Model Canvas & SWOT	–	–	●	–
(11) Business Model Toolbox	–	●	–	–
(12) Canvanizer 2.0	●	–	–	●
(13) Canvas BM	●	–	–	
(14) Canvas for all (Canvas)	–	–	●	–
(15) Canvas Model Design	–	●	–	–
(16) Insight Maker	●	–	–	–
(17) Lienzo	●	–	–	–
(18) NotionCUBE	●	–	–	–
(19) RealtimeBoard	●	–	–	–
(20) Startup Canvas	–	●	–	–
(21) Strategyzer	●	–	–	●
(22) TheStartupToolKit.com	●	–	–	–
(23) TUZZit	●	–	–	–
(24) Waxidea	●	–	–	–

Appendix 3

Table 3 List of business model development tools

Business model development tool	Reference
(1) Abizmo	http://abizmo.com/
(2) Archi	https://www.archimatetool.com/
(3) Biz Canvas	https://itunes.apple.com/us/app/bizcanvas-better-business/id588263801?mt=8
(4) BiZZDesign	https://www.bizzdesign.com/
(5) Blank Canvas	https://www.blankcanvas.io/
(6) BMCanvas	http://www.bmcanvas.com/
(7) BM|Desig|ner	https://bmdesigner.com/
(8) Business Model Fiddle	https://bmfiddle.com/
(9) Business Model Canvas	https://itunes.apple.com/us/app/business-model-canvas-think/id617634578?mt=8
(10) Business Model Canvas & SWOT	https://play.google.com/store/apps/details?id=com.thirdmobile.modelcanvas&hl=en_US
(11) Business Model Toolbox	https://www.appaddict.org/view.php?trackid=431605371
(12) Canvanizer 2.0	https://canvanizer.com/thenextlevel10/
(13) Canvas BM	http://canvasbm.com/
(14) Canvas for all (Canvas)	https://play.google.com/store/apps/details?id=com.canvasforall.app&hl=en_US
(15) Canvas Model Design	https://itunes.apple.com/us/app/canvas-model-design-build/id568186908?mt=8
(16) Insight Maker	https://insightmaker.com/tag/Business-Model
(17) Lienzo	http://lienzo.biz/
(18) NotionCUBE	https://www.notioncube-software.com/
(19) RealtimeBoard	https://realtimeboard.com/
(20) Startup Canvas	https://itunes.apple.com/us/app/startup-canvas/id1019353740?mt=8
(21) Strategyzer	https://strategyzer.com/
(22) TheStartupToolKit.com	http://thestartuptoolkit.com/blog/
(23) TUZZit	https://www.tuzzit.com/
(24) Waxidea	http://businessmodelcanvas.waxidea.com/
(25) CanvasPlanner	https://canvasplanner.com/
(26) e^3editor	http://e3value.few.vu.nl/tools/
(27) Business MakeOver's BMC	https://webtools.innovalor.nl/#/bmc
(28) LeanStack	https://leanstack.com
(29) Lean Canvas (Office Opettaja)	https://play.google.com/store/apps/details?id=net.officeopettaja.leancanvas&hl=en_US
(30) Lean Canvas (Bytesize)	https://itunes.apple.com/us/app/lean-canvas/id825611832?mt=8

(1)–(24) BMDTs used for taxonomy building; (25)–(30) BMDTs used for taxonomy evaluation

References for (1)–(24) retrieved on may 14th, 2018; references for (25)–(30) retrieved on September 26th, 2018

Appendix 4

Table 4 Descriptions of functions of business model development tools

Function		Description: *The function allows to…*
Perspective: Modeling		
Customization	Add	… add a new component (e.g., the component *risk* that is concerned with the planned or unplanned potential of gaining or losing value with a particular business model).
	Divide	… divide an existing component (e.g., the component *distribution channel* into *offline distribution channel* and *online distribution channel*).
	Link	… merge two or more existing components into one (e.g., the components *key partners*, *key activities* and *key resources* into one component *key assets)*.
	Rename	… rename an existing component (e.g., the component *revenue streams* into *revenue model*).
	Change arrangement	… change the spatial arrangement of components (e.g., swap the position of the two existing components *key activities* and *key resources*).
Development	Element	… describe the components of a specific firm's business model using a sticky note for each business model element with a short textual description (e.g., the component *distribution channel* of a specific firm's business model is described by two sticky notes *online store* and *physical store*).
	Element connection	… make the connection between elements explicit (e.g., in a business model with two *customer segments*, element connections allow to express which *value propositions* address which *customer segment*). Connections are represented by, for example, arrows, tags, or the color of a sticky note.
	Templates	… make use of predefined suggestions and/or define suggestions for the elements in a specific business model component (e.g., in the form of lists with elements which could, for example, suggest the elements *online store* and/or *physical store* for the component *distribution channel*), or the entire business model (e.g., in the form of patterns such as *multi-sided platform* or *freemium*).
Commenting and linking	Textual comment at element-level	... describe a business model in greater detail, providing additional textual information for any specific business model element (e.g., the element *online store* of the component *distribution channel*: "Our online store will be an independent, standalone *online store* – rather than being part of an existing platform such as eBay or Amazon Marketplace.").
	Textual comment at business model-level	... describe the entire business model business model with additional textual information (e.g., "This business model was presented at the internal strategy workshop. We got feedback and approval for further action.").
	Graphical comment (predefined graphic)	... describe a business model through predefined graphics such as shapes or symbols (e.g., a battery as the symbol for a *key resource* in a business model of an electric car manufacturer).
	Graphical comment (freeform graphic)	... describe a business model through freeform graphics (drawn with a pen, for example).
	Link file	… provide links to files on the user's device (e.g., protocols of customer interviews).
	Link web-resource	… provide links to information available online (e.g., market studies or press releases).
	Glossary support	... define the terms that are specific to a business model (e.g., the term *Original Equipment Manufacturer* (OEM) as *key partner* in a computer manufacturer's business model is defined: "An OEM produces parts that are marketed by another manufacturer.").
Assessment	Financial assessment	... assess a business model by documenting estimates of prices/costs and quantities (e.g., the costs of setting up a *sales team* or the costs of launching an *online shop*).
	Non-financial assessment	... assess a business model qualitatively (e.g., in the form of *star ratings* or *likes*).
	Assessment status	… document the status of a financial or non-financial assessment (e.g., in hypothesis-driven evaluation: Has the hypothesis already been tested and, if so, has it been verified or falsified?).
	Correctness checker	… analyze the syntax of a business model (e.g., does each component have at least one element?) or the relations between elements (e.g., is each element in the component revenue stream assigned to at least one element in the component customer segment?).
Navigation and filtering	Model comparison	... identify commonalities and differences between two or more business models (e.g., visually or textually).
	Element filter	... show or hide elements (e.g., those of the same color).
	Phase management	... display only functions that are relevant in a given phase of business model development (e.g., idea generation templates in the phase of business model idea generation and *like* buttons in the phase of business model idea evaluation).
	Element clipboard	... store elements that have not yet been assigned to a component of the business model (e.g., customer segments already identified but whose relevance still needs to be decided).
	Link to business models (or parts of them)	... link from one part of a business model to another part of the same business model (e.g., at a different level of abstraction) or to a completely different business model (e.g., a partner's or a competitor's business model).
	Framework support	… represent information that goes beyond the business model context (e.g., the business processes that a business model requires to be performed or the corresponding IT infrastructure). Frameworks covering the entire enterprise architecture such as TOGAF often support representing information on various levels of an enterprise, where business models are at one level.
Perspective: Collaboration		
Communication	Chat	... communicate synchronously (e.g., through text chat, video calls, or screen sharing).
	Discussion board	... communicate asynchronously and archive information (e.g., a discussion on the advantages/disadvantages of choosing one revenue model or another).
	User list	... see which other users are working on the same business model and where applicable which users are currently online (e.g., in the form of a list with all (currently online) users).
Synchronization	Asynchronous modeling	... work with multiple users on a business model and make changes successively, that is, not simultaneously.
	Concurrent modeling	... work with multiple users on a business model simultaneously, but changes are only visible to other users after they have been released by the user who has made the changes.
	Synchronous modeling	… work with multiple users on a business model simultaneously with changes being visible to other users in real-time.
	User management	... add, change, and remove users (e.g., by sending a link or by registering an e-mail address).

Table 4 (continued)

Function	Description: *The function allows to…*	
User/role management	Role management	… assign access status and define roles to users (e.g., read, comment, or edit access).
	Support of task sharing	… add, change, remove, and prioritize tasks (e.g., to validate the willingness to pay of a particular customer segment by conducting a certain number of interviews) and assign them to users through an integrated feature or through the integration of a third-party tool such as the issue tracking system JIRA.
	Workspace awareness	... notify users about changes made by other users; notifications can be delivered inside the tool (e.g., by a pop-up message) or outside (e.g., by e-mail).
	Version control	... document changes between successive versions of a business model and view earlier versions (e.g., by moving a slider back and forth).
Repository/Conflict M.	Local repository	… store data locally on the user's device (e.g., on a computer, tablet, or mobile phone).
	Remote repository	… store data remotely on a server (e.g., physically distant in the cloud).
Perspective: Technical		
Architecture	Client/Server	… distribute the tool's functionality among a client and a server application. A dedicated application acts as the client application (i.e., the client application requires to be installed on the user's device).
	Client only	… enable the tool's functionality solely in a client application. The tool requires an installation on the user's device (and thereby allows to use the tool offline).
	Web-based	… distribute the tool's functionality among a client and a server application. A web browser acts as the client application (no dedicated application needs to be installed on the user's device and, therefore, the tool runs independently of the operation system installed on the user's device).
Data exchange	Export	... export a business model in at least one format that allows making changes to the business model, that is, not only as a screenshot (e.g., a proprietary format, PowerPoint or text).
	Import	... import a business model in at least one format that allows making changes to the business model, that is, not only as a screenshot (e.g., to continue working on a business model developed by another user or developed with another tool).

Appendix 5. Description of the preliminary taxonomy evaluation

For testing and revising the taxonomy and its functions' descriptions during the taxonomy development we exposed preliminary versions of the taxonomy and its functions' descriptions to four graduate students (i.e., people who were not involved in the taxonomy building).

The four graduate students were all familiar with developing business models as they attended a university course on master level in which they had to develop (at least) one business model by using software-based tools that implement the Business Model Canvas. Prior to the workshop, all four students have been already involved in a research project that aims analyzing business models. The age of the workshop participants ranges from 24 to 32 years, and one graduate was female. Participation was voluntary and unpaid, to ensure unbiased task completion and responses during the workshop. Furthermore, the graduate students were given sufficient time to read the taxonomy and its function's descriptions.

A description of the graduate student's background can be found below.

Table 5 Preliminary taxonomy evaluation

Self-assessment via Likert-scale from 1 (strongly disagree) to 7 (strongly agree)					
Participant	P1	P2	P3	P4	Average
"I am familiar with business models"	5	6	7	5	5.75
"I know software tools for business model development"	5	5	6	5	5.25
"I have used software tools for business model development"	5	4	5	5	4.75
Degree of understanding the description of the taxonomy via Likert-scale ("I fully understand the description of the function.") from 1 (strongly disagree) to 7 (strongly agree)					
Minimum value across all functions (average of all four graduates)	5.00				
Maximum value across all functions (average of all four graduates)	7.00				
Average value across all functions (average of all four graduates)	6.54				
Demographic data					
Participant	P1	P2	P3	P4	Average
Age	26	25	32	24	26.75
Gender	male	female	male	male	–
Current position	Graduate student	Graduate student	Graduate student	Graduate student	–

Appendix 6

Table 6 Taxonomy of business model development tools

BMDT				(1) Abizmo	(2) Archi	(3) Biz Canvas	(4) BiZZ Design	(5) Blank Canvas	(6) BM Canvas	(7) BM|Desig|ner	(8) Business Model Fiddle	(9) Business Model Canvas	(10) Business Model Canvas & SWOT	(11) Business Model Toolbox	(12) Canvanizer 2.0	(13) Canvas BM	(14) Canvas for all
Perspectives/ (Sub-) Dimensions																	
Modeling	Customization	Add	F1	–	●	●-	–	–	–	–	–	–	–	–	–	–	–
		Divide	F2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		Link	F3	–	●	–	–	–	–	–	–	–	–	–	–	–	–
		Rename	F4	–	●	–	●	–	–	–	●	–	–	–	–	–	–
		Change arrangement	F5	–	●	–	–	–	–	–	–	–	–	–	–	–	–
	Devel-opment	Elements	F6	●	●	●	●	●	●	●	●	●	●	●	●	●	●
		Element connections	F7	–	●	●	●	●	●	●	●	●	●	●	●	–	●
		Templates definable	F8	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Commenting and linking	Textual comments on element-level	F9	●	●	●	●	●	–	●	●	●	–	●	●	–	–
		Textual comments on business model-level	F10	●	●	–	●	–	–	●	●	–	–	–	–	–	–
		Graphical comments (predefined graphic)	F11	–	●	–	●	●	–	–	–	–	–	–	–	–	–
		Graphical comments (freeform graphic)	F12	–	–	–	–	–	–	–	●	–	–	–	–	–	–
		Link files	F13	–	–	–	●	–	–	–	●	–	–	–	–	–	–
		Link web-resources	F14	–	–	–	●	–	–	–	–	–	–	–	–	–	–
		Glossary support	F15	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Assess-ment	Financial	F16	–	–	–	●	–	–	–	–	–	–	●	–	–	–
		Non-financial	F17	–	–	–	●	–	–	●	●	–	–	–	–	–	–
		Assessment status	F18	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		Correctness checker	F19	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Navigation and filtering	Model comparison	F20	–	–	–	●	–	–	–	–	–	–	–	–	–	–
		Element filter	F21	–	–	–	●	●	●	●	–	–	–	–	●	–	–
		Phase management	F22	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		Element clipboard	F23	–	●	–	●	●	●	●	●	●	–	–	●	–	–
		Link to business models (or parts of them)	F24	–	–	●	●	–	–	–	–	–	–	–	–	–	–
		Framework support	F25	–	–	–	●	–	–	–	–	–	–	–	–	–	–
Collaboration	Commu-nication	Chat	F26	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		Discussion board	F27	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		User list	F28	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Synchro-nization	Asynchronous modeling[1]	F29	–	●	●	–	–	●	–	–	●	●	●	–	●	●
		Concurrent modeling	F30	–	–	–	●	–	–	–	–	–	–	–	–	–	–
		Synchronous modeling[1]	F31	●	–	–	–	●	–	●	●	–	–	–	●	–	–
	User and role management	User management	F32	–	–	–	●	●	–	●	●	●	–	–	●	–	–
		Role management	F33	●	–	–	–	●	–	●	–	●	–	–	●	–	–
		Support of task sharing[1]	F34	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		Workspace awareness	F35	–	–	–	–	–	–	–	●	–	–	–	–	–	–
	Repository and conflict management	Version control	F36	–	–	–	●	–	–	–	–	●	–	–	●	–	–
		Repository local	F37	–	●	●	●	–	–	–	–	●	●	●	–	–	●
		Repository remote	F38	–	–	–	●	●	●	●	●	–	–	–	●	●	–
Technical	Archi-tecture	Client/Server	F39	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		Client only	F40	–	●	●	●	–	–	–	–	●	●	●	–	–	●
		Web-based	F41	●	–	–	–	●	●	●	●	–	–	–	●	●	–
	Data exch-ange	Export	F42	–	●	–	●	●	–	●	–	●	–	–	●	●	–
		Import	F43	–	●	–	●	–	–	–	–	●	–	–	–	–	–

Table 6 (continued)

BMDT / Perspectives/ (Sub-) Dimensions	(15) Canvas Model Design	(16) Insight Maker	(17) Lienzo	(18) Notion CUBE	(19) Realtime Board	(20) Startup Canvas	(21) Strategyzer	(22) TheStartupToolKit.com	(23) TUZZit	(24) Waxidea	(25) Canvas Planner	(26) e³editor	(27) Business Make Over's BMC	(28) Lean Stack	(29) Lean Canvas (Office Opettaja)	(30) Lean Canvas (Bytesize)
Modeling	–	●	–	–	●	–	–	–	–	–	–	–	●	–	–	–
	–	●	–	●	●	–	–	–	–	–	–	–	–	–	–	–
	–	●	–	–	●	–	–	–	–	–	–	–	–	–	–	–
	–	●	–	–	●	–	–	–	–	–	●	–	–	–	–	–
	–	●	–	–	●	–	–	–	–	–	–	●	–	–	–	–
	●	●	●	●	●	–	●	●	●	●	●	●	–	●	●	●
	●	●	●	●	●	–	●	–	●	–	●	●	–	–	–	–
	–	–	–	–	–	–	●	–	–	–	–	–	–	–	–	–
	–	–	●	–	●	–	●	●	●	–	●	●	–	●	–	–
	–	–	–	–	●	–	●	–	●	–	●	●	–	●	–	–
	–	●	–	●	●	–	–	–	●	–	●	–	–	–	–	–
	●	–	–	–	●	–	–	–	–	–	–	–	–	●	–	–
	–	–	●	–	●	–	–	–	●	–	●	–	–	–	–	–
	–	–	–	–	●	–	–	–	●	–	●	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	●	–	–	–	–	●	●	–	–	●	●	–	–	–	–
	●	–	–	–	●	–	●	●	●	–	–	–	–	–	–	–
	–	–	–	–	–	–	●	–	–	–	●	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	●	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	●	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	●	–	–	–	–	–	–	–	–	–
	–	–	–	●	●	–	–	–	●	–	–	●	●	–	–	–
	–	–	–	–	–	–	●	–	●	–	●	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Collaboration	–	–	●	–	●	–	●	–	●	–	●	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	●	–	●	–	●	–	–	–	●	–	–	●	–	–
	●	●	–	●	–	●	–	–	●	●	–	●	●	–	–	●
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	●	–	●	–	●	●	–	–	●	–	–	●	–	–
	–	●	●	–	●	–	●	●	●	–	●	–	–	●	–	–
	–	●	●	–	●	–	●	●	–	–	●	–	–	●	–	–
	–	–	–	–	●	–	●	–	●	–	●	–	–	–	–	–
	–	–	●	–	●	–	●	–	–	–	●	–	–	–	–	–
	–	●	–	–	–	–	–	●	●	–	–	–	–	●	–	–
	●	–	–	●	–	●	–	–	–	–	–	●	–	–	●	●
	–	●	●	●	●	–	●	●	●	●	●	–	●	●	–	–
Technical	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	●	–	–	●	–	●	–	–	–	–	–	●	–	–	●	●
	–	●	●	–	●	–	●	●	●	●	●	–	●	●	–	–
	–	●	●	●	●	–	●	●	–	–	–	●	–	●	–	●
	–	●	–	●	●	–	–	–	–	–	–	●	–	–	–	–

Legend: ● addressed, − not addressed; (1)–(24) BMDTs used for taxonomy building; (25)–(30) BMDTs used for taxonomy evaluation

Appendix 7

Table 7 Cluster analysis of business model development tools

Perspective/Dimensions/Characteristics			F	Cluster 1 (n=10)		Cluster 2 (n=13)		Cluster 3 (n=1)	
				1 in %	0 in %	1 in %	0 in %	1 in %	0 in %
Modeling	Customization	Add	F1	10	90	15.38	84.62	0	100
		Divide	F2	10	90	15.38	84.62	0	100
		Link	F3	10	90	15.38	84.62	0	100
		Rename	F4	20	80	15.38	84.62	100	0
		Change arrangement	F5	10	90	15.38	84.62	0	100
	Develop-ment	Elements	F6	100	0	92.31	7.69	100	0
		Element connections	F7	90	10	76.92	23.08	100	0
		Templates definable	F8	10	90	0	100	0	100
	Commenting and linking	Textual comments on element-level	F9	100	0	30.77	69.23	100	0
		Textual comments on business model-level	F10	60	40	23.08	76.92	0	100
		Graphical comments (predefined graphic)	F11	30	70	23.08	76.92	100	0
		Graphical comments(freeform graphic)	F12	20	80	7.70	92.31	0	100
		Link files	F13	40	60	0	100	100	0
		Link web-resources	F14	20	80	0	100	100	0
		Glossary support	F15	0	100	0	100	0	100
	Assessment	Financial	F16	20	80	15.38	84.62	100	0
		Non-financial	F17	60	40	7.70	92.31	100	0
		Assessment status	F18	10	90	0	100	0	100
		Correctness checker	F19	0	100	0	100	0	100
	Navigation and filtering	Model comparison	F20	0	100	0	100	100	0
		Element filter	F21	30	70	15.38	84.62	100	0
		Phase management	F22	10	90	0	100	0	100
		Element clipboard	F23	60	40	30.77	69.23	100	0
		Link to business models (or parts of them)	F24	20	80	7.70	92.31	100	0
		Framework support	F25	0	100	0	100	100	0
Collaboration	Commu-nication	Chat	F26	40	60	0	100	0	100
		Discussion board	F27	0	100	0	100	0	100
		User list	F28	30	70	0	100	0	100
	Synchro-nization	Asynchronous modeling	F29	10	90	100	0	100	0
		Concurrent modeling	F30	0	100	0	100	0	100
		Synchronous modeling	F31	90	10	0	100	100	0
	User and role management	User management	F32	90	10	15.38	84.62	100	0
		Role management	F33	80	20	15.38	84.62	0	100
		Support of task sharing	F34	30	70	0	100	0	100
		Workspace awareness	F35	40	60	0	100	0	100
Technical	Repository and conflict management	Version control	F36	30	70	15.38	84.62	100	0
		Repository local	F37	0	100	69.23	30.77	100	0
		Repository remote	F38	90	10	38.46	61.54	100	0
	Archi-tecture	Client/Server	F39	0	100	0	100	0	100
		Client only	F40	0	100	69.23	30.77	100	0
		Web-based	F41	100	0	30.77	69.23	0	100
	Data exch-ange	Export	F42	70	30	38.46	61.54	100	0
		Import	F43	10	90	30.77	69.23	100	0

1 = function supported by a BMDT; 0 = function not supported by a BMDT;
% = percentage of BMDTs that support a function

Legend: 0%-29% | 30%-50% | 51%-79% | 80%-94% | 95%-100%

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