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A Literature Review on the Effectiveness and Efficiency of Business Modeling

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Abstract

Background: Achieving and maintaining a strategic competitive advantage through business and technology innovation via continually improving effectiveness and efficiency of the operations are the critical survival factors for software-intensive product development companies. These companies invest in business modeling and tool support for integrating business models into their product development, but remain uncertain, if such investments generate desired results.
Aim: This study explores the effects of business modeling on effectiveness and efficiency for companies developing software-intensive products.
Method: We conducted a systematic literature review using the snowballing methodology, followed by thematic and narrative analysis. 57 papers were selected for analysis and synthesis, after screening 16 320 papers from multiple research fields.
Results: We analyzed the literature based on purpose, benefit, challenge, effectiveness, and efficiency with software and software-intensive products as the unit of analysis. The alignment between strategy and execution is the primary challenge, and we found no evidence that business modeling increases effectiveness and efficiency for a company. Any outcome variations may simply be a result of fluctuating contextual or environmental factors rather than the application of a specific business modeling method. Therefore, we argue that governance is the fundamental challenge needed for business modeling, as it must efficiently support simultaneous experimentation with products and business models while turning experiences into knowledge.
Conclusion: We propose a conceptual governance model for exploring the effectiveness and efficiency of business modeling to occupy the missing link between business strategy, processes and software tools. We also recommend managers to introduce a systematic approach for experimentation and organizational learning, collaboration, and value co-creation.

Keywords: business modeling, business model operationalization, effectiveness, efficiency, context-dependent, governance, software-intensive product development, literature review

1. Introduction

Software-intensive product development (SIPD) companies experience digitalization of their business environments. The embedded flexibility that software offers merges with the high-pace technology innovation, resulting in new business opportunities for creating and capturing value in digital business ecosystems [1, 2]. This has implications for the business model.

A business model is a blueprint for a company's business logic and a description how to manage and innovate the business. Central to a business model is how an organization creates, delivers, and captures value [3]. Business models can be seen as a set of choices and consequences of these choices (strategies and tactics) that impact the realizing organizations, business processes, products, and systems [4]. Business modeling in a business ecosystem is an activity based on transactions of activities geared toward value creation for all stakeholders [5]. Business modeling (BM) is also a practice that aims to analyze the business environment and acquire

insights to formulate and drive change, by adapting and aligning the business strategy with the execution to ensure value delivery for all stakeholders [6, 7].

Optimizing value creation requires profound understanding how the implemented business model (organization, business processes, and systems) interacts with products and stakeholders for value creation and value capture [8]. SIPD companies have a unique position for optimally (efficiently) creating the correct (effective) value for all stakeholders. Given that software is the main component in: 1) the tools for implementing and supporting core business processes; 2) developing the software product itself, and 3) integrating the product into the business ecosystem, SIPD companies could seamlessly adapt and integrate their products to their business model using business modeling [9].

The business model mediates the link between technology and a company's performance, but the literature is missing the studies which focus on the interdependencies between business model choice, technology innovation, and success [10], as well as differentiating the value creation and value capture analysis over individual, organization, and society level [8]. Several prominent authors emphasized the lack of coherence and clear focus in the business model literature [7, 11, 12]. In particular, there is a gap in understanding how BM interacts with software-intensive products in the digitalization transformation, and what effects BM have on increasing the effectiveness and efficiency of the SIPD companies and maximizing the technology innovation realization effects.

This literature study aims to address this gap by investigating what factors determine the effectiveness of BM, and if BM can act as an enabler for improvements in effectiveness and efficiency of SIPD companies. This study provides a software engineering perspective on how software and software-products enable value creation as the unit of analysis for BM. This perspective enables us to narrow the scope of the vast business model literature, as well as limiting the size of the study by defining a more precise context for analyzing effectiveness and efficiency, as affected by the on-going digital business transformation. Based on the literature review results, we present a summary of benefits and challenges associated with BM including reported impacts on the effectiveness and efficiency of the business. Next, we synthesize the implications for the research and practice of BM and propose a conceptual governance model (CGM) for exploring the effectiveness and efficiency of BM (addressing both the innovation of business models as well as the outcome on company level for the implemented business model).

The paper is structured as follows. In Section 2, we introduce fundamental concepts related to BM and theories used to investigate the multifaceted, cross-disciplinary view of BM and business models. Section 3 reports on related work to BM and its usefulness while Section 4 contains a detailed description of the study design and study execution including a validity discussion. Results are presented in Section 5, starting with general results around the study itself, followed by the detailed results regarding each research question. In Section 6, our research synthesis including trends and our proposed CGM for exploring BM are presented. Finally, in Section 7, we list six implications for researchers and industry followed by our conclusions and key statements in Section 8.

2. Background

2.1. Effectiveness, efficiency, and governance in BM context

Business modeling shares several similarities with software engineering, requirement engineering [13–15], and software product lines (SPL) [16]. Software engineering provides new possibilities to efficiently and effectively implement strategies agreed upon during business modeling activities [2].

The business model literature describes several concepts associated with effectiveness and efficiency. They are often adapted to specific contexts, e.g., organizational efficiency, manufacturing efficiency, operational efficiency, product development efficiency, and expressed as a value,

time or in financial terms as for costs, revenues, profits, and margins. By starting with an "umbrella definition" offered by Webster-Merriam on-line, we will discuss definitions suitable for SIPD companies and our study.

Effectiveness is *the power to produce the desired result.* Efficiency is defined as *the ability to do something or produce something without wasting materials, time, or energy: the quality or degree of being efficient (technical)*, but also as *the power to produce the desired result* causing some ambiguity between the two terms. Buder et al. differentiate between quality (effectiveness) and required effort (efficiency) [17]. Organizational effectiveness is discussed by Zheng et al. in combination with strategy and knowledge management, where they use the definition *the degree to which an organization realizes its goals* [18].

Effectiveness is often measured as the quality of the desired result and Frökjeaer et al., in their attempt to correlate usability to efficiency and effectiveness, they define efficiency as *[. . .] is the relation between (1) the accuracy and completeness with which users achieve certain goals and (2) the resources expended in achieving them* [19]. Measurements of efficiency are often related (direct and indirect) to time and cost. In economics the term efficiency focus on different aspects of the balance between supply and demand. It is measured by the relationship between the value of ends and the value of means and examples of terms are allocative efficiency (production represents customer preferences) and productive efficiency (cannot produce more of one good without sacrificing production of another).

Effectiveness and efficiency are subjective and depend on evaluations. Such evaluations are based on an individual's understanding of knowledge and interpretation in a specific context [20]. Therefore, having the same understanding of a context (which the measurements are relative to), is fundamental when defining effectiveness and efficiency measurements for BM (and the over-arching business context). Current research on context description in software engineering provides a useful checklist on context facets (product, processes, people, practices and techniques, and organization and market) [21]. Understanding, specifying, and sharing contextual factors (often as part of contractual agreements) is a critical factor for systematically optimizing the level of sub-optimization in a business ecosystem.

Effectiveness and efficiency are also closely related to governance, and Webster-Merriam on-line defines governance as *the way that a city, company, etc., is controlled by the people who run it.* Understanding governance is also a crucial part of BM as indicated by for example [5,22,23]. Jansen considers measurements and governance as the enablers of a successful software ecosystem [24]. Zott and Amit argue governance is a vital part of evaluating BM experimentation [5]. Page and Spira discuss corporate governance connected to the business model as a growing need to attain accountability by the board by considering conformance, performance, and overseeing management control systems. They conclude that corporate governance is essentially the same thing as sustaining and developing business models [25]. In this paper, we will use the Webster-Merriam definition of governance.

2.2. Business modeling as an enabler for a company's efficiency and effectiveness

There are many diverse and even divergent definitions of a business model and BM, as also highlighted in many literature reviews, e.g., [7,11,12,26]. A business model "models the business", but as such it has a wide range of usage depending on who and why is using it. It can be used as a description of "kinds and types" in a taxonomy to compare businesses or like a recipe for designing and innovating successful (new) business. Business models can also act as a description of the "logic of the firm", i.e., how to create value and generate profit, or as a scale model to investigate, analyze, and evaluate different strategies and tactics, thereby supporting both strategic and daily decision making [27].

There are two ways to interpret "efficient and effective." One interpretation is that the BM process itself should be efficient and effective. The other interpretation is that the business

model realization should increase a company's efficiency and effectiveness, i.e., BM should be the practice that increases a company's efficiency and effectiveness. In this work, we follow the second interpretation of efficient and effective, as we are primarily interested in BM as a way to enable improvements in a company's efficiency and effectiveness. Therefore, we base our work on the BM definition by Rohrbeck et al. as *to be a creative and inventive activity that involves experimenting with content, structure, and governance of transactions that are designed to create and capture value* [28]. This definition supports our investigation of BM for SIPD companies in two ways. Firstly, looking at value creation transactions allows for a value-driven business model analysis in a business ecosystem. Secondly, by introducing the word *experimenting*, it extends BM to a process of "translating an idea into execution, testing and changing until satisfied," similar to the agile software development methods. We complement the BM definition with the proposed capabilities needed for BM (understand and share, analyze, manage, and prospect) [9].

2.3. Translating business strategy into execution using business models

Casadesus-Masanell & Ricart argue a clear distinction between strategy and the business model, where the business model *is a reflection of the firm's realized strategy* and that the strategy is the plan and process to reach the desired goal, via the business model and onto tactics [4]. Among the authors that recognize the role of the business model in translating business strategy into execution, Doganova talks about the business model as a "calculative and narrative device" to innovate and translate the business strategy into execution [29]. In the same vein, Osterwalder defines the business model as a formal model to capture and translate a value-based business idea into requirements for the ICT systems and the organizations that execute that business model [9]. Höflinger defines *A business model is the design of organizational structures for converting technological potentials into economically valuable outputs by exploiting business opportunities* [7]. For this paper, we combine our transaction-based (bottom-up) definition of BM with Höflinger's (top-down) framework for defining the business model since:

- He extensively integrates and builds on the literature for business models.
- He addresses the issue of static versus dynamic business models (where he supports the static nature of the business model and argues business model innovation as the approach to adapt to rapidly changing environments).
- He focuses on the consequences regarding multi-value, superior performance and organizational learning as a mechanism for feedback and control.
- By taking an inside-out view of the research gap addressed in this study, i.e., based on how software and software-products enable value creation as the unit of analysis for BM, it enables both a top-down and bottom-up analysis.

Translating business strategy into execution is not an easy task and requires experimentation with content, structure, and governance of transactions that are designed to create and capture value [28]. Rohrbeck et al. advocate collaborative BM as a way to deal with the complexity and uncertainty of systems and markets. They stress the need for planning, decision making, validation, and experimentation in highly complex environments. Other scholars also acknowledged the role of experimentation in BM [30–32]. Experimentation can help to capture and manage the business environment dynamics, but it also implies new challenges in addition to just capturing and designing a business model. Some of these challenges are emphasized by Ballon when he argues *it is precisely the alignment of control and value parameters that is of most relevance to business modeling* in his aim to describe a theoretical foundation for operationalization (preparing for execution) of the business model [33]. Ballon proposes an analytical framework for making the scope for choice explicit while connecting value to the configuration of a business model, while others formulate the main challenge as *organizations have to reach the alignment state and maintain it alongside its evolution* [34].

2.4. Capturing the change dynamics and value with software products

Effectively dealing with change requires understanding how the concept of strategy relates to the business model and tactics [4], what strategic agility [35] and strategic flexibility [36] the organizations have, as well as how changeability (adaptability, agility, robustness, and flexibility) can be operationalized using modularity in design and software-based systems [37]. Flexibility and adaptability has since long been a top priority for CEOs[1] and business model innovation is becoming a top priority amongst CEOs[2]. Hence, an important part of analyzing efficient and effective BM translates to capturing and managing the change dynamics of today's business operations.

Value creation and value capture are the central concepts for BM. However, there is still missing consensus on the boundaries of these concepts, based on: (1) plurality in source and target; (2) mix of content and the process; and (3) the overlap between value creation and capture. Value creation is divided into use value (as perceived by an individual) and exchange value (as the monetary compensation), and should be related to the source and the target (individual, organization, and society). Value creation is highly subjective and context-specific but always rooted in interactions. Value creation should be primarily analyzed on the individual level, while most business model literature discuss value creation on the organizational level. Value capture overlaps value creation by discussing the sharing of value (value slippage) to society, organizations, and individuals [8].

Moore discusses value creation in a business ecosystem and the importance to have *value-in-the-experience of customers, economics of scale, and continuing innovation*, while investing in expanding communities of allies. He defines a business ecosystem as a complex structure of interested parties and communities interacting with each other to produce and to consume goods and services, in a partially intentional, highly self-organizing, and even somewhat accidental manner [38]. In such a volatile and increasingly complex environment, successful companies cannot just add value, but instead need to address the value-creating system itself. They must reinvent value, and work together with all stakeholders in the business ecosystem to co-produce value [39].

The flexible nature of software-intensive products opens up unique opportunities to quickly reinvent and co-produce value, but also presents new challenges for SIPD companies in business ecosystems [37, 40]. Figure 1 illustrates an example of software-based value creation in an ecosystem, highlighting three distinct, but overlapping process areas: (1) core business processes, (2) product development, and (3) product integration.

SIPD companies possess unique opportunities to harvest the flexible nature of software and reinvent value by integrating and developing native product support for each respective area and the business model(s). These areas are extensively discussed in the business model literature, e.g., covering pure software business models [41], open source/mixed source [42] and digital options [43], transitions from product-based business models to service-based models [44], or to industrial product-service systems and use models [37, 45, 46]. Even mechanical products rapidly become software-intensive products [47].

The software value map (SVM) [48] explores the different value perspectives and the challenges of balancing the relevant value aspects in software development. The SVM is an extensive collection of software value aspects categorized in four perspectives[3]: customer value; the financial perspective; internal business perspective; and the Innovation, market and intellectual perspective on value. The SVM puts precise and explicit terms on concepts discussed by Höflinger,

[1]Based on CEO Challenge 2004: Perspectives and Analysis, https://www.conference-board.org/publications/publicationdetail.cfm?publicationid=893, and revisted by http://www.floordaily.net/flooring-news/survey--most-ceos-say-flexibility-and-adapting-to.

[2]IBM's global CEO report 2006: Business model innovation matters, http://www.emeraldinsight.com/doi/full/10.1108/10878570610701531.

[3]See http://www.softwarevaluemap.org for the SVM Tool and latest details, as it is continuously updated by input from more than 50 companies world-wide, October 2016.

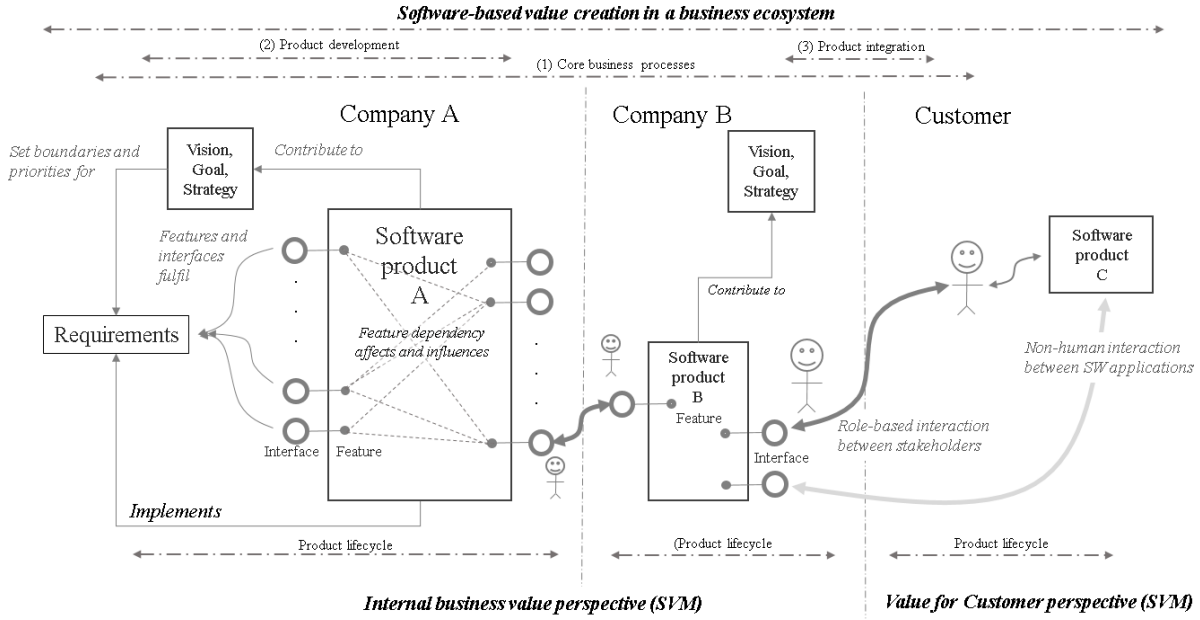

Figure 1. Software-based value creation in a value delivery chain in a business ecosystem

e.g., know-how characteristics, value structure, financial value, social value, and organizational learning. The SVM provides a necessary but often neglected bridge between product strategy, value, and operationalization of software systems and products in requirements elicitation, and decision making.

In Figure 1, two companies, and a customer interact in a business ecosystem. The software products are involved as agents via interfaces and features along the value delivery chain. Value is created in the interaction between two stakeholders, indicated by the arrows between the stick-men and their smiley faces. A company needs to look beyond their borders to identify all stakeholders and possible interactions for value creation (at society, organizational, and individual level).

Different aspects of value are created in these interactions, while external conditions and influences shape the perception of value (as technology and society advances), often resulting in a misalignment between expected and perceived value. BM (in a SIPD context) aims to systematically capture, prioritize, and address how business logic, resources, and governance should be operationalized for optimal value creation and value capture. A software product is hence an essential part of the operationalized business model, both by acting as an agent to the business model (the content, structure, and governance of transactions), as well as through optimizing a software product's changeability [37] to adjust for external influences.

Figure 1 also illustrates the recursiveness and complexity of business models and software-based value creation. Each company typically run their business model while the "overarching" business model for the business ecosystem can be seen as an aggregation and collaboration of the "underlying" business models [28]. Software Product C (e.g., a browser) is using Software Product B (e.g., a crowd-funding application delivered as a cloud service), which in turn is relying on Software Product A (e.g., a database application delivered as a service). Each company develops their software product(s) based on their (business model's) vision and goals. They constantly need adjusting for external influences, using requirement engineering to constrain the vision and goals into an "optimal" realization (time, opportunities, risks, features, and resources) of the software product. A software product should have features addressing (all) the needs of (all) stakeholders (throughout the complete value delivery chain). It must also

support any stakeholders' interaction with the software product throughout the product's entire life-cycle (from the idea, design, production, commissioning, usage, to de-commissioning and obsolescence). Such role-based interaction is illustrated in the figure with features, interfaces, bi-directional arrows and the stick-men. An interaction can also be a non-human interaction between two software products, entirely internal to a company, or any combination thereof. These interactions occur at all levels in activities between actors, within and across company borders, as well as within different life-cycles of the value delivery chain. In a business model, a transaction is an aggregation of such role-based interactions where the exchange of information, goods, payments, and feedback are not necessarily synchronized. Also, the different software products' life-cycles interact and overlap. This puts new requirements on the software product to more efficiently handle the introduction of new interactions and collaborations, e.g., customers being part of the design or test of Company B's software product while Company A and B enter a partnership agreement to share costs and revenue [28]. For SIPD, this creates a tight, highly recursive relationship between BM and the software products.

3. Related work

Several prominent literature reviews are published on the topics of business models. For brevity, we focus on recent publications highlighting aspects relevant for performance [7,11,12,49]. Common to all reviews is the lack of empirical evidence that using BM to evolve the business model increases a company's effectiveness and efficiency. Lambert and Davidson summarize 40 publications and report that choosing the right business model is one factor for a company's success based on evidence of a relationship between success, business models, and business model innovation. They conclude that the studies measure and report what is the current situation, but no empirical research aims to predict company success.

Three of the reviews [7,11,12] highlight the two major challenges in current research on business models: 1) that business model research is too dispersed and needs a consolidation of concepts; and 2) that it is difficult to connect strategy (via business model) to execution, while capturing and handling the needed dynamics of today's global and multi-stakeholder business environments. Other prominent researchers also highlight the lack of a consolidated body of knowledge and concepts [9,23,50,51], indicating a gap in understanding BM's real-world effects.

Business models for explaining a company's performance are frequently discussed both conceptually [52,53] as well as empirically [54–56]. Hacklin and Wallnöfer conclude that the business model acts more as a symbolic artifact and not as an analytic tool. Zott and Amit report empirical evidence suggesting that business model design can provide a competitive advantage, but does not provide conclusions that employing BM to evolve the business model will improve a company's effectiveness and efficiency. Lambert and Davidson studied the relationship between company success, business models and business model innovation. These studies all measure and report what is the current situation, but there is no empirical research that aims to predict company success or to conclude that business modeling enables effectiveness and efficiency of a company [49].

Osterwalder et al. advocate formalization of business models using IS/IT tools and an experimental approach "when-and-how-to-build" [57]. Their eight propositions to be observed and eventually tested seems still be equally valid: 1) use rigorous meta-models; 2) increase understanding business and IS/IT; 3) improve integration business and IS/IT; 4) facilitate and improve IS/IT choices infrastructure/applications; 5) facilitate choices IS role and structure; 6) help defining company's goals; 7) facilitate identification of key indicators; 8) externalize, map and store knowledge of value creation logic [9].

Giessmann et al. extend Osterwalder et al.'s propositions to build a model that can analyze and compare business models, but their work does not address the issues of aligning and daily

execution of a business model [58]. Salgado et al. also build on Osterwalder's business model canvas (BMC) and discuss how to generate a BMC from business goals, rules, and processes, but do not further connect the results to the IS/IT realization and daily operations [59]. They also discuss the alignment between business and IS/IT (from the lens of business model artifacts, enterprise modeling, and strategy and goal modeling) and formulate the main challenge as *Achieving alignment per se is not enough, organizations have to reach the alignment state and maintain it alongside its evolution* [34].

The literature indicates a research gap between modeling the business and executing the business model and more specifically, do business modeling increase a company's effectiveness and efficiency? Höflinger's framework extensively builds on the literature but does not empirically define or explore his angle of *superior performance*, nor the dynamics of a business model related to value. Further, he does not explore how the learning of an organization interacts with the design of, the representation of, and experimentation with a business model [7]. Rohrbeck et al. stop at the preparation for development and do not provide further insights into the mechanics needed for actual experimentation and validation of a business model [28]. Richter et al. discuss flexibility and value as a way to deal with change and implementation of business models. They conclude that further work is needed to better understand inter-firm governance structure [37]. Ballon proposes an analytical framework for making the scope for choice explicit and concludes that further work is needed to make interdependencies of parameters explicit and to extend the model in a more prospective and predictive sense [33].

4. Methodology

4.1. Research questions

We used software and software-intensive products as the unit of analysis. The rationale comes from the central role that software-intensive product play in the on-going business environment digitalization transformation. We focus on the following two research questions:

RQ1: *What benefits and challenges of business modeling are reported in the literature?*

RQ2: *What effects related to effectiveness and efficiency of business modeling are reported in the literature?*

We used RQ1 to investigate the contextual setting for business modeling and to compare and analyze the reported effects on efficiency and effectiveness. The on-going business environment digitalization transformation heavily depends on flexible and scalable software solutions. Therefore we limit the scope to business modeling for SIPD companies developing software-intense products and services. The research process executed in this study is outlined in Figure 2.

4.2. The snowball methodology

Our systematic literature review (SLR) methodology is based on the guidelines for snowballing literature search proposed by Wohlin [60]. The snowballing methodology is considered less noisy compared to a similar database-search based methodology and the critical step for a successful snowballing is to choose a good tentative start set characterized by: 1) studies from different communities; 2) size appropriate for the studied area; 3) diversity of publishers, years, and authors; and 4) is based on the research questions and keyword. The complete study was conducted in four steps, outlined in the subsections below and depicted in Figure 2. We screened 16 320 papers resulting in 57 papers included in the study.

4.2.1. Step 1: Design of the literature review

To minimize the author-bias and to prepare for a cross-disciplinary study (business management and software engineering), we performed two open-ended interviews to identify further reading to understand the terminology to formulate our research questions. These interviews helped us to decide upon the methodology, validity risks, inclusion criteria (IC) and data extraction properties. We also created a study protocol and documented each step and decision. The same IC

Table 1. Search strings for start set

Id	Terms
SS1	("business model" OR "business ecosystem") AND "value creation" AND "strategy"
SS2	("business modelling" OR "business modeling" OR "business ecosystem") AND "business strategy" AND "value creation" AND ("effectiveness" OR "efficiency" OR "business flexibility" OR "modularity" OR "variability in realization" OR "governance" OR "multi-business")

were used defining both the start set and in the following snowball iterations, see Appendix B.

4.2.2. Step 2: Defining the start set

We used a database search in Google Scholar to find the start set and recommendations from the interviewed experts. The two initial interviews (60-minutes, open-ended interview with the question *Does business modeling enable improvements in effectiveness and efficiency for a company?*) with experts in software engineering (telecommunication industry with 25 years of experience) and business management (professor in production management) resulted in a starting point of:

- four recommended studies, of which Höflinger also ended up in the start set [7];
- a wide multi-disciplinary map of subject areas: computer science; software engineering; business management and accounting; economics, econometrics and finance; organization management; and decision science;
- additional keywords – open innovation, strategic management, value creation, value capture, flexibility, business model innovation, business ecosystem, organizational theory, knowledge management, service science, enterprise architecture, software product lines, open source, and product service systems.

After further search in Google Scholar for definitions on these keywords, we created a recommended Golden Set (31 papers) from which we derived a collection of definitions to help us penetrate the terminology. The snowballing methodology recommends using Google Scholar to avoid any bias on specific publishers [60]. The definitions helped us develop the search strings (SS). We used a traditional search schema with iterative clustering to reduce the number of hits while minimizing noise (initially in Scopus since it contains all the subject areas). We ended up with two search strings[4], see Table 1, used to query six databases, see Figure 2.

Executing SS1 and SS2 (limited to title-abstract-keywords) resulted in 2948 papers, see Figure 2. The first author applied the inclusion criteria on titles and abstracts, and 2378 papers were removed. The remaining 570 papers were put in an excel sheet so duplicates and not peer-reviewed papers could be discarded. The final 477 papers were screened more thoroughly (abstract, introduction, conclusion) for IC and the result discussed and validated with the second author, leaving nine papers to be included in the start set. One paper recommended by the experts in business management was also included in the start set.

4.2.3. Step 3: Execute snowballing iterations

The first author collected the references of citations to the papers selected in each iteration. Next, we applied inclusion criteria and calculated the Cohen's Kappa in all iterations, see section 4.3.

In total, we screened 10 414 citations and 2958 references, see Figure 2. Iteration 1 covered the start set and resulted in 35 selected studies (out of 612 references and 249 citations). Iteration 2 resulted in 2011 references and 10 134 citations. The noise in citations is one of the downsides reported for the snowballing methodology, and we applied an initial pre-screening (language, title, abbreviated abstract) giving us a remaining 1335 citations to screen. By having the candidate list in Excel, it was easy to detect all duplicates. We selected 11 studies in iteration 2. Iteration 3 rendered 313 references and 30 citations resulting

[4]SS1 uses stemming and SS2 doesn't. Also, "multi-business" was added upon recommendation of industry expert, since executing several business models in parallel is a significant challenge for large SIPD companies.

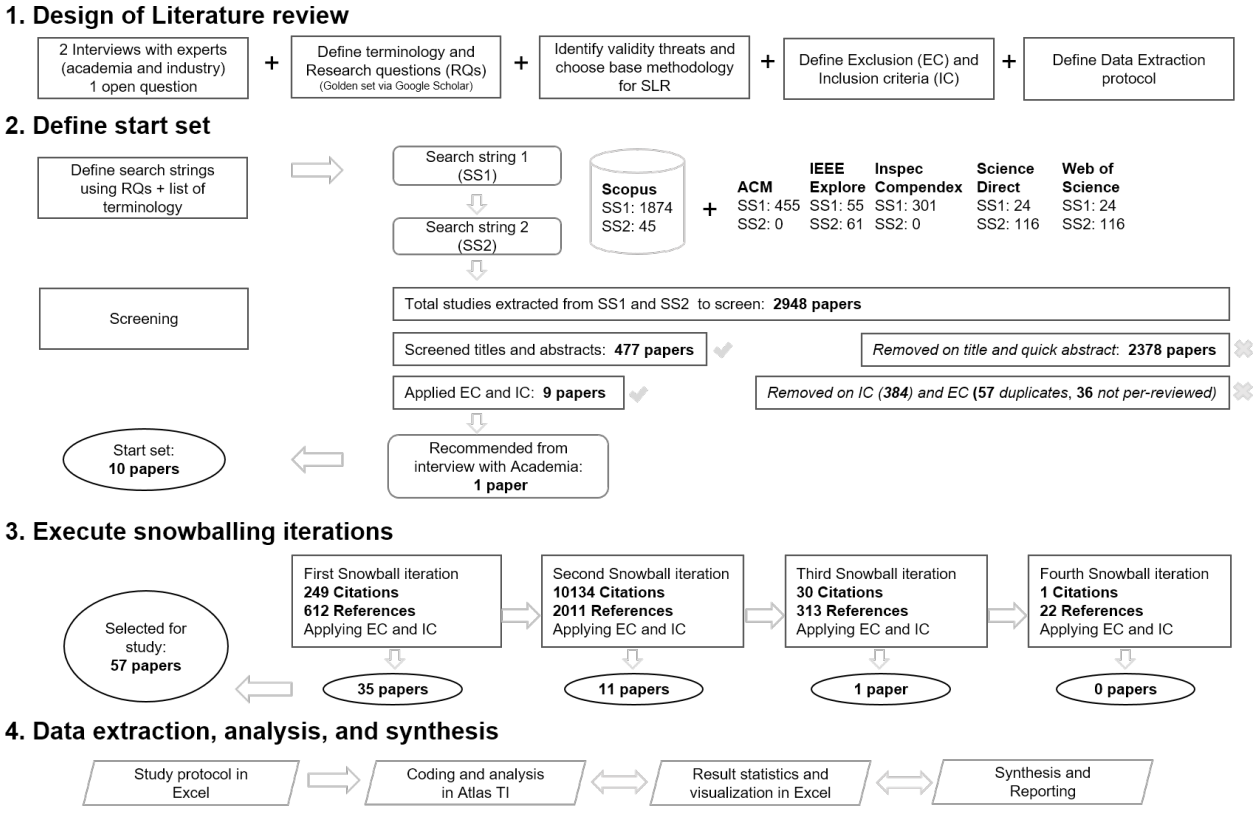

Figure 2. Research methodology overview

in one new paper selected. We got a natural stop of the snowballing procedure by iteration 4 with no more studies discovered resulting in a total of 10+35+11+1 = 57 studies selected for analysis, see Appendix A for a complete list.

4.2.4. Step 4: Data extraction, analysis, and synthesis

Appendix C outlines the data extraction properties (EP) used in this study. ATLAS Ti[5] and Excel were used to keep track of and analyze results as well as synthesize extracted information. The extraction was done by the first author and validated by the other authors, see section 4.3.

Properties EP1–EP4 were evaluated per paper and used to analyze the relevance to industry for each paper's contribution. The property EP3 (Rigor & Relevance) was also used for quality assessment, see extracted raw data per paper in Appendix A and detailed calculations in Appendix C. It helped us to evaluate generalizablity of the results, see section 4.3. Open coding [61] was used for properties EP5–EP9 and the extracted data was thematically analyzed. Properties EP5–EP9 helped us synthesize results regarding BM as phenomena as well as to identify potential research gaps.

The results were iterated in two phases (a) RQ1 and (b) RQ2. For each phase, the first author prepared a summary of listed quotations from all studies. The list was then reviewed against the extracted result, and the first author had to explain a summary of each paper's findings to the reviewer. Phase (a) were reviewed by the second and third author, while phase (b) were reviewed by the second author.

4.3. Validity threats

We adopted the validity guidelines suggested by Runeson et al. [62]. An extensive industrial experience of the authors may have influenced the aims of the study with a stronger bias towards

[5]Software for Qualitative Data Analysis, http://atlasti.com/.

solutions. We mitigated that bias by two initial interviews and an iterative refinement of the research questions and also by applying a grounded theory approach [61], fostering a focus on the merits of each paper before an end-to-end perspective could be evaluated.

The selected ten papers in the start set are highly heterogeneous and therefore minimize the bias on specific author or terminology. Similarly, we mitigated the author's bias by calculating the Kappa coefficient when selecting the start set papers. The Kappa analysis was done by the first and second authors, and the value was $\kappa = 0.566$ and later increased to $\kappa = 0.638$. The Kappa analysis was also performed during the first snowballing iteration on 12% of the studies with a resulting value of $\kappa = 0.763$. These values represent sufficient agreement and increase the validity of the study.

To mitigate author bias during extraction, six random studies were selected (of the 57 studies) and extracted by the first and second authors. The validation showed a discrepancy of one paper for extraction properties EP1–EP4 and after further discussion full agreement was reached. Also, the results to the RQs (EP5–EP9) was iterated in two phases, and each phase was presented by first author before discussed and evaluated by at least one more researcher.

Rigor and relevance analysis was applied to mitigate potential threats to conclusion validity. The rigor classification based on software engineering literature was also adapted for business modeling literature. The relevance parameter was coded using binary weights (0, 1, 2, and 4 instead of the recommended 0 and 1). We also decided to add property EP4 to specifically address the relevance of a paper's content concerning our RQs (since the property EP3 and its' relevance aspects only consider the research method and context of a paper). This provided higher resolution when discussing the relevance and when thematically comparing the papers. The extraction of results was iteratively reviewed and discussed with second and third authors. We minimized potential internal validity threats by following the systematic mapping study guidelines, creating a review protocol and sharing the work associated with data extraction and analysis.

Since this study covers studies from a wide set of research fields, the semantics (and context) of words can often be misleading. We addressed this by our choice of a snowballing methodology in combination with a rigor design to identify the start set. Moreover, we used open coding (inspired by grounded theory [61]) to synthesize and harmonize language between the different research fields.

Because of the interdisciplinary nature of this study, the risk remains that some aspects are underrepresented and other aspects are overrepresented. In particular business model innovation or business process modeling seems to be heavily researched in the business management and the computer science community. However, we decided to limit the scope in these dimensions since our primary interest is the interplay between the strategic intentions, the design of a business model, the realization of it, and the resulting effects on efficiency and effectiveness, rather than details on how individual steps are performed.

We selected our start set studies from different research disciplines and these studies are conducted using many different research methods which improve the external validity of our literature review. Even though the start set is carefully chosen and includes publication years (2004–2014) there are only 17 (out of 57) papers published during 2013–2015.

5. Results and analysis

Table 2 shows results related to research questions mapped to each paper's context (data extraction property EP4, see Appendix refapp:C), including frequency and summarizing comments. Using inclusion criteria IC2 and IC3 we investigated if the papers address flexibility without further exploring the efficiency or effectiveness.

74% of the identified studies (EP4, categories 2 and 3) focus on the business model construct rather than the BM as a practice. One reason for this could be that BM as a practice is a broad, diverse topic forcing researchers to limit the scope

Table 2. Results mapped to research questions and paper context

RQs /ICs	Business modeling (1)	Business model (2)	Other (3)	Sum of papers	Comment
RQ1	2, 6, 15, 17, 18, 35, 36, 37, 41, 49, 51, 52, 53, 54, 56	1, 3, 5, 7, 9, 13, 14, 16, 19, 20, 21, 22, 24, 29, 32, 33, 39, 40, 45	8, 10, 12, 26, 30, 31, 34, 38, 42, 43, 46, 48, 55, 57, 58, 59	50	Scattered in a multitude of practices and frameworks. Results suggest lack a systematic alignment of contextual information hindering re-use and integration of practices
RQ2	17, 35, 37, 54, 56	1, 5, 24, 29, 32, 45	8, 42	13	Quotes on effectiveness and efficiency are not differentiated nor substantiated
IC2	2, 6, 17, 18, 35, 36, 37, 41, 49, 52, 53, 54	1, 3, 5, 7, 9, 13, 14, 19, 20, 22, 24, 27, 29, 33, 39, 40, 45	8, 10, 12, 26, 30, 31, 34, 38, 48, 55, 57, 58, 59	42	Many papers reflect over flexibility. Governance is important for understanding the value (and cost) of (the right) flexibility in order to optimize the value creation and value capture
IC3	2, 6, 15, 18, 35, 37, 49, 51, 52, 54, 56	1, 3, 5, 7, 9, 13, 16, 19, 21, 22, 24, 27, 29, 32, 33, 45	10, 12, 26, 31, 34, 43, 46, 55	35	Variability in the realization is an important aspect of flexibility and should be a part of the business modeling analysis
Sum of papers	15 (29%)	20 (39%)	16 (31%)		The % is calculated of the 51 papers adressing RQs+ICs. 6 papers of the total 57 selected papers did not specifically address any of the RQs+ICs. They all belonged to category 3: Other
Hit rate	33% (5)	30% (6)	9% (2)		The 'hit rate' is the ratio of papers addressing both RQs. For category 3 the ratio include the 6 papers (not listed in the Table) not addressing any RQs

by addressing some aspects of a business model construct rather than BM as an activity or process. Still, only 33% of the paper address both RQ1 and RQ2.

The number of papers addressing multiple RQ+IC is growing since 2005. As the area becomes more mature, it is also becoming more complex, multifaceted, and cross-disciplinary. This trend is also indicated by Kindström where he states *that companies need to focus on all areas of their business models in a holistic fashion, and not just change isolated elements* [P24]. Similar, Reim et al. concludes that more research efforts are needed on the complicated relationship between strategic and operational levels [P3]. This could be one of the reasons why business model research is still scattered and disperse. To evaluate BM efficiency, it is therefore essential to connect the business strategy via the business model to the execution of the business model with traceability to daily operations and results.

We used Rigor and Relevance (EP3) to analyze the identified papers, see Figure 3 and Appendix A. 60% of the studies received industry relevance scores greater than 7, representing a good balance between state-of-art and state-of-practice. A majority of these studies (20) score 15 (highest), and additional eight studies score > 9 (two or more conditions met). The included literature reviews [P3, P9, P29, P40] have (as expected) a relevance score $= 0$ with acceptable rigor scores ($>= 1$). The remaining 19 studies with a non-industry relevance score, discuss specific topics or more general frameworks and methods/aspects (related to BM) divided on: strategy [P15, P19]; life cycles [P25, P28]; effectiveness and efficiency [P35]; flexibility [P27]; static/dynamic [P14, P34]; or frameworks, meth-

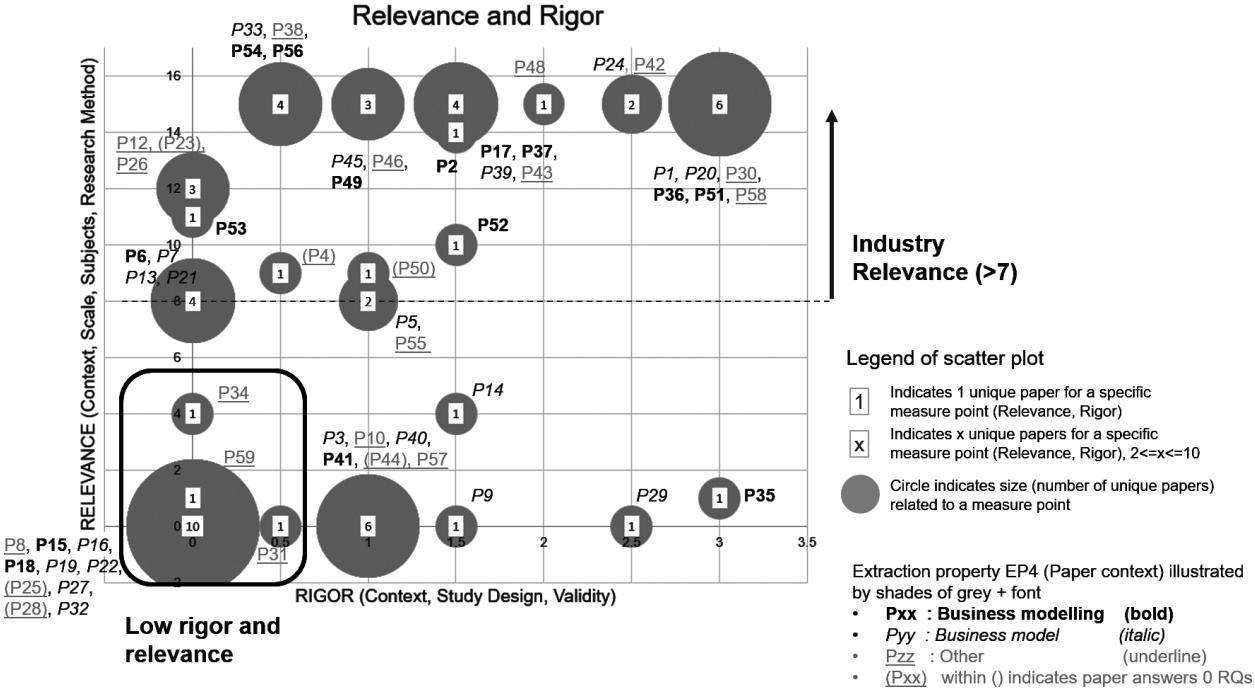

Figure 3. Papers plotted for frequency (size), rigor (X-axis) and relevance (Y-axis) scores, and paper context (font)

ods and models [P8, P10, P16, P18, P22, P31, P32, P41, P44, P57, P59].

45% of the studies are coded with a low rigor (score 0 and 0.5) where 11% only describe the context, but not mentioning any design or validity aspects. The validity aspect is the single most lacking aspect lowering the rigor in 54% of the 22 studies with medium rigor (score 1, 1.5 and 2). Different research fields are different regarding maturity, methodology, and best practices on how to report the research, which we believe are the main reasons affecting the rigor aspect.

5.1. Benefits and challenges associated with business modeling (RQ1)

We extracted 263 quotes of purpose, benefits and challenges of business modeling (EP5), see Appendix D. Quotes of purpose (P) often sets the general context, while quotes of challenges (C) or benefits (B) often are reflections of how well a solution to a specific problem works. Benefits refer to a solution with good enough result while challenges refer to potential issues to obtain a satisfactory result (judged by specific qualities and contextual factors). We identified the following common areas (rows in Appendix D): 1) value creation/capture; 2) cost/revenue; 3) mind-set and knowledge; 4) means[6] (mission, strategy, tactics, directives, organization, and resources); 5) ends[6] (vision, goals, and objectives); and 6) assessment[6] (decision control, clarity, visualization, influencer, etc.).

Our literature review results suggest that the overarching purpose found for BM is for a company to stay competitive and improve its business results. The quotes of purpose are often overlapping and cover a wide variety of more specific topics, like managing individual business aspects (e.g., offerings, market, cost and revenue), capturing the business logic and activity systems, over to a holistic nature like "operationalize strategy", appropriate value from technology, or managing value (co-creation, capture, creation) and partners. Investigating the quotes further, we identified three primary contexts for BM (columns in

[6]We use the terms assessment, ends, and means as defined in 2015 by Business Motivation Model Specification Version 1.3. http://www.omg.org/spec/BMM/. Accessed 2 Nov 2017.

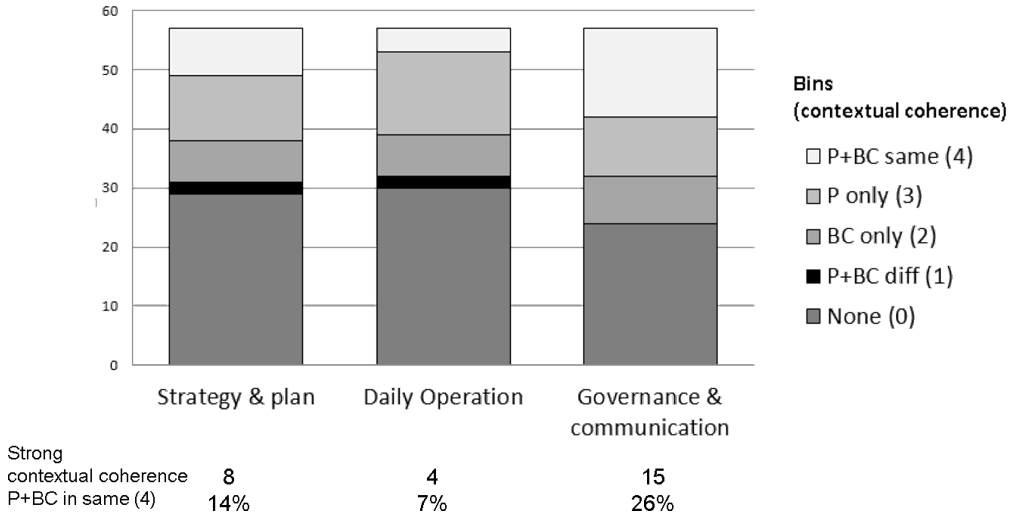

Figure 4. Quotes binned on purpose, benefits+challenges, and distributed over the primary contexts

Appendix D): 1) Strategy and planning; 2) Daily operations (executing strategies and plans); and 3) Governance and communication.

To analyze potential ambiguity (per paper) between the primary context of purpose quotes vs. the primary context of benefits/challenges quotes, each quote is tagged with Paper ID, Type of quote (one of P, B, C), and primary context (one of 1, 2, 3). Figure 4 illustrates the number of papers adhering to different contextual coherence bins distributed over the three primary contexts. We define the five contextual coherence bins. Bin 0 equals a paper having zero quotes in a primary context. Bin 1 equals a paper having quotes of P and B/C only in different primary context. Bin 2 equals a paper having only quotes (B/C) for a primary context. Bin 3 equals a paper having only quotes (P) for a primary context, and Bin 4 equals a paper having quotes of both P and B/C in same primary context.

Strongest contextual coherence is found in bin 4, with the highest ratio for the primary context "Governance & communication" at 16% (15 papers). The most significant contextual ambiguity (bin 1) is found in 4 papers [P8, P13, P19, P49] where a purpose is stated in one primary context while the benefit or challenge is claimed in another primary context without specific detailing the relationship. Romero & Molina discuss the purpose of value co-creation, as a complicated cooperative process (speed, coordination, compromise) with the challenge of managing the experience-sharing network, and how that affects the business modeling [P8]. Chesbrough discusses business model innovation with purposes related to formulating competitive advantage, value proposition and value chain definition while concluding challenges as a lack of tool support and continuous learning associated with BM experimentation [P13]. Richardsson discusses the purpose of formulating and achieving goals and objectives while concluding challenges as managing the different abstraction levels towards execution and getting the details right [P19]. Eurich et al. discuss the purpose of transforming the business opportunity into an organizational implementation via experimentation and business model fit, while concluding challenges in practical aspects like lack of details, not aligned design processes, disregard of external influences, etc. [P49]. Moreover, a significant portion of the papers lack statements on purpose, benefit, or challenge making a discussion around effectiveness and efficiency more challenging due to vague contextual information. Our results highlight a challenging issue how to effectively and efficiently defining contexts to improve understanding and communication in BM literature.

The importance of contextual information is mentioned by seven studies [P8, P17, P18, P20, P25, P51, P59], but no author goes as far as to suggest how to describe or represent the contex-

tual information. At the same time, the current research on context description in software engineering provides a useful checklist on context facets (product, processes, people, practices and techniques, and organization and market) [21]. However, these context facets are ambiguous in themselves, e.g., a market consist of products, customers, and organizations, a product could be a service and therefore include a process, etc. As a reflection of the identified challenges and claimed benefits, related to the paper's contribution to practices and methods for BM (including effects on effectiveness and efficiency), the underlying purpose is contextually vague with statements like "operationalize strategy" [P36, P37], or "deal with uncertainty" [P2, P52, P54]. The papers offer no empirical evidence to support that the purpose can be realized with claimed benefit nor do they quantify the extent of the challenges.

Similarities between the quotes on benefits and challenges are found, but only eight quotes are reported by multiple authors, for example: "(−) difficult managing dynamics (agility, adaptability, planning, decision) for alignment to environment and other organizations" [P2, P5, P7, P9, P36]; "(−) hard to visualize, document and share" [P26, P32]; "(−) difficult to mobilize and align available resource in time" [P9, P15]; "(+) better understanding, better language and legitimacy" [P17, P32]. We speculate that this low level of coherence between the papers is a result of the wide topical area of BM. We also note that seven of these eight quotes discuss common topics of governance ("handle dynamics", "align") and knowledge ("understanding", "sharing", "legitimacy", etc.), while the remaining statement covers value creation.

There are also cases where the same type of statement is argued both as benefit and challenge (by different authors). For example, (+) "building better strategies" [P32] vs. (−) "BM design requires better integration with strategy analysis" [P37] or (+) "improves dealing with uncertainty" [P2] vs. (−) "difficult to deal with uncertainty, complexity and dynamism" [P54] or (+) "improves alignment of strategy, organization and technology and integration business IS/IT domains" [P32] vs. (−) "hard to reach and maintain alignment of business model and information system model" [P59]. This kind of ambiguity can be a result of the wide topical area of BM in combination with a poorly specified contextual setting, opening up for a different interpretation of results.

The majority of the quotes are found in the union of (Governance) | (Mindset, Knowledge) | (Assessment) indicating that learning (knowledge) and control (governance) is key to BM. This is also backed by [P5, P13, P32, P51] which discuss the importance of experimentation and learning to adapt to the changing environment. The changing environment is also highlighted by [P2, P9, P49] as a challenging fact of business models, and as McGrath concludes, everything cannot be planned, but rather adapted to a suitable fit [P18]. In the same vein, we notice the vast number of papers belonging to bin 0, 2, and 3, indicating that a majority of the papers foucs on a single primary context of BM, rather than connecting the strategy to the execution and evaluating the business outcome (as a consequence of the BM practice).

Summarizing the results, the most common challenge is how to deal with the dynamics of business models [P2, P5, P7, P9, P36] and most of the quotes on challenges relate to the non-existing solutions for governance (representation, simulation, decision-support, and feedback) of the proposed frameworks and methods. Since governance is not addressed, each BM method or framework may work in its' specific context, but taken out of context or combined with other methods may fail to deliver the claimed benefits. Also, the quotes of benefits are unsubstantiated or claimed with limited empirical evidence (except for an empirical case which evaluates and compares user's understanding of two value models [P35]).

5.2. What impact does BM have on effectiveness and efficiency (RQ2)?

Only two studies make a clear distinction between the terms effectiveness and efficiency [P5, P35] where Chew and Buder & Felden both specifically link effectiveness to quality and ef-

ficiency to effort to perform a task. Zott et al. recognize efficiency as an important value driver, and that any value driver can enhance the effectiveness of the other drivers [P29]. Osterwalder et al. connect efficiency to infrastructure management while effectiveness is indirectly connected to value [P32]. Chew and Romero & Molina connect effectiveness to customer experience [P5, P8]. Mason & Mouzas argue efficiency is a product of careful management of resources and capabilities driven by a "network focused" approach while effectiveness (via marketing) is a product of being market-focused to keep in touch with changing customer needs by flexible products and service offerings [P58]. The terms are also used on different abstraction levels hindering in-depth analysis. We believe this is a likely result due to the combination of: 1) none of the 57 studies have research questions that directly address effectiveness and efficiency; 2) that business model research is still not coherent with a consolidated view of what a business model is used and useful for; and 3) few scholars address both primary contexts of strategy and the execution making an evaluation of effectiveness and efficiency difficult.

Measurements of effectiveness, efficiency, and company's performance (as an expected outcome of efficiency and effectiveness improvements) are neither sufficiently described nor substantiated. Measurements of effectiveness were only explicitly defined by Buder & Felden where they used a ratio of correctly answered questions to evaluate the effectiveness of individual methods about understanding value [P35]. No explicit measurements on efficiency or company's performance were found amongst the papers, except for Andries & Debackere who suggested company's survival rate to measure its performance for new technology-based business models [P42]. Ghezzi discussed how discontinuity can be detected before it affects a company's performance but does not mention how to measure the performance [P37]. A company's performance is also referred to by different terms but not further substantiated, for example by profitability [P29], value creation [P29], organizational performance [P29], operating cost or gains in productivity [P54]. We found no empirical evidence (except [P42]) to substantiate claims on effectiveness and efficiency. We also note that all 13 papers addressing RQ2 also address aspects of flexibility and variability in the realization (IC2 and IC3, see Table 2).

Indirect effects on effectiveness (and efficiency via profitability) are reported by three papers [P24, P29, P37]. Kindström discusses the transition to the service-based business model as a key to remaining competitive [P24]. He does not make any specific claims about effectiveness or efficiency, but proposes focusing research efforts on: 1) how to industrialize service offerings to a larger scale; and 2) understanding how a transition to service-based business models affects profitability and growth. Zott et al. in their literature review acknowledge the possible contingent effect of BM linking product market strategy and company performance [P29]. They also refer to a study by at IBM Global Business Services in 2006 that says financial out-performers put twice the effort on business model innovation compared to under-performers, but do not further elaborate as on how. Ghezzi looks at the strategic planning process and BM under discontinuity [P37]. He concludes that the 'business model parameters mix', as derived from the different business model blocks, directly affects the company's performance. He provides a strategy-analysis tool based on BM, VN, and RM constructs (business model, value network, resource management), to detect what is changing in the company's strategy when discontinuation occurs, but he does not discuss in any detail how to derive any changes in effectiveness or efficiency.

Summarizing the results, we found limited empirical results indicating that BM has an overall effect on a company's results regarding effectiveness and efficiency improvements. It is also not possible to judge whether a favorable outcome can be achieved in a scenario of continuous (experimental) BM, or it is just a result of a one-time activity to modify the business model. Also, we note that all 13 papers addressing RQ2 also address aspects of flexibility and variability in the realization. These limited results prompt us to do a contextual analysis of the effectiveness and efficiency of BM.

5.3. Contextual analysis of effectiveness and efficiency

We base our analysis on the two main contextual BM settings: 1) the business model realization should increase a company's effectiveness and efficiency; and 2) the effectiveness and efficiency of the BM process itself.

For **increasing effectiveness and efficiency** (contextual BM setting 1), we found the same three primary contexts as reported in Section 5.1: 1) strategy and planning; 2) daily operations (executing strategies and plans); and 3) governance and communication, see Table 3. From these contexts, we identified three patterns (full, partial, and single) describing whether a paper covers all three contexts or parts of them. The patterns are derived from the first three columns (define, execute, and governance) in Table 3. Full means that the paper does address topics in planning and strategy, daily execution, plus governance and communication contexts. Partial refers to any combination of two contexts, while single refers to only one context. We also analyzed the papers according to the three key areas aggregated from the studies: value creation/capture; decision support; mindset and knowledge.

The **BM process' effectiveness and efficiency** (contextual BM setting 2) are discussed by 3 of the 13 studies [P35, P54, P56]. Buder & Felden recognize the hurdle of keeping models consistent during transformations and suggest a specific value representation model as a remedy [P35]. Salgado et al. propose a method for modeling and visualizing requirements on the define and execute processes of the business model [P56]. Both studies offer limited empirical evaluations. Meier & Bosslau recognize the importance of a continuous, integrated BM to capture the dynamics of the ecosystem [P54]. It is the only paper clearly discussing the importance of not separating the process of BM from the actual define and execute processes of the business model. However, they do not quantify any effects on effectiveness and efficiency, while concluding that tools are a necessary focus for further research. We believe the lack of empirical results is a direct consequence of: 1) the wide contextual settings for business model research; and 2) the lack of consolidated view on what a business model is used and useful for. Given our study's primary focus (contextual setting 1), we also interpret the ratio of papers addressing our main contextual setting (77%) as a quality measure of our study design.

Full pattern category papers [P1, P5, P8, P24, P29, P54] advocate that to yield effectiveness and efficiency, the overall focus is how the plan/strategy/goal should be aligned with the execution of the strategy. Woodard et al. discuss how "design moves" enable rapid product development in a new domain with fierce competition and how to formulate and execute digital business strategies (align strategy to execution) based on option value and technical depth [P1]. They propose decision-support via option value and technical depth to integrate the perspectives of designers and corporate strategies. They empirically illustrate effectiveness and efficiency from a set of design moves but do not state on what level anything became more efficient.

A transition into service-based business models to improve competitiveness and efficiency of the business model is proposed by three papers [P5, P54, P24]. Chew argues that business model design impacts directly financial performance but does not state how nor to what extent it affects effectiveness [P5]. Effectiveness is a result of service variability and aligning the three contiguous processes for optimal value co-creation (customer value-creating, supplier value-creating, and the service encounter processes). He focuses on the **define** process with a service design concept to understand the customer needs and value appropriation, and concludes that execution also requires *support by a corresponding modular organizational architecture as well as IS architecture.* Meier & Bosslau discuss the difficulties when transitioning from a product-centric business model into a product-service centric model, with empirical findings that only 21% of manufacturing companies succeed in this transition [P54]. The fundamental problems are: a drop in efficiency, diversified portfolio, and an increased cost due to an increased product-service port-

Table 3. Identified effects on effectiveness and efficiency

Pattern and key areas	Strategy & planning (Define) (contextual setting 1)	Daily operations (Execute) (contextual setting 1)	Governance & communication (contextual setting 1)	Business modeling (contextual setting 2)
Full pattern P1, P5, P8, P24, P29, P54	x	x	x	P54
Partial pattern P32, P37, P56 P42	x x	– x	x –	P56 –
Single pattern P17, P35, P45	x	–	–	P35
Value creation/ Value capture	Concept of design moves [P1] Service concept design, service design, customer experience design, service architecture design [P5] Effective product market strategy [P29] Business process modeling efficiency [P35] Cumulative changes have a positive effect on success rate in immature markets [P42]	Concept of design capital [P1] Adaptations to initial BM are crucial, over- and under-adaptations effect performance [P42] The availability of resources and capabilities are more important to quality of adaptation [P42]	Transition to service-based business model improves profitability [P24] Dynamic business models (with flexibility) are important for a successful transition to service-based business models [P54]	Modeling overhead in transformation and reduction to maintain consistency [P35]
Decision support	Provide relevant information for next stage [P17] Strategic tools, business model, value network, resource management, signal radical change [P37] Empirical findings on instrumental efficiency for business modeling show no convergent results [P45] Process, goals, rules improves traceability [P56]	Decision-support via option value and technical depth [P1] Representation of information to enhance pragmatic validity [P17] Foundation for improved speed to react on external event and business environment [P32]	Quantitative modeling and simulation is vital in continuous loops [P54] Process, goals, rules improves traceability [P56]	–
Mindset and knowledge	–	Capitalize user's knowledge for innovation (idea generation, prototyping) [P8] Cumulative changes have a positive effect on learning and success rate [P42]	Formalizing activities forces implicit understandings become explicit [P17] Generating and transferring of insights is key for reuse, e.g., business model cockpit [P54]	Generating and transferring of insights is essential for reuse [P54]

folio without a matching increase in revenue. They propose an iterative learning process based on an integrated business model design and engineering using System Dynamics (SD). SD is used to specify the business models run-time behavior over time, but they conclude that the provision and further development of this approach are crucial in further studies. Kindström identifies vital aspects in **define**, **execute** and **governance** when changing into a service-based business model, and also recognizes the challenge of staying profitable [P24]. However, he makes no specific contribution how to improve efficiency or effectiveness and concludes that more research is needed to link a transition to profitability and growth.

To enhance the effectiveness of collaborative networked organizations, Romero & Molina propose an experience-centric network reference framework based on open-business models (co-innovation/open innovation) [P8]. By integrating a multi-value perspective with a multi-stakeholder approach, one can capitalize on the networked organization's knowledge to achieve better business models (e.g., better risk management and transparency through value co-creation). They present no evidence for improved effectiveness or efficiency.

Partial pattern category papers [P32, P37, P42, P56] focus on the **define** process in combination with **governance** to ensure the expected results. Osterwalder et al. discuss how a formalized model can help to react to external events with speed and effectiveness, but presents no empirical evidence thereof [P32]. Salgado et al. argue that the gap in the business-IS/IT dialogue, which in turn leads to inefficient and non-effective IS/IT solutions, partly comes from: 1) the lack of formality; and 2) high dependency on specific and skilled analysts, when deriving IS/IT requirements from business goals [P56]. They propose the use of PGR (process-level use cases, goals, and rules) to improve traceability and the alignment of Business and IS/IT as a way to improve effectiveness (of both developing and running the IS/IT solution). To close the gap in the business-IS/IT dialog and increase efficiency, they propose a method how to generate a BMC from goals and rules to improve decision making and increase traceability. The method has only been tested on a small, manual scale with considerable limitations: 1) a high dependency on individual analysts and their knowledge and business heuristics; and 2) limited scope due to the amount of human resources needed. Conclusions on effectiveness and efficiency for their work are too early to derive. Ghezzi discusses business strategy under discontinuity and presents three tools to help managers identify a signaling "vector of inputs" to trigger a strategic re-planning process [P37]. He refers to the relation between the business model performance and a company's performance but makes no claims on effectiveness or efficiency with his contribution. Andries & Debackere instead look at the **define** and **execute** processes in their discussion how adaptation and performance are related to new technology-based businesses [P42]. They conclude that business model adaptation is beneficial in less mature, capital-intensive and high-velocity businesses, as it reduces failure rates in dependent business units. However, they do not detail how this can be done using BM.

The *Single pattern* category includes studies [P17, P35, P45] focusing on the **define** process and advocates more research addressing effectiveness and efficiency. Hacklin & Wallnöfer discuss how the business model is applied for strategic decision making [P17]. They explore implications and limitations of using a business model as a "strategizing device" and how BM is forcing to formalize current activities and make implicit understandings. They propose future research on the effectiveness of business: 1) deal with technical aspects how to systematically use BM to improve effectiveness; 2) to test the linguistic legitimacy of various frameworks for BM; and 3) improve the effectiveness of different representational modes of the business model to gain pragmatic validity. Buder & Felden evaluate the efficiency of representation and formalization of value models (e^3value and REA) to understand business models [P35]. They discuss the impact of business processes on value creation and stress the importance of consistency between business and process modeling. They find e^3value

to be more effective and efficient in improving the linkage between BM and business processes. Doganova & Eyquem-Renault investigate the commercialization of technology in the first years of new ventures and the dual role the business model play [P45]. They argue the "performative" role as a demonstration and as a scale model that gradually bring the company's business into existence. They also conclude that empirical findings still fail to provide convergent results regarding the effectiveness of business models.

To summarize, the improvements associated with efficiency and effectiveness are neither substantiated by empirical evidence nor grounded in empirical data. Given the diverse contextual settings in the studies and the dependence of the BM approach, it remains an open question whether the application of any of the identified practices results in increased or decreased efficiency or effectiveness for a company's business. Any outcome variations may simply be a result of fluctuating contextual or environmental factors rather than the application of a BM method or technique. Reaching reasonable coverage of efficiency and effectiveness as external factors require considering several measurable internal factors. With a reasonable coverage of relevant internal factors and taking into account contextual factors, we most likely operate on tens of independent variables that need precise definition and measurement instruments. Given this, we argue that none of the identified studies come near to the required level of details to be able to consider their measurements trustful (except for Andries & Debackere linking business model adaptation to a company's performance via a survival rate measurement and other variables collected from the annual CorpTech directory [P42]).

We concur with Zott et al. that *literature is developing largely in silos, according to the phenomena of interest to the respective researcher* [12]. We conclude that business model research still lacks a consolidated view of what a business model is, while at the same time being forced to address more complexity (e.g., dynamic business models, co-creation, collaboration, and ecosystems with a growing number of stakeholders).

6. Research synthesis

6.1. An analysis of business modeling trends

We synthesized five main trends within our surveyed literature on BM:

- Business models as the building blocks, and the structure of a business model construct as a cornerstone for analyzing, planning and managing competitive and strategic advantages [P1, P2, P3, P4, P9, P13, P16, P19, P29, P32, P40, P41, P51]. Much research is put into frameworks, methods, and tools but the effectiveness and efficiency when integrating this research into practical solutions still miss empirical evidence.
- Locus of the company is shifting to the ecosystem resulting in an explosion of new roles and values that need consideration, as they are connected to the value creation/capture logic [P2, P3, P4, P6, P21, P53, P57]. This trend makes future research more complicated and time consuming, given the lack of consolidated body knowledge on what a business model is and how it can be represented to support experimentation and efficient information management.
- Experimentation and operationalization of flexible business models, to manage the speed of change fueled by technology innovation and the digitalization of the value delivery [P1, P2, P9, P13, P15, P18, P49, P51]. We too, argue for a more cross-disciplinary agenda [57], as business modeling is facing the same challenges as agile requirement engineering and software development has been looking at for the past 10 years trying to increase speed and productivity [63].
- Changeability and modularity as ways to strategically address all new roles and values via choices to enable faster transitions from strategy to execution (operationalization) [P1, P3, P5, P6, P23, P25, P26, P27]. By systematically approaching the information management related to business models, changeability, and modularity, parts of the

practices for business modeling may become automated as a solution to faster transitions.
– A growing need for multifaceted optimization of business models, as fueled by new roles and new values, as a contrast to the currently more dominant single dimension of cost and revenue [P2, P7, P8, P9, P26, P53], often leading to sub-optimal solutions. Such optimization will drive a need for more sophisticated decision support and higher levels of automation in the governance of business models and business model execution.

We found no solutions or evidence related to multifaceted optimization of business models, while at the same time multiple studies highlighted the need for alignment of strategy and execution (daily operations). In combination with the two related trends of experimentation and changeability, we identified a common denominator in governance, as a foundation for faster and more transparent decision-support (for all roles in their interactions). Also, we found no systematic mechanism for organizational learning that potentially could minimize misunderstandings and improve decisions, even though organizational learning is important for successful BM [P9, P46].

We believe an important step towards such multifaceted optimization of business models lies in understanding how the business modeling practice connects to governance for evaluating effectiveness and efficiency of a company. We, therefore, propose CGM to facilitate the exploration of a governance framework for evaluating effectiveness (creating the right values) and efficiency (while using a minimum of resources).

6.2. A conceptual governance model (CGM) for exploring governance and evaluating effectiveness and efficiency of BM

We synthesized CGM for exploring governance and evaluating effectiveness and efficiency of BM. CGM is presented in Figure 5 and is inspired by Zott and Amit's work on business models as activity systems that create value in transactions [5], and influenced by the theories of learning and knowledge creation by Pask and Nonaka [20,64]. CGM links governance to BM via the antecedents (H1, H2), the business model (H3), real-world interactions (creating value and learning), and consequences (H4) as defined by Höflinger [7]. It is a conceptualization of the diversity of the problem of BM concerning value, effectiveness, and efficiency. We propose CGM be used for exploring experimentation in business modeling and designing a scalable IT solution. We believe the concept of "context frame" and intent-driven systems [65] offers an exciting path forward and will be elaborated as part of our future work.

Figure 5 illustrates how the BM practice facilitates experimentation with a business model through a set of interactions between actors involved in the *define* (P_0) and *execute* (P_1) processes. P_0 and P_1 are abstracted from the underlying phases of interaction and learning, as mentioned both by Nonaka (dialogue vs. practice) and Pask (explaining vs. demonstrated understanding). The processes exist in a context, influencing and influenced by the environment on different abstraction levels (and each process can also be seen as a representation of an activity system with its interdependent activities in line with Zott and Amit's work). Please note that both processes are highly context-specific, but always executed in pairs (as interactions of activity systems), e.g., context A = producing a strategy, context B = translating the same strategy into an operationalized business model in products. Therefore, P_0 and P_1 interact in a highly recursive, non-linear, interactive manner.

Depending on the context, different tasks and activities are executed (by sharing and modifying information related to various parts of the company's strategies, organizations, policies, rules, and products in close relation to the ecosystem). Such context dependency is a critical and challenging factor for a process-centric implementation of activities since reuse easily becomes complex, unpredictive, and slow [66].

Governance is an abstraction of goals, measurements, follow-up, rules, knowledge, and insights. Relationships r_1 and r_2 represent the relationship between governance of *define* and *execute* processes and how governance is used

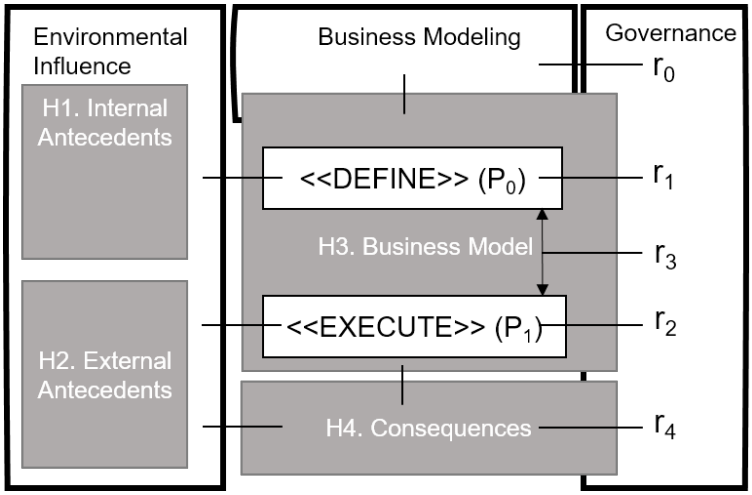

Figure 5. CGM, a conceptual governance model for exploring effectiveness and efficiency in relation to BM with key relationships r_x

to form an agreement (alignment of strategy and execution via goals, objectives, rules, measurements, and knowledge). r_3 represents the relationship between the *define* and *execute* processes and how governance is involved in tracking daily progress and facilitating alignment including change management (by executing in relation to the agreements established/updated via r_1 and r_2). r_0 is used to manage the effectiveness and efficiency of the BM process, while r_4 is used to control the outcome of the business (model execution). Our future work aims to develop these relationships into software interface in accordance with intent-driven systems [65].

Sustaining competitive advantage requires constant change [4]. Fundamental to this change is to understand the difference (make an assessment) between the current position (means) and the desired position (ends). Successful change is thus a multifaceted function of alignment between ends and means, maintained by timely actions to modify ends and the means in response to the environmental influences and consequences. The purpose of the relationships r_0–r_4 in Figure 5 is to manage successful change systematically. However, common to all studies (with quotes of purpose, Appendix D) is a lack of details describing the r_1–r_3 relationships and how the alignment can be achieved and maintained.

The importance of aligning the execution with the strategy is specifically addressed by papers [P6, P32, P59] (without empirical results). Only Salgado et al. suggest solutions to how that could be done (methods and representation of information) [P59]. Ballon proposes an analytical framework and discuss how BM is interpreted as (re)configuration of control parameters (combination of assets, vertical integration, customer ownership, modularity, distribution of intelligence, interoperability) and value parameters (cost sharing model, revenue model, revenue sharing model, positioning, customer involvement, intended value) [P6]. Osterwalder et al. advocate formalization of business models to create traceability between business (the building plan) and execution (IS/IT systems) [P32]. Giessmann et al. extend Osterwalder et al.'s propositions to build a model that can analyze and compare business models, but their work does not address the issues of aligning and daily execution of a business model [P55]. Salgado et al. also build on Osterwalder's BMC and discuss how to generate a BMC from business goals, rules, and processes, but do not further connect the results to the IS/IT realization and daily operations [P56]. They also discuss the alignment between business and IS/IT from the lens of business model artifacts, strategy and goal modeling, as well as enterprise modeling [P59]. They formulate the primary challenge as *Achieving alignment per se is not enough, organizations have to reach the alignment state and maintain it alongside its evolution.*

The quotes for challenges and benefits (Appendix D) also lack details describing the relationships r_1–r_3 in Figure 5. Also, there are 62% more quotes than for purposes, which could be explained by that benefits and challenges are often more specific by nature than the corresponding purposes. The identified quotes indicate a more inhomogeneous nature regarding contextual settings, resulting in a scattered picture of benefits and challenges. We speculate this is a result of each paper framing their conclusions with some form of benefits or challenges, rather than constructing them from empirical findings.

The papers within the governance column and assessment row (see Appendix D) present important aspects of goals, rules, measurements, options, flexibility, and knowledge. However, they do not propose solutions on how these concepts (with artifacts) should be represented or managed to create traceability to, and alignment with, the define and execute processes (via r_1, r_2, r_3) in Figure 5.

Six papers [P2, P22, P29, P32, P36, P54] cover all three columns (define, execute, and governance), but no author elaborates on the relationships r_1–r_3 (alignment of define and execute processes using governance), see Table 3. Rohrbeck et al. study eight companies and discuss how collaborative BM can improve both define and execute processes [P2]. They report improvements in four areas (dealing with uncertainty, finding creative solutions, facilitating a strategic discussion, and allowed to start the innovation planning), but provide little details or empirical evidence as to how well it works. Baden-Fuller & Morgan scan the literature and discuss business models as models, describing their multivalent character and the wide range of usage [P22]. They conclude *Business models are not recipes or scientific models or scale and role models [. . .] they play any – or all – these roles, often at the same time.* Osterwalder et al. propose eight propositions for BM that need to be tested [P32]. Zott et al. in their review six years later reveal that scholars still do not agree and that literature is developing in silos [P29]. Cortimiglia et al. explore, in a large empirical-based investigation, the relationship between the strategy making process and business model innovation (BMI) [P36]. They summarize a large number of purposes found in literature, which also matches the improvement areas we have identified, see section 5.1. Their findings validate the role of business model innovation as a valuable tool for, and link, between strategy execution and operationalization. Meier & Bosslau, in their case study, propose an integrated design and engineering approach as an iterative learning process based on system dynamics. They conclude that further development of modeling and simulation that depicts the dynamics and flexibility in the whole life-cycle is one of the key challenges for business model research (in a context of industrial product service systems) [P54].

7. Implications for research and practitioners

The results suggest that business model (and BM) is a diverse research area which would benefit from more aggregation efforts [P29, P40, P3, P9] on how business models could address the vast set of purposes and practices for BM, and what effects BM have on effectiveness and efficiency of a company. More work is needed to consolidate these different angles of the business model construct into a scalable, practically useful representations that will facilitate innovation, experimentation, and operationalization of the business model. The lack of coherence is more recently investigated by Massa et al. [67], as they identify possible reasons for the current lack of agreement in literature as terms and concepts slowly morph over time.

In the same vein (seen from a practitioners' side), Gartner[7] in 2014 points out that *digital business should not be considered an IT program and should instead become an enterprise mindset and lingua franca, with digital expertise spread across the enterprise and value ecosystem.*

Our results confirms the above and highlight a challenging issue for effectively and efficiently

[7]Gartner identifies six key steps to build a successful digital business, https://www.gartner.com/newsroom/id/2745517

defining contexts to improve understanding and communication in BM literature. We also note a potentially strong correlation between flexibility, effectiveness, and efficiency (all 13 papers addressing RQ2 also address aspects of flexibility and variability in the realization, IC2 and IC3, see Table 2).

We recommend the following topics to be added to a cross-disciplinary agenda for BM:

- Further exploring how contextual information in the business model construct could be systematically represented, structured, and stored. The improved representation of contextual information is going to increase effectiveness and efficiency when creating, modifying, and deleting information needed to transform strategies into tactics and daily execution, e.g., facilitating business model choices, including a residual set of choices related to tactics, and deciding on choices controlling daily interactions between stakeholders (as controlled by a set of configuration parameters and rules in software applications). A business model construct must support collaborative and role-based interaction, including exchange and interpretation of contextual information, scalable to thousands of actors, and across corporate borders. We believe intent-driven systems [65] could be a way forward for this purpose.
- Connecting the BM practice with Learning Theory would help to create a model that can help explain: 1) how value creation and stakeholder motivation is derived from, and connected to, daily interactions; 2) how daily interactions, in combination with organizational learning, shape the transformation of strategy into execution; and 3) how organizational learning influences the process of BM. These aspects become increasingly important since experimentation with value co-creation and business models are gaining interests [P2, P9, P13, P18]. This implies BM to be involved, not only in strategy and planning but also in the operationalization and follow-up of the business model, as the focus of a business model is shifting beyond the company borders into the ecosystem.

The implications for industry originate mainly from the lack of tangible results linking efficient BM to efficient and effective businesses. We recommend managers to investigate and build awareness of the following aspects:

- Systematically converting experience into knowledge will help the organization identifying and verbalizing (new) values and motivators relevant to the business. Investigate how to incorporate organizational learning (OL) [68] into everyday practices and business processes to support experimentation with business models, e.g., what is the current level of OL? How is OL incorporated into important business processes? Which roles are currently not involved in structured OL? How is OL related to the fulfillment of goals, an organization's creativity and motivation, and incentives?
- Critical components in any SIPD business model are concepts such as value co-creation, collaborative value networks, and acquiring resources beyond the control of the company (i.e., creating an ecosystem of partners and customers). How to prepare a company's staff and products to these concepts? How do you facilitate similar activities for your partners? These ideas will affect the products and offerings but also fundamentally change most aspects of a company's policies and business processes including incentive structures and management systems (e.g., sharing of information internally/externally and risk management). We believe the introduction of a value vocabulary, to facilitate more precise understanding and definitions of business-critical concepts, is a concrete and valuable first step, e.g., SVM [48].
- What factors hinder business model experimentation? What level of business flexibility is required (and used)? How is that flexibility implemented in the products, organization, business processes, and management systems? The value creation process is highly interdependent and not well suited for isolated practices [P14, P15, P30]. Business modeling

could become a tool to bridge these practices [P2] and SIPD companies should not see software architectures and methods as costs. It's a significant investment that facilitates experimentation while adding to the value creation. Such investments in business flexibility will become a crucial source of innovation and an enabler for automating business processes, resulting in an increased efficiency and competitive advantage.

– A governance mechanism is a critical element to build a commitment to experimentation and the development of the appropriate business flexibility. The mechanism should support multi-contextual governance views, maintaining traceability between all choices (strategical, tactical, and operational) and the views must be based on data from different contextual situations (narrative, planning, development, daily operational tasks, phase out, etc.) [65].

8. Conclusions

This systematic literature review explores the purpose of business modeling and its impact on effectiveness and efficiency of a company's business. Most companies invest in business modeling, but remain uncertain whether their investments allow them to change and adapt their business fast enough.

Our results show that the reported benefits are unsubstantiated or claimed with limited empirical evidence and the challenges are dispersed. The most common challenge is how to deal with the dynamics of business models, and most of the quotes on challenges relate to the non-existing solutions for governance (representation, simulation, decision-support, and feedback) of the proposed frameworks and methods.

The improvements associated with efficiency and effectiveness of BM are neither substantiated by empirical evidence nor grounded in empirical data. Given the diverse contextual settings in the studies and the dependence of the BM approach, it remains an open question whether the application of any of the identified practices results in increased or decreased efficiency or effectiveness for a company's business. Any outcome variations may simply be a result of fluctuating contextual or environmental factors rather than the application of a BM method or technique.

We concur with Zott et al. that *literature is developing largely in silos, according to the phenomena of interest to the respective researcher* [12]. Since the influential work by Osterwalder et al. on business models [9], which later gained a lot of interest among practitioners[8], researchers are still reporting that business models and BM is a diverse research area missing an agreed definition of business model. It is an area that would benefit from more aggregated cross-disciplinary research results [57, 67].

Supported by our results, we argue that:

– Related to RQ1, what makes business model research results challenging to analyze, compare, and combine is the lack of a systematic approach in describing the contextual information used to define the context for a specific business model construct and business modeling practice. The lack of systematic contextual information leads to inefficient communication, knowledge creation, and organizational learning, which affects the quality of decisions (on all levels). A consequence for business modeling is misalignment between the business model and its realization, which negatively affects the value creation (effectiveness) and the efficiency. By improving the information management parts of these processes, tasks may become automated, opening up for new ways of specifying and visualizing strategies, goals, and operational consequences, as related to effectiveness and efficiency.

– Related to RQ2, we conclude that governance is going to gain importance, as it must effectively support a chain of continuous adaptations and learning (experimenting). Such governance can enforce a continuous (business model) design aligned with the continuous

[8] Originally called the Business Model Generator in 2010, now changed into a commercial product https://strategyzer.com/canvas.

(business model) execution. We further argue that governance is the primary challenge for business modeling, and that (continuous) business modeling can be used (via governance) to effectively and efficiently cope with change, by connecting the definition of strategy to the execution of operations in daily decisions and activities as depicted in Figure 5.

– By combining above conclusions, that the lack of a rigorous, scalable, context-dependent (software and IT) representation of the business model, in combination with efficient governance mechanisms (to manage needed flexibility), are currently significant obstacles for progressing the research area and supporting the industry in managing innovation in co-creation-driven (software-intensive) business ecosystems.

We, therefore, believe our conceptual governance model is a significant step to explore and identify how the business modeling practice could become an integrated cornerstone in a more effective and efficient software-intensive product development enterprise. Our conceptual governance model can facilitate the creation a common business model construct including mechanisms to support effective and efficient governance with value-based decision-support for all affected roles and stakeholders.

Also, we believe our extensive, cross-disciplinary review of the business model literature, seen from the perspective of software and software-intensive products, is a valuable contribution for the Software Engineering community when trying to address the digitalization's effects on software engineering and software product development.

Our next steps in our research towards efficient and effective business modeling are to use our proposed conceptual model to identify essential characteristics of a governance framework and a scalable business model construct, as required to facilitates effective and efficient operationalization of a business model. We will also verify the conceptual model with practitioners to ensure that our results can be disseminated by industry.

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Appendix A. Selected articles

Table A lists all the articles selected through the snowballing methodology. It contains Paper ID, author/bibliographic reference, plus extracted data for rigor and relevance factors (EP3), paper content (EP4), and the number of topics (RQ1+RQ2+IC2+IC3)[9] addressed by the paper. A detailed description of EP3 (including calculation of scores) and EP4 are found in the Appendix C while details of IC1–IC3 are found in Appendix B.

In the main article we use the notation [Paper ID,...] to indicate a reference to one or more of the study's selected papers when we specifically talk about a result or an synthesis thereof. Please note that the start set consists of P1–P10.

Table A. Selected papers including extracted properties

Paper ID	Authors/Ref	Year	Rigor (EP3)			Relevance (EP3)				Content	No. of
			C	SD	V	C	Sc	Su	RM	EP4	RQ+IC
P1	Woodard et al. [69]	2013	1	1	1	1	1	1	1	2	4
P2	Rohrbeck et al. [28]	2013	0.5	1	0	1	0	1	1	1	3
P3	Reim et al. [26]	2013	0.5	0.5	0	0	0	0	0	2	3
P4	Hackney et al. [70]	2004	0.5	0	0	1	1	0	0	3	2
P5	Chew [71]	2014	1	0	0	1	0	0	0	2	4
P6	Ballon [33]	2007	0	0	0	1	0	0	0	1	3
P7	Loss & Crave [72]	2011	0	0	0	1	0	0	0	2	3
P8	Romero & Molina [73]	2011	0	0	0	0	0	0	0	3	3
P9	Höflinger [7]	2014	0.5	1	0	0	0	0	0	2	3
P10	Goel et al. [74]	2009	0.5	0	0.5	0	0	0	0	3	3
P12	Casadesus-Masanell & Ricart [4]	2010	0	0	0	1	0	1	0	3	3
P13	Chesbrough [30]	2010	0	0	0	1	0	0	0	2	3
P14	Demil & Lecocq [75]	2010	1	0	0.5	0	0	1	0	2	2
P15	Doz & Kosonen [35]	2010	0	0	0	0	0	0	0	1	2
P16	Dubosson-Torbay et al. [76]	2002	0	0	0	0	0	0	0	2	2
P17	Hacklin & Wallnöfer [54]	2012	1	0.5	0	1	1	1	1	1	3
P18	McGrath [31]	2010	0	0	0	0	0	0	0	1	3
P19	Richardson [77]	2008	0	0	0	0	0	0	0	2	3
P20	Storbacka & Nenonen [78]	2011	1	1	1	1	1	1	1	2	2
P21	Zott & Amit [5]	2010	0	0	0	1	0	0	0	2	2
P22	Baden-Fuller & Morgan [27]	2010	0	0	0	0	0	0	0	2	3
P23	Gao et al. [79]	2011	0	0	0	1	0	1	0	3	2
P24	Kindström [80]	2010	1	1	0.5	1	1	1	1	2	4
P25	Meier & Massberg [81]	2004	0	0	0	0	0	0	0	3	2
P26	Meier et al. [46]	2010	0	0	0	1	0	1	0	3	3
P27	Richter et al. [37]	2010	0	0	0	0	0	0	0	2	2
P28	Schuh et al. [82]	2009	0	0	0	0	0	0	0	3	1
P29	Zott et al. [12]	2011	0.5	1	1	0	0	0	0	2	4
P30	Amit & Zott [83]	2001	1	1	1	1	1	1	1	3	2
P31	Baden-Fuller & Haefliger [10]	2013	0.5	0	0	0	0	0	0	3	3
P32	Osterwalder et al. [9]	2005	0	0	0	0	0	0	0	2	3
P33	Al-Debei [23]	2010	0.5	0	0	1	1	1	1	2	3
P34	Bouwman [84]	2006	0	0	0	0	0	1	0	3	3
P35	Buder &Felden [17]	2012	1	1	1	0	1	0	0	1	4
P36	Cortimiglia et al. [85]	2015	1	1	1	1	1	1	1	1	2
P37	Ghezzi [86]	2013	0.5	0.5	0.5	1	1	1	1	1	4

[9] IC1–IC3 are topic-oriented while IC4 and IC5 are related to rigor and relevance.

Paper ID	Authors/Ref	Year	Rigor (EP3) C	SD	V	Relevance (EP3) C	Sc	Su	RM	Content EP4	No. of RQ+IC
P38	Ghezzi [87]	2012	0.5	0	0	1	1	1	1	3	2
P39	Haaker et al. [22]	2004	0.5	0	1	1	1	1	1	2	2
P40	Krumeich et al. [11]	2012	0	0.5	0.5	0	0	0	0	2	2
P41	Zolnowski & Böhmann [44]	2011	0.5	0.5	0	0	0	0	0	1	2
P42	Andries & Debackere [88]	2007	1	1	0.5	1	1	1	1	3	2
P43	Björkdahl [47]	2009	0.5	0.5	0.5	1	1	1	1	3	2
P44	Casadesus-Masanell & Llanes [42]	2011	1	0	0	0	0	0	0	3	2
P45	Doganova & Eyquem-Renault [29]	2009	0.5	0.5	0	1	1	1	1	2	4
P46	Mason & Leek [89]	2008	0.5	0.5	0	1	1	1	1	3	2
P48	Lindström [90]	2014	0.5	0.5	1	1	1	1	1	3	2
P49	Eurich et al. [6]	2014	0.5	0.5	0	1	1	1	1	1	3
P50	Ning et al. [91]	2011	0.5	0.5	0	1	1	0	0	3	0
P51	Dmitriev et al. [92]	2014	1	1	1	1	1	1	1	1	2
P52	Schneider & Spieth [36]	2014	0.5	0.5	0.5	1	0	0	1	1	3
P53	Short et al. [93]	2013	0	0	0	1	1	0	1	1	2
P54	Meier & Boßlau [46]	2013	0.5	0	0	1	1	1	1	1	4
P55	Giessmann et al. [58]	2013	0.5	0	0.5	1	0	0	0	3	3
P56	Salgado et al. [59]	2014	0.5	0	0	1	1	1	1	1	3
P57	Kim et al. [94]	2008	1	0	0	0	0	0	0	3	2
P58	Mason & Mouzas [95]	2012	1	1	1	1	1	1	1	3	2
P59	Salgado et al. [34]	2014	0	0	0	0	0	0	1	3	2

Appendix B. Inclusion and exclusion criteria

To identify literature related to our research questions, we developed the Inclusion criteria (IC) and Exclusion criteria (EC) listed in Table B. These criteria allow us to explore why BM is used, how it is applied, and what solutions currently exist. Since our research topic covers multiple research disciplines, we decided to address the RQs by designing the IC as wide as possible, to give us a large variety of articles discussing BM (IC1) in any relationship to effectiveness and efficiency. To evaluate BM efficiency, it is important to connect the business strategy via the business model to the execution of the business model with a traceability to daily operations and results. So to understand if business modeling enables effectiveness and efficiency, we want to know how a business model can be operationalized by developing the right type of flexibility (variability in the realization, IC3) matching all desired strategical and tactical choices (business flexibility, IC2).

Business modeling allows an organization to identify and prioritize changes to current business operations (content, activities, and governance). This change is continuously translated into a realization of the business model, through experimentation or otherwise, by understanding how the desired flexibility can be operationalized using modularity in design and software-based systems to support content, activities (all stakeholders, e.g., internal organization, partners, suppliers, and customers) and governance.

Effectiveness and efficiency should be evaluated from the gap between all strategic and tactical choices, in combination with how the organization (and supporting software) utilize the remaining flexibility to create satisfied customers in everyday transactions. The dilemma of not only implementing the right flexibility (supporting the needed business options) but also implementing it efficiently, is key to success, i.e., the right level of variability in the realization combined with the appropriate changeability in the realization to facilitate experimentation with the operationalized business model.

The selection critera was based on IC1 AND (IC2 OR IC3 OR IC4 OR IC5) to achieve a broad selection of papers as possible. If only the term Business model were used (and not specifically Business modeling), the paper could still be a candidate if it referred to activities related to creating, maintaining, or otherwise using a business model.

Appendix C. Data Extraction properties

Table C lists the data extraction properties used for this study and maps their relevance to each RQ.

Properties EP1-EP4 are evaluated per paper and used to analyze the relevance to industry for each paper's contribution. Properties EP5-EP9 use open coding and the extracted data was thematically and narratively analyzed.

Property EP1 and EP2 are subset of property EP3 (Rigor & Relevance) where property EP2 categories the paper's context. We extend the definition of Context (EP3 [96]), by adding (large-scale) Software intensive industry. The relevance parameter (EP3), we coded with binary weights (originally proposed as plain sum of 0 or 1), allowing us to visualize the impact of different relevance aspects. The weights were guided by RQ1, hence setting our priority: Industry (8), Scale (4), Subjects (2) and Research method (1), e.g. a value of 9 or higher would represent anything in "industry" with at least one additional relevance aspect met. Originally the Relevance element of property EP3 focus on the paper's context in relation to industry so we added property EP4 (Paper content) to map the relevance of each paper's content related to answering the RQs.

EP5 corresponds to our inclusion criteria (IC). EP6 was used to look for patterns on the business model construct as to describe what it is, why it is important and how it is used. This is important since the topic of BM is wide and lacks a clear definition. EP7-EP9 was used to understand the context for effectiveness and efficiency as related to business modeling.

Appendix D. Quotes of purpose, benefit and challenges

Table D lists the quotes of purposes, benefits, and challenges for business models and business modeling, extracted from the selected studies (see Appendix A for paper references). All quotes have been categorized into common areas (first column), and then listed under respective primary context they are found in. We use prefix notation (+) for benefit, (−) for challenge, and [PID] for the paper reference.

Table B. Inclusion and exclusion criteria

Criteria	Evaluate (=Yes)	Reasoning
EC1	Exclude if not written in English	Must be able to read and understand to evaluate
EC2	Exclude if not peer-reviewed	Basic quality assurance of paper
EC3	Exclude if duplicated	Snowballing will give many duplicates
IC1	Does the abstract, introduction, conclusions (or full text if needed) mention purposes, benefits or challenges (PBC) for business modeling?	Papers must identify real problems and issues related to business model, business modeling or business model innovation.
IC2	Does the text mention aspects of business flexibility (BF)?	BM is becoming increasingly complex due to growing business ecosystems and the digitalization of the value delivery, which both introduce a need for variability in the offering. Offering services on top of products are one example to address BF.
IC3	Does the text mention aspects of variability in the realization (VR)?	Planning a business model is not enough. It needs to be efficiently realized as well, so the business flexibility needs to be matched with a variability in the realization of the business model. Offering Software Product lines (SPL) or Product Service Systems (PSS) are examples of addressing VR.
IC4	Is it an empirical study?	We want to investigate how business models are used in practice, and not only in theory. Empirical is done in an industrial context, no student work, no proof of concept, no examples even if they are "based on real data"
IC5	Is it referring to a SIPD context?	The realization of business models is highly dependent on software due to the digitalization of the value delivery. This opens up new opportunities for value capture (and value creation) in the business ecosystems.

Table C. Data extraction properties

Id	Evaluate	How	RQ mapping
EP1	Research methods	Action research, case study, conceptual analysis, design science research, experiment, interview, literature review, not stated, other	relevance of paper
EP2	Paper context	SW intensive, industry, general (e.g. literature review), non-industry (in priority order)	RQ1 and relevance
EP3	Rigor & relevance of the paper	Detailed rubric definitions per aspect [96] Rigor: Context is described Rigor: study design is described Rigor: validity is discussed Each rigor aspect measurement: strong description (1), medium description (0.5), and weak description (0) Relevance: context (weight=8), i.e. in industrial setting Relevance: scale (weight=4), i.e. realistic size and industrial scale Relevance: subjects (weight=2), i.e. industry professionals Relevance: research method (weight=1) Each relevance aspect measurement: contribute to relevance (1), do not contribute to relevance (0)	Overview and relevance
EP4	The relevance of the paper content in respect to business modeling.	Coded 1-3: (1) business modeling; the paper discuss specifically the process of modeling your business (2) business model; the paper mainly focus on the business model and discuss how different aspects of the Business model constructs are developed (3) Other; it only refers to a specific business model(s), or discuss specific instances thereof, or a topic related to business model (e.g. flexibility); therefore of minimal significance to our study	RQ1
EP5	IC1-IC3	Use ATLAS TI to extract related quotes for each RQ.	RQ1, RQ2
EP6	Business element context	Use ATLAS TI to extract related quotes referring to a part of the business model construct, what it is, why it is important and how it is used and relates to other parts.	RQ1
EP7	Practice/technique	Use ATLAS TI to extract quotes referring to a practice or technique presented, described or used.	RQ1, RQ2
EP8	Measurement perspective	Use ATLAS TI to extract quotes related to – Product view (how well is the value created) – Process view (how efficient have you organized the value flow) – Resource view (how well is the resource utilized and adapted for the needed task) – Project view (how efficient is the goal fulfilment) – Relationship view (how effective is the communication)	RQ2
EP9	Success indicator and metric	Use ATLAS TI to extract related quotes	RQ2

Table D. Quotes on purpose, benefits and challenges for BM

Common areas	Strategy & planning (define)	Daily operations (execute)	Governance & communication
Value creation, value capture	Conceptual discussion and visualization of value creation/capture [P2] Articulate Value proposition [P7], [P13], [P35] Identify a market segment and value chain [P7], [P13], [P20] Appropriate value from technology [P36] (+) depicts the logic for value creation/capture [P17] (+) fosters innovation and increases readiness for future [P32] (+) rigorously describes and analyses business with system dynamics [P36] (−) hard managing tension between value creation and value capture (trade-offs monetization) [P5] (−) hard managing service flexibility (segmentation, QoS) [P5], [P24] (−) ensure consistent service experience (multi-channels) [P5] (−) a total value need consideration (not only financial) [P53]	Reconfiguration of roles and relationships [P8], [P20] Determining the logic for value [P30] (+) captures how resources transforms into customerswillingness to pay for value [P18] (−) service vs. product centric create conflicts, balancing is difficult [P1], [P24] (−) low effectiveness (customer experience) of value co-creation (organization/customer) [P5] (−) it is difficult to incorporate closer customer interaction [P24] (−) how to acquire resources in value chain not previously available in-house [P24]	Describe and classify businesses [P32], [P22] Meeting customerś needs [P58] Compare value creation approaches [P32] (+) facilitates strategic discussion and finding creative solutions [P2] (+) it is a structural template for mapping existing value logic [P17] (+) reduces imitability, create sustainable advantage [P24] (+) creates novel approach for using services in value creation [P41] (+) it is explicative and predictive power to value creation [P45] (+) helps calculate technology value to investors, customers, partners [P45] (−) complex coordination for ecosystem collaboration [P2] (−) negatively influences optimal value co-creation in aligned processes [P5] (−) new value (co-)creation focus on relationship-centric aspects [P7] (−) difficulty in identifying market opportunities due to changing customer needs [P9] (−) difficulty to effectively communicate (articulate, visualize) emerging value proposition [P24] (−) hard to analyse business process vs. value activities [P35] (−) many frameworks has many deficits concerning consistency and value activities [P35] (−) lacks a quantitative way to convey value and no sales model for perceived value [P48] (−) difficult to visualize value for integrated offers [P48] (−) BM has a dual nature conceptualizing value and organizing for that value (in different life cycles) [P51]

Common areas	Strategy & planning (define)	Daily operations (execute)	Governance & communication
Cost, revenue, profit	Estimate cost/revenue potential [P7] (+) depicts actual structures for a company to profit from business [P9] (+) experiment with cost before investing [P18] (−) "black-hole" investment [P18] (−) incorporate requirements for lean consumption and achieve the objectives of service profit chain [P5] (−) develop technology innovations in an adaptive process (trial-and-error) with cost as main cause for readjustments [P51]	(−) adaptation to environment by trial-and-error [P51] (−) amount of human resources needed for modeling [P56] (−) new revenue streams driven primarily by customer perceived value instead of internal cost [P24]	Incentives to engage in and control operations [P20] (−) maintain accurate definition of ownership conditions in a collaborative business model, and revenue model considering risk distribution [P54] (−) maintain a new value chain reward system [P24]
Mind-set, Knowl-edge	Experimenting [P2], [P22], [P49] Shift companyś boundaries [29] Exploit business opportunity [P22], [P29] Foster Innovation [P32] Increase knowledge [P29] (+) focus beyond company-centric focus [P17] (+) shifts focus from WHAT resources to HOW to use them [P18] (+) BMI enables strategic renewal [P36] (−) turns shared meaning into identity lock-ins [P17] (−) resistance to change [P17] (−) plan for "experimentation and learning" in established companies [P18] (−) systematic servitization (product to service shift) [P24] (−) hard to define business requirements (lack of information and specific details) [P56]	Enhance creativity, unlock barriers of innovation [P2] Build trust [P2] Increase readiness via portfolios and simulation [P9], [P32] Build knowledge [P22] (+) uses of mixed techniques between Business and IT improved communication and IT development [P56] (−) how to achieve organizational and customer learningś incorporated into iterative design [P5]	Mediating, facilitating and sharing strategic discourse [P17], [P36] Address lack of knowledge [P45], [P22] (+) unlocks barriers of innovation + building trust [P2] (+) breaks cognitive structures and act as communicative, mediating device for shared meaning and commitments [P17], [P32] (+) improves understanding, language and legitimacy [P17], [P32] (+) formalization forces implicit understanding becoming explicit (move strategy into execution) [P17] (−) lack of formality and analyst dependency with high skills [P56] (+) promotes outside in view on customer value [P18] (+) provides early warning for threatened BM via analysing dynamism of completive advantage [P18] (+) highlights consistency strategy and BM building blocks [P24] (+) provides new insights (externalize, map and store knowledge) [P32] (+) fosters systematic BMI [P32] (+) unambiguously defines dimensions, properties and semantics [P33] (+) visualization improves understanding [P32], [P56] (+) helps define goals [P32] (+) educates decision-makers for informed decisions, goals and requirement engineering [P32]

Common areas	Strategy & planning (define)	Daily operations (execute)	Governance & communication
Means	Innovation and technology management [P29] Plan and design business logic [P32] Understand complex interplay [P31] Adopt servitization to further enhance global competiveness [P54] (+) Prepares implementation (identifying joint activities with priority and validating the business model) [P2] (+) Helps to build better strategies (e-business) [P32] (−) Business model design requires better integration with strategy analysis [P37] (−) Difficult to be systematic (too slow, too detailed, iterative) [P17] (−) limited empirical validation [P17] (−) provides good insights but lacks support where to start investing to reach future business [P18] (−) capture customerś reaction to new technology [P5] (−) hard to effectively balancing (conflicting) requirements (user and design) and strategic interests (of partners) [P39] (−) tools conceptual, complicated and too time consuming (for network centric BM) [P53] (−) paradigm shift business activities and consumption patterns must be aligned with environmental and social objectives [P53]	Change and implement business logic (and business process execution) [P17], [P32] Realize strategic tasks [P9] Support resource fluidity [P15] Commercialize ideas & technology [P29] (+) better requirement engineering [P32] (+) facilitates and improves choices in IS/IT [P32] (−) difficult to mobilize and align available resources (not only internal but also extending external base) in time [P9], [P15], [P24] (−) integration, agility and change [P10] (−) barriers to change business model are real processes and tools are not good enough [P13] (−) a structured service development process connected to the business model [P24]	Alignment of strategy, business organization and technology [P32] Manage flexibility and increase change capability [P58] (+) improves measuring, observing and comparing business logic [P32] (+) improves design of sustainable business models [P32] (+) improves alignment of strategy, organization and technology and integration business IS/IT domains [P32] (+) BM may enable strategy execution and how operational choices affect companyś performance [P37] (+) helps to react to environment change due to strategic flexibility and dynamic capabilities [P52] (−) hard to reach and maintain alignment of business model and information system model [P59] (−) value co-creation is a hard cooperative process (speed, coordination, compromise) [P8] (−) how to industrialize large-scale service offerings [P24] (−) how to avoid isolated change (relationships, value, dynamic portfolio) [P24] (−) hard to visualize, document and share basic elements due to relationships and speed of change [P26], [P32] (−) hard to achieve consistency between BM and BPM and achieve real improvements with BPM [P35] (−) lack of appropriate methods and tooling for BM integrated with BPM [P35] (−) BM design requires better integration with strategy analysis models [P37] (−) discovery of goals and rules no common process for elicitation [P56]
Ends	Describe position of company in value network [P7], [P13], [P29] Formulate competitive strategy with goals and objectives [P19], [P37] Act as receipt for the business [P22]	Operationalize strategy [P36], [P37]	Alignment of strategy, business organization and technology [P32] Act as a scale model and role model for characterization of similarities and definition of difference [P22] (+) facilitates and improves choices in IS role and structure [P32]

Common areas	Strategy & planning (define)	Daily operations (execute)	Governance & communication
Assessment	Deal with uncertainty [P2], [P52], [P54] Holistic picture of future state [P2], [P32] Explain strategic issues (value creation, competitive advantage, company performance etc.) [P36], [P29] Support Leadership unity [P15] Explore and design promising business concepts/ideas [P32], [P36], [P41] Strategy and business model innovation [P17], [P36], [P52], [P53] (+) facilitates strategic discussion with shared insights to barriers/drivers (visual + levels of details) [P2] (+) facilitates interaction to create strategic options and share mediate strategic discourse [P17] (+) help to better understand the business and its important parts [P24] (+) helps to improve planning, change and implementation (with knowledge and facilitate choice of indicators) [P32] (−) difficult managing dynamics (agility, adaptability, planning, decision) for alignment to environment and other organizations [P2], [P5], [P7], [P9], [P36] (−) different methods or patterns not aligned, no guidance how to obtain final design [P49] (−) neglects the relevance for environment – focus on model-internal consistency [P49]	Alignment of control and value parameters [P6] Mapping of business roles or interactions onto technical modules, interfaces, etc. [P6] Analyse functioning of an organization [P32] Describe use of information technology [P32] Improve the Business-IS/IT dialogue [P32], [P56] (+) managing a business model portfolio can lead to flexibility in re-organizing resources [P9] (+) low-risk experiments via simulation [P32] (−) balancing act between customer, revenue, cost, functionality (e.g. local adaptation vs. sw platform) [P1] (−) mutual alignment between steps/organizations/customers when performed iteratively and holistically [P5] (−) how to match consequences of environmental changes onto company with best fit [P9] (−) a continuously learning business model experimentation [P13] (−) business model change (hard decision, risky organizational adjustments, and collective commitment) [P15] (−) efficient management of information (explore vs. create collective understanding) is difficult [P45]	Force decisions [P2] Analyse Business model fit [P49] Bridge static view for change and performance over time [P14] Computerize DDS for better design, critique and simulation of new BMs [P32] Understand how technology is converted into market outcome [P29], [P31] Provide contextual information [P35] Identification of critical success factors and investigate performance [P41] Proof, persuasion, comparison and benchmarking [P45], [P55] (+) creates common language, shared priority and forces decisions [P2] (+) improves dealing with uncertainty (reduction by sharing, turn into advantage, enhance understanding of barriers) [P2] (−) difficult to deal with uncertainty, complexity and dynamism [P54] (+) facilitates brainstorming (today and future) and integrative (no theory bias) [P17] (+) helps reducing complexity (visual) [P32] (+) improves mutual understanding Business and IT domains [P32] (+) facilities identification of key indicators to follow execution of plan [P32] (−) difficulty in reliable monitoring of key indicators [P54] (+) BM as “scale model” demonstrates feasibility and worth to partners [P45] (−) achieve joint strategy when decisions create cross-functional/divisional conflicts [P5] (−) align social, organization, and technology (due to richness and change of knowledge economy) [P7] (−) difficult to choose from massive results regarding BM design experimentation [P18] (−) hard to identify threats to BM in time [P18] (−) managed different abstraction levels and get the details right in execution [P19], [P21] (−) requires decision-making on multiple parameters of activity systems [P21] (−) BM has a dual nature (instance vs. classification) [P22] (−) hard to overcome resistance to and awareness of need to change [P52] (−) over-estimate/false impression of your ability to change [P52]