TOWARD UNDERSTANDING THE COMPLEXITY OF BUSINESS MODELS – A TAXONOMY OF BUSINESS MODEL DEPENDENCIES

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TOWARD UNDERSTANDING THE COMPLEXITY OF BUSINESS MODELS – A TAXONOMY OF BUSINESS MODEL DEPENDENCIES

Research Paper

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Abstract

Digital innovation accentuates the importance of technical and economic dependencies existing within and between business models. Companies such as Amazon, Facebook, and Salesforce are known for creating ecosystems in which business model dependencies are a crucial part of success. However, despite the steadily growing interest in business models in various disciplines, including management and information systems, there is no consensus to date about the constituent elements of business model dependencies. Current business model designers and users of modeling languages fail to comprehensively understand such dependencies. To address this gap, we investigate business model dependencies by developing a taxonomy which identifies common characteristics on the basis of a literature review, fourteen business model modeling languages and 95 real-world examples. The resulting taxonomy, consisting of thirteen dimensions, provides a framework for empirical validation, and contributes to research and progress on business model modeling languages.

Keywords: Business Model Dependencies, Business Models, Modeling Language, Taxonomy

1 Introduction

The growing use of advanced information technology and the simultaneous realization of many innovative business ideas has given rise to new digital businesses (Teece, 2010). Business models have become a well-established means of creating and analyzing these new businesses, and are currently the focus of keen attention among academics and practitioners. Business models describe the mechanisms with which organizations create, deliver, and capture value (Osterwalder and Pigneur, 2010). Business model innovation is of paramount importance for the competitiveness of organizations of all sizes and across industries (Massa et al., 2017). The visualization of business models has been considered a promising approach for guiding the design and assessment of business models (Täuscher and Abdelkafi, 2017). The conceptual representations of business models are typically defined by their components or ‘building blocks’ (Demil and Lecocq, 2010; Boons and Lüdeke-Freund, 2013). The Business Model Canvas by Osterwalder and Pigneur (2010), for example, describes one of its nine building blocks as “Revenue streams result[ing] from value propositions successfully offered to customers” (p. 17). This description highlights the interrelatedness of components, and that even small changes within one component can entail various consequences, and lead to the necessity to adapt other components (Wirtz, 2020; Krumeich et al., 2013). From a theoretical perspective, components can be connected to each other in the form of dependencies on other components due to a resulting output. When a component is
dependent on another and at the same time influenced by the other component, the dependency is referred to as reciprocity (Rai und Tang, 2014). Reciprocal dependencies particularly illustrate the inherent complexity of business models and significantly affect the business model’s chances of financial success (Demil and Lecocq, 2010; Cosenz und Noto, 2018). As a consequence, business models are never static constructs and must be adapted continuously over time (Wirtz, 2020; Alt, 2020; Bouwman et al., 2020; Moellers et al., 2019). When modifying a business model, no single component should be regarded or changed in isolation (Al-Debei and Avison, 2010; Kindström, 2010).

In addition, rising business model interconnection emphasizes the importance of knowledge in describing external dependencies (Rai and Tang, 2014). Based on the various dependencies between internal components, consequences resulting from external influences can induce changes to many internal components (Moellers et al., 2019). In most industries, the creation, delivery, and capture of value are already critically dependent on the interplay between related business models (Wirtz, 2020). Many studies have suggested that the locus of value creation is found in the relationships between firms (e.g., Dyer, 1997; Foss and Saebi, 2017). For example, Zott and Amit (2008) argue that in a digitally interconnected world, the organization and structure of relations with partners, suppliers, and customers make up a distinct source of value creation that differs from a firm’s traditional competitive strategy. In addition, the importance of external relationships for a firm’s business success continues to grow substantially as the environment becomes increasingly characterized by (platform) business ecosystems (Hein et al., 2020, Reuver et al., 2018). Ecosystems are intentional communities whose participants share, to a large extent, the same fate (Moore, 2006), and typically consist of a complex web of interdependent business models that contribute to solving a customer’s need. In the words of Adner, “the success of a value proposition depends on creating an alignment of partners who must work together in order to transform a winning idea to a market success” (Adner, 2013, p. 4). Sony’s first mover e-reader failed in the marketplace because of the scarcity of e-books, which demonstrates how a lack of understanding of external dependencies can contribute to failure (Adner, 2013). Another real-world example to understand the characteristics of business model dependencies can be found in the ecosystem of Apple’s App Store (Eaton et al., 2015). Epic Games, a large gaming company that develops videogames, use the Apples’ App Store to distribute their videogames. In Apple’s App Store, payments are only possible through the prescribed payment system which adds a commission of 30% to every sale. This creates a critical business model dependency (i.e. for the revenue stream) for all the app-developer using Apples’ App Store. To avoid this payment commission, Epic Games introduced its own in-app payment method in the mobile versions of their game Fortnite, which bypassed Apple’s App Store’s payment system, with payments being processed directly by Epic Games. In response, Apple removed Fortnite from the App Store, which is leading to a substantial loss in revenue for Epic Games.

However, to guide the design and assessment of business models, its visualization often takes a static view of the components implemented to create and deliver value, while neglecting dependencies and changes over time (Täuscher and Abdelkafi, 2017). Several articles have analyzed structural dependencies (e.g., the cost structure depends on key resources) that have been discovered between business model components (e.g., Cosenz and Noto, 2018; Krumoich et al., 2013). Even though these structural dependencies offer valuable insights about business model dependencies between business model components, the current visual modeling of these findings has several shortcomings. Dependencies within and between business models are often overwhelmingly large and complex (see e.g. Krumoich et al., 2013). The number of uniform dependency visualizations that can be comprehended by a person at a time is limited by their working memory capacity. When this is exceeded, a state of cognitive overload ensues and comprehension degrades rapidly (Miller, 1956). Currently, the great potential of business model modeling languages in supporting the design of complex and intertwined business models and ecosystems (e.g., Apple’s App Store) remains untapped. Recent business model research has criticized the lack of knowledge which describes the essential characteristics of these dependencies (Foss and Saebi, 2017; Massa et al., 2017; Wirtz, 2020). Understanding the underlying characteristics of business model dependencies and clustering them to business model dependency archetypes should ensure less complex and more effective business model visualizations.
Information systems (IS) research sees its role as focusing on the interplay between strategy, business models, and business processes and the resulting requirements for information technology (Veit et al., 2014). If, for example, a company changes its business model from internal to external production, this will also impact the resource requirements and related business processes. The importance of considering dependencies has been demonstrated for business process models (e.g., Wetzstein et al., 2011), as well as for business strategy (e.g., Dabholkar, 1998). However, despite the inherent complexity of business models and the increased interconnection between business models, the consideration of dependencies as a distinct field of research has not yet been explored. Therefore, investigating business model dependencies will emphasize the business model concept as a mediator between strategy and business processes by revealing the nexuses between the three concepts (Casadesus-Masanell and Ricart, 2010; Fritscher and Pigneur, 2015). Thus, adopting a more holistic view of the conceptualization of dependencies could benefit IS research, in particular the business model concept, and business model modeling languages. To the best of our knowledge, there is currently no consensus about the constituent characteristics of business model dependencies. The definition and specification of dependencies among business models are still seen as major gaps in the current IS literature, and understanding the various dependencies within and between business models is of paramount interest to both researchers and practitioners (Foss and Saebi, 2017; Massa et al., 2017; Alt, 2020). The objective of this paper, therefore, is to tackle this research gap by addressing the following research question: What are the underlying characteristics of business model dependencies within and between business models?

Taxonomies support researchers in conceptualizing phenomena based on the classification of objects according to shared dimensions and characteristics. The phenomenon of business model dependencies, however, requires not only theoretical but also empirical investigation, because only real-world observations can reveal all relevant dimensions and characteristics. Within several iterations, taxonomies draw not only on academic literature (conceptual-to-empirical) as a source for creating dimensions and their characteristics, but also on the observation of empirical objects (empirical-to-conceptual). Without classifying objects, however, researchers would have to perceive each object as unique, and thus, would be overwhelmed by the sheer diversity of objects. Taxonomies have consequently become an accepted part of IS research (e.g., Remane et al., 2016). Nickerson et al. (2013) proposed a rigorous method for building taxonomies in a systematic, transparent and replicable manner. Therefore, to answer our research question, we first conduct a literature review, followed by a taxonomy development process which synthesizes, consolidates, and conceptualizes the existing conceptual as well as empirical knowledge. In the context of complex systems, dependencies may not only affect the objects directly involved (i.e., first-degree dependencies), but also cause second-degree dependencies (Gao et al., 2012). In this research, we focus our analysis on first-degree dependencies. Our taxonomy is therefore designed and intended to describe first-degree business model dependencies. Once this first-degree dependency is well understood, future research might be able to analyze second and third-degree dependencies within and between business models as a distinct research object. Our taxonomy development process combines two approaches in five iterations: two conceptual-to-empirical and three empirical-to-conceptual iterations. The result of this study is a conceptually derived taxonomy with 13 dimensions and 38 characteristics. We also reveal that business model dependencies emerge only as a sub-concept of business models and literature has not yet offered a clear definition of what constitutes a business model dependency.

2 Theoretical Background

2.1 Business Model Research

Research on business models is a rapidly growing field and the usefulness of the concept has been highlighted in many reviews (Zott et al., 2011; Foss and Saebi, 2017). The concept’s evolution is broadly divided into three research strands, respectively focusing on: (1) the attributes of real organizations, (2) cognitive or linguistic schemas, and (3) the formal conceptual presentation of organizations’ activities (Massa et al., 2017). Although the business model literature has agreed on some central characteristics
of business models (e.g., value creation), definitions differ between strands and studies (Massa et al., 2017). However, according to Foss and Saebi (2017), most current definitions of business models are coherent with “how organizations create, deliver and capture value for their customers” (Osterwalder and Pigneur 2010, p. 14) and the “design or architecture of the value creation, delivery, and capture mechanisms of a firm” (Teece, 2010, p. 172).

A crucial part of Teece’s definition is the notion of “architecture.” Foss and Saebi describe business model architecture as “interdependencies among the firm’s value creation, delivery, and capture mechanisms and the underlying activities” (Foss and Saebi, 2017, p. 216) and conceived business models as complex systems that are composed of interdependent subsystems. Interpreting business models as complex systems, Hedman and Kalling (2002) were one of the first to deal concretely with the dependencies within, or among the components of a business model. They emphasize the importance of the causal dependence between its components, but do not explain how the individual components presented in their approach are connected, and how dependencies should be considered in business practice. Krumreich et al. (2013) conducted an analysis of business model literature and discovered multiple dependencies in the business model component framework, such as the dependence between the revenue model and the cost model. Cosenz and Noto (2018) analyzed the interactions between business model components by using a system dynamics approach, and identified various reinforcing loops. Whilst conceptualizing business model dependencies is still under-researched, it is nevertheless of great interest to researchers and practitioners to increase understanding of the complexity of business models (Foss and Saebi, 2017).

2.2 Dependencies as a Research Object

The interdisciplinary theory of coordination developed by Malone and Crowston (1994) describes a dependency as an essential element in coordination encountered in a variety of disciplines. Malone and Crowston’s coordination theory is based on the tenet that “coordination is the managing of dependencies between activities” (Malone and Crowston, 1994, p. 90). If coordination is defined as the management of dependencies, the identification and characterization of different types of dependencies are essential for a successful coordination process. As a consequence, dependencies have been analyzed in various IS contexts, such as business process models (e.g., Wetzstein et al., 2011), IT project portfolio management (e.g., Meier et al., 2017), and enterprise architecture management (e.g., Winter et al., 2006). All of these research domains emphasize the importance of knowledge on dependencies, and each views the phenomenon from a different perspective. However, none provides a means of identifying or explaining business model dependencies. For example, in each field, dependencies are considered to have a different origin (e.g., activities, workflows, or projects).

2.3 The Role of Business Model Modeling Languages

Business model innovation is both a challenging and a collaborative task (Ebel et al., 2016), which often requires knowledge drawn from different disciplines (e.g., marketing, research and development). Business model modeling languages explicitly communicate the core logic and elements of a business model, including business requirements (John et al., 2017). Efforts to formally represent business models are not new. Zott et al. noted nearly 10 years ago that “several authors have attempted to represent business models through a mixture of informal textual, verbal, and ad hoc graphical representations” (Zott et al., 2011, p. 8). Several languages for business modeling have been proposed, such as the e3value ontology (Gordijn and Akkermans, 2003) and the Value Net (Parolini, 1999). The most commonly known and used language in both management practice and the academic literature was developed by Osterwalder and Pigneur (2010): The Business Model Canvas. John et al. (2017) revealed that modeling languages support five conceptually distinct—yet often related—purposes for business models: (1) understand and communicate, (2) analyze and evaluate, (3) deduce requirements, (4) generate ideas, and (5) support design through software tools. Although these languages were developed in different research domains (e.g., management or IS), for different purposes, some business model
modeling languages use a syntactic connection-based visual notation. However, none of these languages provide constructs for describing different types of dependencies (John et al., 2017).

A widely used method for formalizing domain-specific languages is the metamodeling approach (Bork et al., 2020). When models and model building itself become the objects of modeling, this is called metamodels. According to the language-based metamodeling concept, a model is considered a metamodel in relation to another model if it represents a descriptive model of the language in which the model is formulated (Atkinson and Kuhne, 2003). The choice of a suitable metamodeling approach is a challenging task because there is often a lack of knowledge about the selection criteria and available metamodeling features. Bork et al. (2020) examined a survey of modeling language-specific techniques and described connector types (see Figure 1) as one meta element of every metamodel. This connector type meta element might be trivial when using a line between two object types, but the analysis of the modeling languages revealed various types as well as different conceptions of connectors. The specifications and techniques employed to specify a modeling language comprehensively are very heterogenous and typically incomplete (Bork et al., 2020). Hence, before being able to comprehend the specification of a modeling language (e.g., connectors), it is important to have a good understanding of the specific domain (Frank, 2013). To improve an existing business model modeling language that incorporates business model dependencies, the development of a metamodel is necessary to avoid misunderstandings and redundancies between different business models of interest. A more formalized understanding of the semantics (i.e. the vocabulary of a language) is required to create or improve business model modeling languages and enable more advanced computer-aided business model design tools and simulations with high-level decision support (Schwarz and Legner, 2020).

![Figure 1. Metamodel and model elements from Bork et al. (2020).](image)

### 3 Research Methodology

Taxonomies are artifacts that describe and conceptualize existing objects of a specific domain and thus provide practitioners and researchers with guidance to understand and analyze the domain. To develop our taxonomy, we follow the method proposed by Nickerson et al. (2013), which is widely accepted in IS research and has been used for developing taxonomies in various research areas as diverse as crowdsourcing processes (Geiger and Schader, 2014), the internet of things (Püschel et al., 2016) or IS artifact evaluation methods (Prat et al., 2015). It has also been used to develop taxonomies for business models in many diverse domains such as carsharing (Remane et al., 2016), smart energy business models (Paukstadt et al., 2019), sustainability in business process models (Schoormann et al., 2017), FinTech start-ups (Gimpel et al., 2018), or functions of business model development tools (Szopinski et al., 2020).

For this study, we conducted a two-step research design. We started with a large-scale literature review to examine common understandings of the business model concept and to identify relevant articles. This first step was required to concretely define the crucial concept of business model dependencies. Second, we developed a taxonomy of business model dependencies following the procedure proposed by Nickerson et al. (2013) by going through several conceptual-to-empirical as well as empirical-to-conceptual iterations.
3.1 Phase 1: Taxonomy Preparation

To produce an overview of how business model research considers dependencies, we comprehensively reviewed this stream of literature in a sequential review approach, following the guidelines proposed by Webster and Watson (2002). A three-step keyword search was employed to identify relevant articles: (1) We developed the following search string: “business model*” AND (relation* OR link* OR connection* OR *dependenc*); (2) we selected 23 relevant journals, largely following Massa et al. (2017); and (3) we searched in titles, abstracts, and keywords. Through this process, we obtained an initial set of 252 articles from 21 different journals. The articles had to fulfill two criteria: first, they had to deal with the concept of business models and, second, with the concept of dependencies. During the first review, we found that, whilst there is existing research on business model dependencies, the studies published so far have not considered dependencies as a distinct sub-concept of the concept of business models. In other words, we found that the business model literature has not yet offered a clear definition of what constitutes a business model dependency.

Therefore, to identify directly relevant articles, we had to define business model dependencies as part of our literature review. For this purpose, we consider the Interaction Model developed by Håkansson (1982), which is a widely recognized model for defining relationships in a business context. According to Håkansson (1982), a dependency exits between two objects because of the dependence of outcome. In addition, a business model object can consist of different manifestations (Gordijn et al., 2000), such as business model elements (e.g., monetizing content), business model components (e.g., revenue stream), or concrete business models. Based on these two specifications, the authors identified relevant articles dealing with business models and dependencies. We validated the coding of the articles by calculating the interrater reliability (88%). In the few cases of disagreement, the co-authors discussed their views to arrive at a joint verdict on the inclusion or exclusion of an article. We identified 219 articles that do not deal with business models and/or dependencies and deemed 33 articles from 12 different journals as relevant to the conceptualization of business model dependencies (see Figure 2).

<table>
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<tr>
<th>Journal</th>
<th>Number of Articles</th>
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<td>SUM</td>
<td>252</td>
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</table>

Figure 2. Literature Review Results.

3.2 Phase 2: Taxonomy Development

The goal of our research is to develop a comprehensive understanding of business model dependencies. The method proposed by Nickerson et al. (2013) allows to systematically develop a taxonomy and is rigorous as it clearly defines seven necessary steps: (Step 1) Determine Meta-Characteristic: the phenomenon under consideration, the purpose and the target group of the taxonomy is specified for directing the development of the characteristics (i.e., properties) and dimensions (i.e., groups of

1 To conceptualize business model dependencies based on business model research, we searched in the same journals that have already been used in the well-received article by Massa et al. (2017) to conceptualize the business model concept. In addition, we also searched in the Academy of Management Annals (because Massa et al. (2017) was published there) as well as, for obvious reasons, the Journal of Business Models.
properties) of the taxonomy. (Step 2) Determine Ending Conditions: conditions must be defined that describe when the taxonomy development is successfully completed. (Step 3) Approach: the method continues with iterations of two distinct approaches. (Step 4c-6c) Conceptual-to-empirical: The first approach is deductive, which means that the dimensions and characteristics are derived from relevant literature. (Step 4e-6e) Empirical-to-conceptual: The second method is inductive, which means that objects are evaluated to identify common characteristics and dimensions. New characteristics and dimensions are added to the taxonomy. (Step 7) Ending conditions: The taxonomy development is successfully completed when all ending conditions are met.

Determine meta-characteristics (Step 1) There are two potential target groups for our taxonomy: (1) researchers who are interested in business models as well as business model innovation and (2) practitioners with the same interest. We defined the meta-characteristic as attributes of dependencies within and between business models. All characteristics and dimensions must comply with this meta-characteristic.

Determine ending conditions (Step 2) To determine when to stop the iterative development of the taxonomy, we adopted all eight objective and five subjective ending conditions from Nickerson et al. (2013).

Select approach (Step 3) We ran through two conceptual-to-empirical iterations and three empirical-to-empirical iterations (see Table 1). In the following we describe both approaches in more detail.

Conceptual-to-empirical (Step 4c-6c) In the first iteration, we integrated relevant characteristics from the literature review on business model dependencies (see 3.1 Phase 1: Taxonomy Preparation). This enabled us to determine an initial taxonomy and to add nine dimensions: Layer, Embeddedness, Temporality, Agreement, Decisional power, Objective, Necessity, Degree and Resource. In the second iteration, we created a subset of existing business model modeling languages, as these artifacts provide valuable knowledge about the ways of conceptualizing information on business model dependencies, as well as the visual notation for presenting this information. John et al. (2017) conducted a literature review on visual languages for modeling business models and identified 14 different business model modeling languages. These artifacts have been proposed by scholars from various research disciplines such as accounting (e.g. Resource-Event-Agent; Sonnenberg et al., 2011), computer science (e.g., e3value; Gordijn and Akkermans, 2003), IS (e.g., Business Model Canvas, Osterwalder and Pigneur, 2010) or strategy research (e.g., Causal Loop Diagram; Casadesus-Masanell and Ricart, 2010). As we recognize the review of John et al. (2017) as a comprehensive overview of the current state of artifacts, we finish the subphase with the results of fourteen business model modeling languages. During the second iteration, we added three more dimensions (Association, Multiplicity, and Direction) and revised the dimension Resource.

Empirical-to-conceptual (Step 4e-6e) In the first and second iteration we built a taxonomy with twelve dimensions. However, to develop a rigorous taxonomy, we confirm our conceptually derived taxonomy with an inductive approach to improve the dimensions with real-world examples (empirical). To this end, we examine empirical objects and determine whether the existing characteristics are sufficient for describing business model dependencies or if new characteristics, and possibly new dimensions, are needed. To build a subset of real-world business model descriptions, we used the 95 business model descriptions from Business Model Zoo (for further details, see http://businessmodelzoo.com/), which was developed by Charles Baden-Fuller and comprises a detailed description of business models, such as Airbnb or Shazam. To have manageable empirical-to-conceptual iteration cycles, we split the 95 business model descriptions into five equally numbered subsets. As a result, one empirical-to-conceptual iteration contains nineteen business model descriptions randomly assigned to one of the five subsets. The third iteration revealed the dimension of Complexity, while the fourth iteration revised the iterations Association and Direction. During the fifth iteration, no dimensions were added or revised. Hence, after iteration five, all ending conditions were met, and we ended our development process. The resulting taxonomy is comprehensive and allows to differentiate between dependencies within and between business models.
Check Ending conditions (Step 7) After having conducted deductive and inductive iterations, all eight objective and five subject ending conditions of step 2 were met (2). The taxonomy satisfies the definition of a taxonomy specifically in that it consists of dimensions, each of which with mutually exclusive and collectively exhaustive characteristics. We catered for this condition by developing clear definitions for each characteristic and avoiding redundancies among them. In addition, we confirmed all mutually exclusive and collectively exhaustive characteristics using several real-world dependencies from the Business Model Zoo. The resulting taxonomy is comprehensive and allows to differentiate between dependencies.

### Table 1. Taxonomy development iterations.

<table>
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<tr>
<th>#</th>
<th>Iteration</th>
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<tbody>
<tr>
<td>1</td>
<td>Conceptual-to-empirical: The first iteration uses the conceptual-to-empirical approach since the existing knowledge holds relevant insights about the phenomenon under consideration. In this iteration, we analyzed the 33 articles from the literature review on business model dependencies.</td>
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<tr>
<td>2</td>
<td>Conceptual-to-empirical: Since interactions are necessarily covered in visual languages, we also reviewed existing business model modeling languages and the corresponding literature.</td>
</tr>
<tr>
<td>3</td>
<td>Empirical-to-conceptual: After two literature-based iterations, empirical-to-conceptual iterations were used to help achieve a robust empirical grounding. Subsequently, we analyzed 19 real-world business model descriptions from Business Model Zoo. This analysis revealed one more dimension.</td>
</tr>
<tr>
<td>4</td>
<td>Empirical-to-conceptual: We continued with an empirical-to-conceptual iteration of another 19 business model descriptions. As before, not all end conditions were met, and therefore, further refinements to the dimensions were made.</td>
</tr>
<tr>
<td>5</td>
<td>Empirical-to-conceptual: In this iteration, 19 real-world business models were again selected. Analyzing the descriptions did not lead to any additional dimensions or further refinements. With this iteration, we met the objective and subjective end conditions.</td>
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</tbody>
</table>

## Results

The resulting taxonomy contains thirteen dimensions, each with 2-6 characteristics (see Figure 3). Each dimension is grouped into one of three perspectives: Role Type, Modality or Implication. Figure 3 also indicates in which iteration the dimensions were added or revised. In the following section, we explain each dimension and its corresponding characteristics in more detail.

![Figure 3. Taxonomy of Business Model Dependencies.](image_url)
4.1 Role Type

A role type defines how objects (i.e. business models, components or elements) participate in a business model dependency. An object can influence a dependency because some of its characteristics are transferred to the attributes of the business model dependency (e.g., an attribute of the object customer segment can be the number of customers).

Layer: Intra-business model dependencies refer to relations within a business model. In this layer, one business model object depends on another business model object within the same business model. For example, Cosenz and Noto (2018) describe intra-business model dependencies in the context of financial results. More marketing spending increases the number of website users. This affects the hosting costs which determine the cost structure, and consequently, a decrease in financial resources. Inter-business model dependencies describe relations between two or more business models. In this layer, an object depends on another object from a different business model. Dawar and Stornelli (2013) describe inter-business model dependencies by focusing on the relationship between manufacturers and retailers. A manufacturer’s business model considers business model dependencies with regard to a retailer who distributes the manufacturer’s products or services. The business model of the manufacturer therefore depends on the business model of the retailer: the way in which the retailer creates value for its customers affects the manufacturer’s business.

Association shows whether instances of objects only depend on each other or can be combined logically in some dependency aggregation. A binary association, which exists between two objects, appears as a straight line in the e3value ontology whereas a n-ary association is a constellation of multiple objects depending on each other (Gordijn and Akkermans, 2003). The first empirical-to-conceptual iteration of the real-world business models revealed the concept of ternary associations, where companies identify two different customer segments, A and B, and deliver a (different) product or service to each segment. However, B also gets additional value from A’s usage that is orchestrated by the company. For example, the ridesharing platform BlaBlaCar brings together drivers and passengers who are willing to travel together between cities. By using the product, one customer segment creates an additional value to the other customer segment and both create value for the platform provider BlaBlaCar. This means that the value proposition is aggregated triadically. The company delivers independent benefits to each customer segment and orchestrates additional value between passengers and drivers. Therefore, we add ternary associations as an additional characteristic and define n-ary associations as those with greater than three involved objects.

Multiplicity defines the number of objects that can be related to another object in the context of a business model dependency. The multiplicity can be defined with concrete cardinality values (e.g., 0..1, 0..n, 1, n, 1..n,n..m). If the multiplicity is not supported, then the value is often 0..n by default (n ∈ N). Examples of applied multiplicities are described in the e3value ontology (Gordijn and Akkermans, 2003). For instance, a value interface can consist of at least one value offering (either incoming or outgoing) or a maximum of two value offerings – one incoming and one outgoing. However, a value interface has at least a value of 0 or a maximum of 1 actor.

Embeddedness describes the topological structure of objects around a dependency. The simplest embedding structure is a pipeline with a dependency between two or more objects. Pipeline dependencies are not interconnected and do not have recurring effects. In contrast, cycles are closed loops with repetitive patterns. For instance, Cosenz and Noto (2018) describe dependencies within reinforcing cycles through which a firm generates financial resources. Investing financial resources in marketing leads to more users, which generates more revenue and income and therefore more financial resources. Meanwhile, in a platform typology, every peripheral object is connected to a central object that is positioned in the middle, bridging the peripherals. All peripheral objects must be connected to the central object. Zhu and Furr (2016) define platforms as “intermediaries that connect two or more distinct groups of users and enable their direct interaction.” A network consists of at least three interconnected objects at the same level. In a fully connected network, all objects are interconnected and have direct dependencies upon each other, whereas in a partially connected network, only certain objects are interconnected. Sabatier et al. (2010) investigated business model portfolios in the European
biopharmaceutical industry and found dense networks of small firms sharing risks and returns due to high initial research investments.

4.2 Modality

The modality perspective considers the conditions that denotes the method and manner and allows to describe the parameters of a business model dependency.

**Temporal**: The temporal dimension characterizes the duration of a business model dependency. The literature distinguishes between short-, medium-, and long-term dependencies. Short-term or temporary dependencies (Rossignoli and Lionzo, 2018, p. 697) demonstrate a foreseeable timeframe, whereas long-term dependencies are present for more than five years or without a foreseeable time limit (Ausrød et al., 2017, p. 984).

**Agreement** refers to the contractual level of a dependency and takes on only two forms: contractual or non-contractual. Contractual dependencies can have different causes, such as franchising (Hellström et al., 2015, p. 229) or licensing (Leiponen and Delcamp, 2019, p. 298), and are legally assured. Non-contractual dependencies are not legally binding but are often socially embedded. Reficco et al. (2018) describe long-term and socially embedded relations with a high degree of trust between a restaurant chain and its fish suppliers.

**Decisional power** describes the objects in charge of a dependency. In the case of unbalanced power, one objects decides about the outcome, and others must accept its decisions. For example, owners of platforms such as Uber can determine the terms of pricing and collaboration. In contrast, balanced decision-making means that more than one object can discuss and determine the terms of the dependency. Reficco et al. (2018) studied sustainable innovation from a business model perspective and found collective decision-making in farming communities in Columbia, where farmers worked together to achieve price stability for their products. In a multi-business model company, dependencies can also be determined by an administrative authority, without the involvement of directly connected objects (Mason and Leek, 2008, p. 776).

**Complexity** describes the level of technical intricacy of the objects’ dependencies. The description of real-world business models distinguishes between unsophisticated and sophisticated complexity. Unsophisticated complexity focuses on well-specified and simple, replicable requirements to produce the outcome. For example, the first mobile investment broker, Robinhood, sells the order flow of retail investors and receives value from an unsophisticated retail order flow that creates additional liquidity. Regarding sophisticated complexity, the homeware retail company WorldStores developed a complex data analysis system by which the company tracks web searches for home furnishings and gardenware and adjusts its demand from suppliers and warehouses accordingly. As a result, WorldStores has developed close dependencies with over 700 different suppliers and warehouses and installs its own tracking software and hardware in order to monitor the stock in each warehouse.

4.3 Implication

Implication refers to the terms and effects of the output resulting from the business model dependency. It is the most frequently mentioned perspective in the business model literature as well as in the analyzed real-world business models.

**Direction** indicates whether the dependency is one-sided, reciprocal, or even multi-sided. In a one-sided dependency, only one object depends upon the other, whereas in a reciprocal dependency, both objects depend on each other. Direction is modeled in different business model modeling languages. For example, Casadesus-Masanell and Ricart (2010), in their causal loop diagram of the business model of Ryanair, use straight lines with one-way arrowheads to indicate whether an object only depends upon one other, and lines with two-way arrowheads to describe reciprocal dependencies. We found multi-sided dependencies in the business model of Green Man Gaming, as the video game platform stands in the middle of a multi-sided dependency with gamers on one side and publishers on the other.
Objective describes how the output aligns with the strategic goal and, hence, the business impact. The literature distinguishes between three characteristics. The objective of a dependency can be complementary, with reinforcing impact. For example, Hellström et al. (2015) describe complementary mechanisms for business models in the distributed energy ecosystem and identify complementary objectives between business models for fuel production and business models for boiler manufacturing because these companies cannot reach their target customers on their own. Collaboration exists, for example, in partnerships between universities and science-based start-ups (see Sabatier et al., 2018, p. 432), whereas concurrent impact occurs when, for instance, both objects are serving the same customer need. Kortmann and Pillar (2016) describe a concurrent dependency between the business model of Daimler and the business model of Car2go, with Car2go having partially cannibalized Daimler’s traditional business model.

Necessity divides dependencies into critical and non-critical. Critical dependencies are those that are important for the core business (e.g., relations with key resource suppliers), whereas non-critical dependencies do not influence the essential outcome of a business model. Key resource suppliers are typically critical for a business. Reficco et al. state, “internally, the company had to develop the capacity to manage effective relations with low-income communities, given that those relations were now critical to its core business” (Reficco et al., 2018, p. 1176).

Degree: The degree of dependency, also described in the literature as the level of dependency, is defined as the extent to which objects depend on each other in terms of alternatives. There are three different types of dependency with rising intensity: low, medium, and high. A low degree of dependency is referred to as non-essential and includes indirect dependencies without any lock-in effects. For example, Kiel et al. (2017) describe cost structure as the least-affected business model element, with an indirect interrelationship to the value proposition. In contrast, a high degree of dependence comprises direct, sometimes exclusive relationships with high lock-in effects. Dawar and Stornelli (2013) describe a high degree of dependence in the relationship between retailers and manufacturers, in which the latter are locked into large fixed investments with long payback cycles. Meanwhile, a medium degree of dependence exists with, for example, partially integrated conditions. The degree of dependence is related to complexity but remains distinct. A business model dependency can be of low complexity but have a high degree of dependency with substantial switching costs, for example, due to an initial investment.

Resource is by far the most described dimension in the current business model literature and demonstrates why dependencies exist in terms of concrete outcome. The outcome of dependencies is diverse. Examples of resources in dependencies include goods, services, money, and knowledge. However, Allee (2008) suggests that the resource dimension can be clustered into two clearly distinguishable characteristics: tangible and intangible resources. Therefore, we revised the resource dimension after the second iteration. Tangible resources are driven by constraints such as scarcity or complexity and appear, for example, in the form of technology, equipment, or capital (Ausrød et al., 2017, p. 992). Intangible resources are those that are not physical and are difficult to value, such as platforms for accessing customers, knowledge or co-branded products that use the same trademark in retail (Dawar and Stornelli, 2013, p. 87).

5 Discussion and Implications

Thus far, we have examined business model dependencies as a promising approach to increase our understanding of the complexity of business models and business ecosystems. The results of this study present different theoretical contributions for business model research. First, we see the lack of conceptual knowledge on dependencies as one reason for the absence of evaluations of dependencies in business model research. Hence, our results can support further research on structural interrelations of business model objects.

Second, we expect the characteristics of business model dependencies to provide a valuable basis for developing a business model modeling language that incorporates the understanding of dependencies. Modeling languages are often described in metamodels. A metamodel makes statements about what can be communicated through a selected modeling language. With our results we contribute to the research
of business model modeling languages by providing a foundation for connector type specifications in the metamodel. Extending and improving business model modeling languages through a pre-defined structure of dependency types allows users of modeling languages to explore complexity without the pitfall of oversimplification through nonexistent connections.

In managerial practice, the single components of the business model concept are well understood. The widely used Business Model Canvas provides a shared language for visualizing, describing, and modifying business models (Osterwalder and Pigneur, 2010). While the business model canvas approach is informal and can be used with a great level of freedom, it does not allow to go beyond the components toward the causal interactions based on their dependencies. The current focus on dependencies of the Business Model Canvas is mainly between the value proposition, the customer segment, and the revenue stream. However, understanding a revenue stream can, for example, depend on a partnership, a dependency which is not described in the basic business model ontology (Osterwalder, 2004). And there are many more components that could benefit from an in-depth analysis of their dependencies. Different types of digital platform, e.g. business-to-business (B2B) or business-to-consumer (B2C), in various industries are confronted with one or several attributes of network effects (Belleflamme and Peitz, 2018). These attributes essentially depend on the characteristics of dependencies between supply and demand. To understand how the characteristics of dependencies that are underlying your business network influence the shape of the network effect curve can be of great interest to researchers as well as constitute a big advantage for practitioners when designing a platform business model. In the case of a low degree dependency, the perceived value of an additional participant joining the digital platform (e.g., an Uber driver to Uber), is far less than in the case of a high degree dependency (e.g., a big corporate to a B2B platform). The conceptualization of business model dependencies allows managers to better align strategy, business processes, and IT infrastructure of a business model. For enhanced business model innovation, the process has to move beyond the design stage toward simulating the model to see if it is ‘workable’ (Moellers et al., 2019). A good business model needs both the right elements within a component and a functioning interaction, just like an engineer needs to understand all the underlying physical forces that support the uplift stream: It is not sufficient for an engineer to understand the individual components and elements that make up a plane; he or she also has to understand their interdependencies.

Therefore, from a practical point of view, this research offers insights for entrepreneurs and decision-makers in developing more sustainable business models. It will support business model innovation in various way. First, by revising existing business models due to an improved understanding of unsuitable elements. Second, the extension of business models with new elements can be facilitated by directly understanding the implications of additional elements and critical emerging dependencies on external business models. Third, the process of developing new business models can be supported due to more sophisticated evaluation criteria which allow the direct identification of weak points. Fourth, by understanding the dependencies, non-functioning business models can be detected and terminated. Overall, business model dependencies support the entrepreneurial learning process and help decision makers (e.g., investors) to evaluate the risks and success factors of a business model.

Furthermore, we see the insights of business model dependencies as a critical part of the upcoming research on B2B platform ecosystems (e.g., Riemensperger and Falk, 2020). Currently, standardized infrastructure fosters the formation of more and more B2B platforms across different industries (e.g., Internet-of-Things). However, these platforms account for special technical requirements, like the need for stable services, security compliance, high quality standards, or regulations (Hein et al., 2019). Participants are not private individuals but legal organization, which use the platform for business-critical processes. To optimize opportunities for value co-creation, the platform needs to establish a high level of transparency. Hence, B2B platform owners need special insights into the business models and their dependencies to participating businesses to ensure sustainable value creation for each participant on the platform. B2B platform participants often have inhomogeneous and highly sophisticated requirements for processes and systems which need be considered. Therefore, the platform has to provide sophisticated interfaces such as application programming interfaces (APIs) or software development kits (SDKs) to enable dependent business models to combine complementary resources.
Our research is subject to certain limitations. The aim of this study was to conceptualize the existing but heterogeneous and implicitly given knowledge about business model dependencies in the literature as well as in practice, rather than making actual recommendations for distinct dependency archetypes. Another limitation of the study concerns the literature review. We aimed to look at the phenomenon of business model dependencies from different perspectives. However, relevant prior articles might have been missed due to the selection of journals, databases and the applied search string. Additionally, our definition approach and coding are subjective. Even though we defined crucial concepts and implemented a two-author coding process to reduce inconclusive coding, this limitation cannot be fully resolved. However, taxonomies are never perfect (Nickerson et al., 2013), and we plan to proceed with rigorous empirical evaluation.

6 Conclusion and Future Research

This paper has provided a comprehensive analysis of business models with the objective of conceptualizing dependencies in form of a derived taxonomy. Taxonomies support the understanding and analysis of complex phenomena for both researchers and practitioners by classifying existing knowledge (Nickerson et al., 2013). Our contributions are (1) a conceptually and empirically derived taxonomy of business model dependencies and (2) the verification of current research gaps. In sum, we believe that the business model is the appropriate unit of analysis for understanding how dependencies are involved in firms’ value creation. At present, we see the lack of conceptual knowledge on dependencies as one reason for the absence of further improvements of structural evaluations of dependencies in business model research as well as for business model modeling languages.

For future research, several steps are necessary to evaluate the usefulness of our taxonomy and to use the knowledge to develop a modeling language that incorporates an understanding of business model dependencies. First, following the design science objective of building and evaluating artifacts, it is generally prescribed that the development of new artifacts requires determining its usefulness. Typically, usefulness indicates the extent to which the design of an artifact is able to support its users and positively impact the intended purpose of its application (Peffers et al., 2012). However, only limited guidance is available on how to evaluate the usefulness of taxonomies. To ensure applicable criteria, we will follow the framework proposed by Szopinski et al. (2019) whose primary objective was to guide design science researchers on how to evaluate a taxonomy. This allows the taxonomy’s usefulness to be evaluated by means of expert interviews, case studies or experiments. To this end, practitioners will be provided with the taxonomy to evaluate its intended purpose (classification of business model dependencies). Second, we will cluster the dependencies’ characteristics that occur typically together to develop archetypes of business dependencies. This simplification can focus managerial attention on solving problems and identifying opportunities arising from changing environments. We expect that reducing design complexity will enhance attention and increase flexibility. Third, all these steps result in the construction of an artifact (i.e., a business model modeling language). Therefore, we plan to conduct a large design science research project following Peffers et al. (2007) aimed at improving business model modeling languages. In so doing, we hope to leverage the application of business model dependencies in order to empower business model designers by enabling them to capture more comprehensively the complexity of business models and their uncertain environments. Our taxonomy can be seen as a starting point for researchers developing business model modeling languages and can help practitioners choose appropriate coordinative practices from among the large number of business model design choices available.

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