Supporting Business Model Decision-making in B2B Ecosystems: A Framework for Using System Dynamics

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Abstract

Digital technologies have led to new ways of creating value across organizational boundaries within business ecosystems and now increasingly transform existing business models. However, organizations searching for a successful business model in an ecosystem environment are faced with uncertainty. Previous studies have shown that decision-making can be improved systematically with modeling and simulation. We conducted a two-year action design research study with a B2B start-up and developed a framework with a business ecosystem perspective that supports the use of System Dynamics. This research investigates how an organization in a B2B ecosystem can use simulation to decide on a business model while considering the perspective of other ecosystem actors. We contribute to research on business ecosystems and provide a foundation for further improvements of quantitative business model development tools.

Keywords: Business Model Innovation, Business Ecosystems, System Dynamics, Modeling Framework, Action Design Research

1. Introduction

Driven by the rapid advances in digital technology, digitalization has enabled a remarkable transformation of organizational processes, boundaries, and value creation mechanisms (Cennamo et al., 2020). This impact is noticed across almost all industries, which, as a result, are constantly being reorganized. In such an increasingly specialized and digitally connected business environment organizations shift their focus from producing products toward (smart) solution-based offerings (Kohtamäki et al., 2019). This means that organizations are moving away from an isolated intra-organizational view of value creation to an inter-organizational view (ecosystem perspective) because "digitalization not only affects individual firms' business models but also requires the alignment of the business models of other firms within the ecosystem" (Kohtamäki et al., 2019, p. 380). The ecosystem perspective stresses the collaboration of organizations to create superior solutions that an individual organization cannot create on its own (Iansiti & Levien, 2004). However, to accomplish this perspective shift, organizations face multiple challenges concerning how such collaborative offerings can be created, tested, and innovated (Demil et al., 2018; Fuller et al., 2019). These challenges call into question the predominant approaches of business model innovation due to increased requirements for analyzing and evaluating business model dependencies (Foss & Saebi, 2017). For example, the failure of a single ecosystem partner implies a significant threat to the focal value proposition. Contingency risks require an improved understanding of what other ecosystem partners want, what they do, and their contributions (Adner, 2017). The ecosystem perspective thus calls for a multi-actor assessment of how value is created and captured, i.e., an assessment of whether for each ecosystem participant a viable business model is established and, hence, a sustainable ecosystem can be achieved (Adner, 2017; Demil et al., 2018; Khademi, 2020).

Research on modeling languages, methods, and tools to enhance business model innovation has become an important research strand (Szopinski et al., 2020). Currently, the most widely applied modeling approaches in business focus on representing and innovating a business model from the perspective of one company (e.g., Gassmann et al., 2014; Osterwalder & Pigneur, 2010) but less so on joint value creation or dynamic inter-organizational dependencies (Demil et al., 2018). Therefore, few approaches are suitable to the context of ecosystems (Schwarz & Legner, 2020). In addition, Athanasopoulou and De Reuver (2020) state that existing business model innovation tools support the design of new business models but, by and large, they do not sufficiently support comparing and identifying the most promising business models. There are still few artifacts for the quantitative evaluation of business

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models (Wirtz & Daiser, 2018). In practice, a standard tool utilized for quantitative decision-making is MS-Excel, which offers scant support for dynamic simulations. Artifacts that enable decision-making with an ecosystem perspective can only view business models through a systemic lens (Williamson & Meyer, 2012).

System Dynamics (SD), a mathematical modeling technique for understanding complex systems may, however, have the potential of closing this gap. Researchers have already used SD to simulate business models as complex and dynamic systems and have shown its value for decision-making (Abdelkafi & Täuscher, 2016; Cosenz & Bivona, 2021; Cosenz & Noto, 2018). Especially in a B2B environment, business model experimentation in the field is often risky and costly. In that case, simulation becomes a practical approach to discovering how a business model works and which innovation decisions should be made (Cosenz & Noto, 2018). However, existing SD approaches are hampered by various limitations in business ecosystems. We therefore propose an ecosystem simulation approach and pose the following research question: *How can System Dynamics be used for business model decision-making, adopting a business ecosystem perspective*?

In this paper, we present an Action Design Research (ADR) approach following the methodology of Sein et al. (2011). We develop a framework for modeling and simulating business ecosystems using SD. The modeling framework is created collaboratively with a German B2B start-up, which used it to support its business model decision-making.

This study bridges the conceptual gap between the business model, the business ecosystem concept, and the tools-in-use in business model innovation research. We contribute to the business ecosystem concept (Adner, 2017; Jacobides et al., 2018) by building on scientific knowledge for the initial design. Moreover, we contribute to research by strengthening the theoretical base underlying the usage of SD in the context of business ecosystems and joint value creation. Our contribution to practice is a framework that practitioners innovating a business model can use to solve similar decision issues.

2. Research Approach

We pursue the dual goal of creating academic knowledge and solving real-world business problems. ADR is based on the premise that artifacts are shaped by the organizational context during development and use Sein et al. (2011). By drawing on existing scientific knowledge and guiding the artifact in such a way that the phases of building, intervention, and evaluation do not follow one another, but take place simultaneously, ADR supports the development of prescriptive design knowledge. Therefore, ADR is appropriate to answering our research question. It is widely accepted in IS research and has been applied in the context of business model innovation, e.g., to design business models for cloud platforms (Giessmann & Legner, 2016), and to create a framework for business model development tools (Ebel et al., 2016).

We conducted a two-year ADR project with a German B2B start-up (in the following called 'the start-up') that is faced with the problem of early-stage business model innovation in a business ecosystem context. Figure 1 illustrates the stages we performed. The ADR method consists of four stages. In the first stage (problem formulation), we formulate the problem identified in practice. We then describe the knowledge base for our research question, which lays the foundation for generalizing the problem and the results (Sein et al., 2011). We developed and evaluated the artifact in two cycles in the second stage (Building, Intervention and Evaluation). In the first cycle, we use the problem statement and theoretical learnings developed in the first stage as the foundation for the initial design. We evaluate the initial design in a simplified context with the start-up to gain formative feedback for its refinement. In the second cycle, we build on the respective learnings to refine the initial design and evaluate the refined artifact with respect to modeling and decision-making.

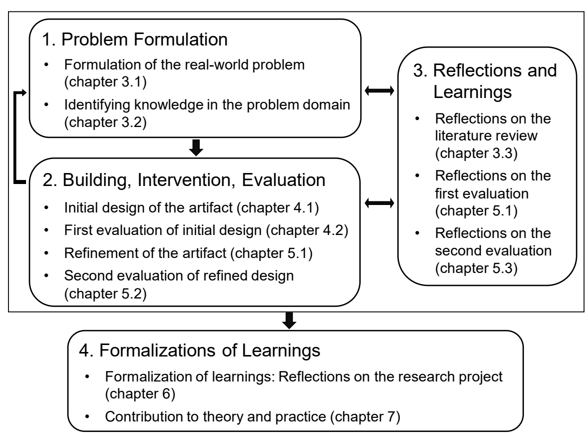

Figure 1. Stages of the conducted ADR project (adopted from Sein et al., 2011).

The third stage (Reflection and Learning) parallels the first two stages and emphasizes a process of continuous reflection and learning along all the phases of the research project. In the fourth and final stage (Formalization of Learning), we formalize situational learnings into general knowledge for a class of problems. We formalized our design knowledge as a framework in line with Vaishnavi (2015) to be used as a support or conceptual guide. We position our framework as an 'exaptation', i.e., an innovative adaptation of known solutions for new problems (Gregor & Hevner, 2013).

3. Problem Formulation

3.1. Formulation of the real-world problem

The company with which we conducted the research project is a German start-up founded in 2017. The start-up offers a novel data-driven solution to analyzing and optimizing manual work processes in industrial logistics and production environments. The solution encompasses hardware (sensor technology) to collect process data, and software to analyze the data and derive optimization options. To create the solution, the company collaborates with a component supplier and an infrastructure service provider. The start-up operates explicitly in a business-to-business (B2B) context. Two stakeholder groups utilize the solution to create value for their own business. First, the start-up's primary customers are large logistics and production companies that use the solution for internal process optimization, e.g., in lean management teams. Second, consulting companies have shown an interest in the solution, and are performing the process optimization for companies that do not have the resources for internal optimization endeavors, e.g., small and medium-sized enterprises (SME). Figure 2 shows the ecosystem the start-up operates in.

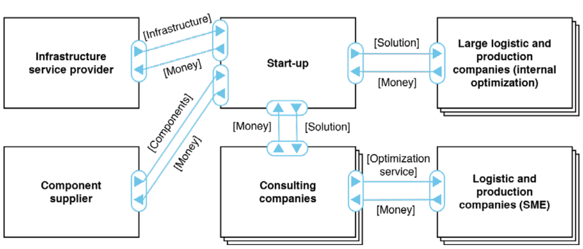

Figure 2. E3-Value model (Gordijn & Akkermans, 2001) of the start-up's B2B ecosystem.

The start-up relies on a business model, which entails up-front investment costs. Although this is a perceived pain point for the start-up customers, this was a deliberate choice by the start-up, to ensure liquidity in the early company lifecycle phase (bootstrapping). At this point the ADR project started with the intention to innovate the business model to become more customer-oriented (i.e., no up-front investments from customers needed).

However, the start-up did not have the resources to experiment with different business model alternatives (e.g., subscription, pay-per-use, or outcome-based contracting) in the market and potentially risked losing key customers. This is particularly relevant in the B2B context as the number of customers is limited, compared to the B2C context. The three founders of the start-up, who never before executed business model innovation, were faced with the following dilemma: On the one hand, the decision for a new business model was critical for the future of the company. On the other hand, they could not take the decision based on experience and did not have sufficient resources to conduct market experiments. This raised the question of how the decision-making process can be supported in order to innovate the start-up's business model.

3.2. Knowledge in the problem domain

Business model research. The concept of business models has allowed practitioners to depart from traditional business approaches to systematically improve business model innovation (Foss & Saebi, 2017). A business model describes the business logic by which an organization creates and delivers value for customers, and how it captures value to make a profit (Osterwalder & Pigneur, 2010). Some business model definitions make references to representing a system. Previous studies on the intersection of business models and systems theory have advocated systems thinking as a promising approach to business model innovation (Moellers et al., 2019).

Business model innovation, i.e., a targeted and systematic change to the existing business model, is subject to a process consisting of several phases. Wirtz and Daiser (2018) identify seven different process phases for the business model innovation process: (1) Analysis, (2) Ideation, (3) Feasibility, (4) Prototyping, (5) Decision-making, (6) Implementation, and (7) Sustainability. Essential phases in this process are the prototyping of business model alternatives and their evaluation for decision-making (Wirtz & Daiser, 2018). The business model prototyping phase ensures an analysis of different business model alternatives to test and refine the design. This analysis typically involves the prototyping—in a quantitative sense—of costs and revenues by which the value is captured. As part of the decision-making phase, the innovator evaluates and selects a business model from several alternatives, which is then implemented in the field (Osterwalder & Pigneur, 2010; Wirtz & Daiser, 2018).

Static and Dynamic Business Modeling. Efforts to formally represent business models are not new (John et al., 2017). Static modeling languages for representing business models explicitly communicate a business model's core logic and elements and often use visualizations for idea generation (John et al., 2017). For example, the Business Model Canvas (Osterwalder & Pigneur, 2010) and its multiple derivatives are easy to use and great for the innovation phases of analysis and ideation. However, both researchers and practitioners have criticized the static nature of these artifacts, which is not ideal for deciding upon different business model alternatives (Athanasopoulou & Reuver, 2020).

First attempts to model dynamic changes are value network modeling techniques, such as the e3-Value ontology (Gordijn & Akkermans, 2001). Value networks are used to analyze value constellations from a multi-actor perspective (Weigand, 2016). E3-Value aims to conceptualize business models, create a shared understanding of the business models among collaborating organizations, and improve the alignment between business and information technology. Using a corresponding software tool, it further allows profitability calculations by quantifying the value streams and the application of what-if scenarios (Gordijn & Akkermans, 2001). Despite this, other concepts, such as scenario planning, agent-based modeling, or SD for decision support, have been transferred to the domain of dynamic business modeling.

Currently, the most commonly used approach for dynamic business modeling is System Dynamics (SD) (e.g., Abdelkafi & Täuscher, 2016; Cosenz & Bivona, 2021; Cosenz & Noto, 2018; Moellers et al., 2019). SD was developed in the 1950s for the analysis of complex and dynamic systems (Sterman, 2000). To illustrate such systems, SD models use a graphical syntax in which stock and flow variables can be distinguished and combined into a simulation-capable diagram by using SD-based simulation software (Sterman, 2000). These diagrams enable decision-makers to simulate the behavior of a business system over time (Sterman, 2000). Researchers have shown in corresponding studies that the application of these diagrams and corresponding simulations facilitate decision support with respect to start-ups (e.g., Cosenz & Noto, 2018), SMEs (e.g., Cosenz & Bivona, 2021) or sustainability cases (e.g., Abdelkafi & Täuscher, 2016). In addition, SD has already become established in practice, as it is being used by BMW to develop new business models for e-mobility (Moellers et al., 2019). According to existing literature reviews on dynamic business modeling, most approaches use the Business Model Canvas as a framework for structuring the variables, but take less into account external business model dependencies (Schaffer et al., 2019; Stadtländer et al., 2021).

Business ecosystem research. The business ecosystem concept was originally adapted from biology to the business context by Moore (1993), who described it as a diverse set of organizations from different industries collaborating and co-evolving their capabilities around a shared purpose. Several studies have concluded that business ecosystems lead to competitive advantages for each of the companies involved (Adner, 2017; Fuller et al., 2019; Jacobides et al., 2018). However, when one or more companies in an ecosystem start to change their business models, these changes affect others within the system. Thus, the concept of a business model seen in the context of a business ecosystem should be understood as both complex and dynamic, requiring continuous analysis and reconstruction (Fuller et al., 2019). The purpose of a business ecosystem is to realize a focal value proposition, which cannot be achieved by the individual efforts of one company alone (Adner, 2017; Jacobides et al., 2018; Khademi, 2020).

For this paper, we understand business ecosystems according to research from Adner (2017), who states that it is the creation of a focal value proposition that enables businesses to collaborate and align in an ecosystem. Similar to Moore's view of 'ecosystem-as-affiliation', Adner's concept of 'ecosystem-as-structure' encompasses all the suppliers, customers and stakeholders who add substantial value to the ecosystem. However, this ecosystem view is purposively designed and developed around a focal value proposition, whereas the ecosystem-as-affiliation view naturally evolves around one or more key-stone organizations (Adner, 2017). Moreover, theory on ecosystems emphasizes specific types of complements (Jacobides et al., 2018). Unlike supply chains, a business ecosystem is neither fully hierarchical nor contractually managed (Jacobides et al., 2018). While ecosystems differ from platforms, the two concepts are closely related. Platforms are associated with the technical infrastructure that offers the foundation for exchanges between multiple actors (McIntyre & Srinivasan, 2017). Thus, while ecosystems may be based on platforms, they do not need them (e.g., the Michelin PAX tire ecosystem described by Adner, 2012). Several artifacts have been developed to support practitioners in designing and innovating business ecosystems such as the ecosystem pie model (Talmar et al., 2020) or the value blueprint (Adner, 2012). While being well-suited for identifying stakeholders and their role in the ecosystem, and for generating ideas for innovation, these frameworks function mainly on a macro level, without the possibility of in-depth analysis, and therefore are ill suited for quantitative decision-making.

3.3. Reflections on the literature review

Having reviewed three research areas and consolidated this knowledge, we identified four relevant conclusions to inform our research.

First, business models have traditionally been considered from a single organization's perspective. Research on business models proposes valuable insights on how an organization creates, delivers and captures value. However, static modeling languages building upon this consideration are not suitable for comparing alternative potential business models. Second, dynamic business modeling is an upcoming research stream. E3-Value (Gordijn & Akkermans, 2001) visualizes the business model from a multi-actor perspective and has been used successfully to conceptualize business ecosystems in the past (e.g., D'Souza et al., 2018). However, the MS-Excel calculations behind e3-Value modeling approaches offer limited options for more complex and dynamic simulations. Third, while SD (Sterman, 2000) has been used in many studies and has proven its usability for decision-making support in complex business cases, the SD elements for a specific business model component are neither closely linked nor well-structured in specific models, which complicates its simple transferability (Stadtländer et al., 2021). Fourth, the research on business ecosystems proposes valuable theories and concepts on how multiple actors are structured, engage and align with each other around a focal value proposition. This is especially pertinent to our B2B real-world problem case, hence we embrace a business ecosystems perspective and the concept of ecosystem-as-a-structure (Adner, 2017).

ADR aims to define the problem as an instance of a class of problems. The problems that the founders of the start-up were facing are not new to research. However, we lack frameworks for quantitative decision-making on business models in (B2B) business ecosystems. A framework should be generic enough to apply to different simulations while being useful to an individual modeler—in other words, we need the framework to balance generality and specificity.

4. First Iteration

4.1 Initial design of the artifact

For the initial design of the artifact we build on Adner's (2017) conceptualization of "ecosystem-as-structure" (see chapter 3.2). Following Adner (2017, p. 42) a business ecosystem "is defined by the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize." Here, the value proposition serves as the boundary condition of the ecosystem as it encompasses all the companies and customers (also referred to as actors) who are intent on participating in the joint value creation (Adner, 2017). As a blueprint for how this joint value is created within an ecosystem, Adner (2017) proposes four structural elements: (1) Activities, in order for the value proposition to materialize, (2) actors as the entities that undertake the activities, (3) positions that specify the location of actors in the flow of activities across the system and (4) links which clarify the flow of material, information, influence, and financial resources across actors. This business ecosystem perspective highlights the configuration and alignment of activities as if they are not sustainably aligned, the ecosystem will not capture enough value for every participant and will not become successful in the long term (Adner, 2017).

The modeling of the ecosystem is represented by the actors collaborating in order to create joint value (Adner, 2017). Thus, actors are the artifact's focal modeling element. The system boundary encompasses all actors participating in the joint value creation, including individuals, organizations, customers, and other stakeholders (Adner, 2017; Moore, 1993). In a B2B context, every actor is considered an organization, not just an individual. This consideration is relevant for customers as they utilize the value proposition in the organization's own value creation, and thereby fulfill their role in the value creation of the ecosystem. In order to avoid modeling every customer as a distinct actor, the researchers adopted the concept of customer segments (Osterwalder & Pigneur, 2010), which assembles similar customers with homogeneous characteristics and behaviors in one corresponding customer segment actor.

Every actor in an ecosystem accomplishes value creation activities and thus captures value for their own organization (Adner, 2017). Consequently, every actor constitutes a value creation and a value capture dimension, which forms the basis for the initial design of the modeling framework. In addition to theory on ecosystems, we build on the business model concept (see chapter 3.2) to structure the elements within these dimensions for one specific actor. Value creation comprises the undertaken (1) activities of the actor contributing to the joint value creation (Adner, 2017) and the requisite (2) resources (Gassmann et al., 2014; Osterwalder & Pigneur, 2010). Value capture encompasses the structure of (3) costs and (4) revenues (Gassmann et al., 2014; Osterwalder & Pigneur, 2010). With respect to the condition of the captured value that an actor's participation in the ecosystem is dependent upon (Adner, 2017), the researchers added (5) benefits resulting as net of costs and revenues, as a viability measure. These five elements form the unified modeling framework of each actor in the ecosystem. The value proposition is considered as flows of activities and resources (e.g., materials, information, financials, etc.) across actors in the ecosystem (Adner, 2017). Figure 3 shows a customer solution-provider relationship modeled as actors with the unified modeling framework.

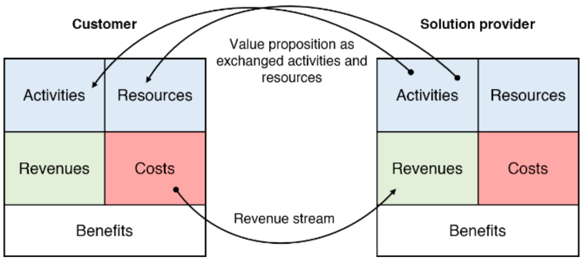

Figure 3. Unified modeling framework applied to a customer solution-provider relationship.

4.2 First Evaluation of the developed artifact

The focus of the first evaluation lies on the modeling framework and whether it guides the modeling process of the ecosystem. It is conducted in two steps: (1) the inquiry of the necessary data and (2) the modeling of the ecosystem as a simulation-capable stock-and-flow model in SD with the help of the artifact.

First, the researchers needed to gather the data needed as input for the model that comprises actors, the flows across actors, and each actor's value creation and value capture system. Hence, we conducted an ecosystem analysis workshop with the three founders utilizing e3-Value as a qualitative modeling approach (Gordijn & Akkermans, 2001). The workshop took four hours, was executed digitally using the video communication service Zoom and the collaboration service Miro, and comprised the following structures: (*1) Get a business ecosystem overview.* We elaborate the constellation of actors in the ecosystem and deduce the flows between them. Crucial for this step was to work out the flows in a differentiated manner, i.e., material, financial, informational, etc. (Adner, 2017). Accordingly, the value proposition of the start-up was captured as flows of products, services, software and information. (*2) Analysis of value creation and value capture for the start-up.* We deduce the corresponding activities and resources to create those flows and estimate their expenditures and costs in a quantified manner, e.g., 30 work hours per manufactured product. (*3) Analysis of value creation and value capture for other actors.* We execute step two for the other actors in the ecosystem in form of a role play, with the founders adopting the role of the other actors, e.g., customers and estimated activities, resources, costs and revenues.

In the second step, the SD modeling of the ecosystem was accomplished with the help of the artifact. In order to reduce complexity, the researchers limited the number of actors to a minimum viable ecosystem (MVE) (Adner, 2012). We chose the start-up, the primary customers and the infrastructure service provider as MVE to be modeled. We elaborated the corresponding variables and modeled them in the respective section within the framework in the silico software. As recommended by Sterman (2000), the simulation time comprised the past (2 years) and the future (5 years). Time unit quarters were assumed sufficient by the researchers and the founders.

5. Second iteration

5.1 Refinement of the artifact

Focal actor. In this ADR study, the business model decision was made by the start-up. Accordingly, the ecosystem analysis is considered from the perspective of the start-up. In the course of initial modeling, we noticed that the final decision-maker's perspective has to be considered right from the modeling stage. However, based upon Adner (2017), the initial design of the artifact prescribes a uniform modeling logic for every actor. Therefore, we extended the initial design with the concept of the *focal actor*, "from whose perspective the analysis is conducted" (Adner, 2017, p. 56). The modeling of the focal actor differs from the ones of the other actors of the ecosystem in two ways (see Figure 4).

1. Customer segment scaling element. As the focal actor defines the perspective from which customer segments are considered, this element is associated with the focal actor. Additionally, the focal actor is responsible for the number of customer-actors residing in a customer segment over time. As the actions of one actor can impact the value creation and value capture system of other actors in the ecosystem (Adner, 2017), the number of customer-actors within a customer segment acts as a scaling variable for the segment's impact on the other actors, e.g., revenues and required activities/resources.

2. Value chain on department level. We elaborated the value proposition of the start-up in a differentiated manner, i.e., as flows of products, services, software and information. This enabled us to explicitly assign to these differentiated flows the activities needed to generate them and the associated resources and costs. The chain of activities, resources, and costs could be explicitly allocated to the company departments, e.g., software development or hardware development. In the course of initial modeling, we found that the department-level distinction led to a more focused and organized modeling. This also resulted in a slight adjustment of the benefit element, which is now located between revenues and accumulated costs.

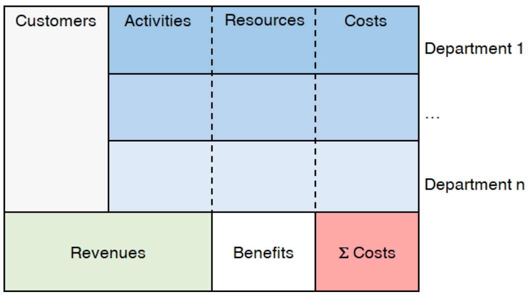

Figure 4. Focal actor modeling framework.

Simulation time. The initial design followed the approach of Sterman (2000) who recommends that the simulation time should encompass the past and the future. In our case, it was not possible to model the past development of variables, because in a start-up change iterations happen rapidly, e.g., within weeks. Additionally, it became apparent that capturing the status quo as variable/model initialization and its extrapolation into the future were sufficient to support the business model decision.

Data inquiry. To build a model of an ecosystem, various data is required, i.e., the actors' positions, their corresponding flows and internal value creation, and capture structures. This data lies across various tangible sources (databases) and intangible sources (mental models). In our case, the ecosystem analysis undertaken in the workshop with the founders was sufficient to elaborate the ecosystem structure and a first draft of the internal value creation and value capture system of the start-up. However, the founders had limited insight and could only assume the internal value creation and capture structures of the other actors. Even for several internal variables the founders were unable to give a precise quantification. Hence, additional internal (e.g., employees) and external (e.g., customers) data sources are needed to build a valid simulation-capable model of the ecosystem.

5.2 Second evaluation of the refined artifact

It became apparent that the customer segment considered in the MVE contains the start-up's most relevant target customers and thus the main objective of the business model innovation process. Hence, the project team decided to stick to the MVE in the second evaluation and to not extend the number of actors in the model. In doing so, we (1) consulted additional internal and external data sources, and modeled the MVE using the refined artifact, and (2) use the model to conduct simulation experiments and enable decision-making with the founders.

Ecosystem modeling with the refined artifact. For the model of the start-up, we interviewed seven employees in total, conducting the respective activities in the different departments. The modeling process can be described as iteration loops of inquiry, modeling and validation with the respective employees. This process was repeated until we generated a validated model. For some activity variables the data was missing. In this case, we formulated assumptions with the respective employees and marked them in the model to ensure the model's simulation capability.

For the model of the customer segment, we interviewed five corresponding customers regarding their value creation (activities and resources) and value capture structure (costs and revenues) with respect to the offered solution of the start-up. This marks the system boundary, i.e., everything that is relevant in the context of the customers' utilization of the value proposition is included in the model. The interviews provided the necessary structural information and the quantified measures to formulate the SD model of the customer segment. We implicitly validated the model of the customer segment with every additional customer we interviewed. For the model of the infrastructure service provider, the input data gathered from the start-up founders were sufficient to model the parameters relevant for the business model decision. With respect to the model's purpose and the research objective, no additional inquiry was deemed necessary.

Utilization of the model. The utilization phase of the model comprises two three-hour long workshops with the three founders of the start-up. We went through the model structure, discussed the critical parameters, and then run simulation experiments with them. The first workshop focussed on the value creation and value capture within the ecosystem, especially on customers. One critical parameter here was the intensity of use, i.e., how many optimization projects a customer conducts in a year. Thus, we applied different usage intensity scenarios and assessed the impact on the ecosystem. To provide one example from the workshop, Figure 5 illustrates two scenarios of how and to what extent the customers' usage intensity determines the flow of data across the ecosystem and, thus, affects the start-up's costs and the infrastructure provider's revenues. The elaborated ecosystem structure and customer behavior in the form of quantified measures helped the founders to understand how customers use their solution and, in doing so, create value for the ecosystem. Based on the estimated customers' usage intensity the founders decided on the subscription model and its price.

The second workshop was focused on the start-up's value creation and value capture. Critical parameters were the number of customers and the acquisition rate. We applied different growth scenarios, i.e., the intensity of customer acquisition, and elaborated their impact on the value creation and value capture system of the start-up. The results helped the founders to develop a mid-range growth strategy, e.g., the need of hiring employees for different departments.

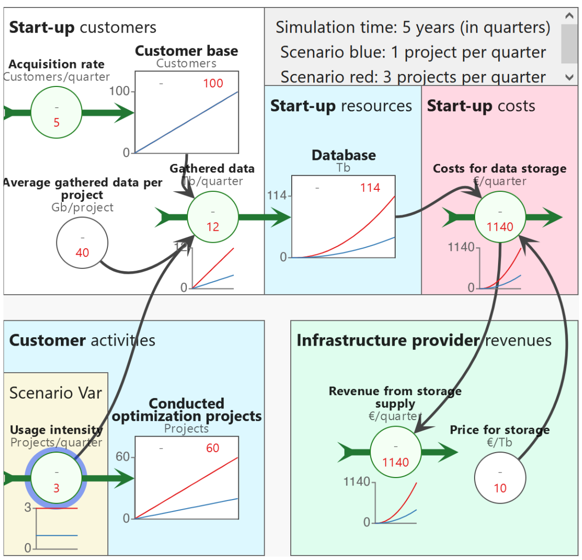

Figure 5. System Dynamics model excerpt.

5.3 Reflections on the second evaluation

The goal of the second evaluation was to assess the artifact's utility and efficacy. Therefore, two perspectives are relevant, first the modeler who is the actual user of our developed artifact, and second the founders (decision-makers) who take decisions induced by the model's simulation results.

By consulting additional data sources, it became possible to formulate a validated and simulation-capable SD model of the business ecosystem. Thereby, the framework helped the modeler to organize the plethora of variables within the actors' boundaries and give the model a comprehensive, accurate structure.

Enabling them to take business model decisions, the founders appreciated the in-depth insights into the ecosystem's value creation and value capture mechanisms. The ecosystem model allowed them to view their own value proposition from the perspective of other actors, making them more empathetic, which led to (more) ecosystem-focused decisions, e.g., revenue model and price. Moreover, the differentiated view on their own value creation and value capture mechanism provided interesting managerial insights, e.g., regarding growth strategy.

6. Formalization of learnings

We developed a modeling framework as the focal artifact to model and simulate ecosystems with SD and thus reached the dual goal of supporting decision-making in business model innovation and simultaneously encompassing the ecosystem perspective. Hereafter, we reflect on the different phases relevant for the utilization of the artifact.

Inquiry. The input data to model an ecosystem lies in various organizations and sources, e.g., tangible in form of databases, or intangible in form of mental models. An internal ecosystem analysis workshop (see Section 4.2) of the focal actor's perspective using e3-Value was sufficient to develop a (qualitative) first understanding of the ecosystem, to identify any blind spots, and enable further inquiry sources to be consulted. What follows is an in-depth analysis of the value creation and value capture mechanisms of the actors, for which databases and activity operators, i.e., employees who accomplish the value creation activities for the actors, are sufficient sources. In the overall course of inquiry we found that, where mental models were flawed due to missing data or blind spots, formulating assumptions is a sufficient approach to develop a working model, as assumptions can be validated or falsified in later inquiry iterations.

Modeling. Modeling, here, describes the process of transferring the gathered data into a simulation-capable SD model of the ecosystem. In this respect, our framework pursues the dual mission of guiding modeling by setting certain boundaries and simultaneously ensure a free modeling approach as ecosystems and business models represent a highly individual context. This helps to organize the plethora of variables in a reliable and consistent structure and thus to handle the model's complexity. By setting actors as the focal modeling element, the ecosystem model becomes flexible, allowing actors to be easily plugged in and out, i.e., the model can be extended and reduced as required for the purpose of the analysis.

Decision-making. The modeling framework is actively used by the modeler but considers the decision-makers as an indirect target audience. The consistent model structure helped the decision-makers to gain an in-depth understanding of value creation and value capture mechanisms of the ecosystem and corresponding actors. In this way, the model facilitates communication and decision-support with respect to the decision-makers and accomplishes its role as a boundary object (Carlile, 2004). It allowed different levels of analysis, i.e., a zoom-out on the ecosystem level and a zoom-in on the actor level. The zoom-in on different actors' value creation and value capture mechanisms was especially valuable in enabling the decision-makers to develop empathy for other actors, thus fostering ecosystem-focused decision-making.

7. Contribution to theory and practice

The aim of this research was to support the founders' decision-making process in the course of innovating the business model of their company. As the start-up operates exclusively in the B2B context, which constitutes an ecosystem, the ecosystem-perspective had to be taken into account. An ADR project was conducted to solve the field problem and to create corresponding design knowledge which can be applied to other contexts, e.g., other branches or companies of different sizes. We identified SD modeling and simulation as an effective approach to support business model decision-making. In order to accommodate the consideration of the ecosystem perspective, a modeling framework was built as the contributing artifact. After two iterations it was shown that the artifact facilitates the modeling of an ecosystem in SD and thus supports decision-making in the course of business model innovation. The contribution of this ADR project is threefold: First, we modeled and simulated the start-up's MVE in SD. This instantiation serves as a proof of concept that ecosystem simulation is possible using SD. Figure 6 illustrates an excerpt of the start-up's ecosystem modeled in Silico (instantiation) with an overlay of both frameworks, the general actor framework for the customer segment and the focal actor framework for the start-up. Second, as the developed artifact encapsulates design knowledge, it contributes to the research on business ecosystems (Gregor & Hevner, 2013), and, specifically, on how ecosystems can be modeled and simulated and thus prototyped and (artificially) tested with SD. Information Systems researchers will benefit from the ability to explore and analyze ecosystem dynamics with SD, including the value creation and capture mechanisms. Third, in the course of the research project further design knowledge in the form of generalized learnings could be formulated (see Section 6), including methodological guidelines on how to gather the necessary data of the ecosystem and how to transform it into an SD model. In future research, we plan to complement our framework with the development of design principles for how to use SD in an ecosystem environment.

With the ADR project comprising the single case of a start-up, it raises the question of generalizability. The data sources, e.g., customers willing to be interviewed, were limited and did not allow for rigorous model validation. In some cases, valid data were missing and assumptions had to be made to ensure the model's simulation capability. However, the process of modeling and conducting scenario-experiments with the ecosystem model was valuable to the decision-makers as it revealed various managerial insights. Moreover, the founders stated that the SD model has more expressive power than what they could ever have achieved in spreadsheet calculations, i.e., using MS Excel.

In the context of business model and ecosystem innovation we see lots of potential for the utilization of SD. We encourage researchers to apply and adapt the artifact to different contexts, for example to knowledge or platform ecosystems (Jacobides et al., 2018) or by applying social and ecological factors.

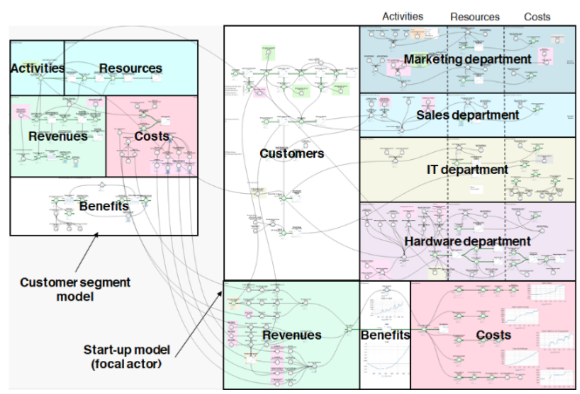

Figure 6. Framework instantiation as excerpt of the start-up's ecosystem model, modeled in Silico

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8. References

Abdelkafi, N., & Täuscher, K. (2016). Business Models for Sustainability From a System Dynamics Perspective. Organization & Environment, 29(1), 74–96.

Adner, R. (2012). *The wide lens: A new strategy for innovation*. Portfolio Penguin.

Adner, R. (2017). Ecosystem as Structure. Journal of Management, 43(1), 39–58.

Athanasopoulou, A., & Reuver, M. de (2020). How do business model tools facilitate business model exploration? Evidence from action research. Electronic Markets, 30(3), 495–508.
Carlile, P. R. (2004). Transferring, Translating, and Transforming: An Integrative Framework for Managing Knowledge Across Boundaries. Organization Science, 15(5), 555–568.
Cennamo, C., Dagnino, G. B., Di Minin, A., & Lanzolla, G. (2020). Managing Digital Transformation: Scope of Transformation and Modalities of Value Co-Generation and Delivery. California Management Review, 62(4), 5–16.
Cosenz, F., & Bivona, E. (2021). Fostering growth patterns of SMEs through business model innovation. A tailored dynamic business modelling approach. Journal of Business Research, 130, 658–669.
Cosenz, F., & Noto, G. (2018). A dynamic business modelling approach to design and experiment new business venture strategies. Long Range Planning, 51(1), 127–140.
Demil, B., Lecocq, X., & Warnier, V. (2018). Business model thinking, business ecosystems and platforms: The new perspective on the environment of the organization. M@n@gement, 21(4), 1213–1228.
D'Souza, A., Bouw, K., Velthuijsen, H., Huitema, G. B., & Wortmann, J. C. (2018). Designing viable multi-commodity energy business ecosystems: Corroborating the business model design framework for viability. Journal of Cleaner Production, 182, 124–138.
Ebel, P., Bretschneider, U., & Leimeister, J. M. (2016). Leveraging virtual business model innovation: a framework for designing business model development tools. Information Systems Journal, 26(5), 519–550.
Foss, N. J., & Saebi, T. (2017). Fifteen Years of Research on Business Model Innovation. Journal of Management, 43(1), 200–227.
Fuller, J., Jacobides, M. G., & Reeves, M. (2019). The myths and realities of business ecosystems. MIT Sloan Management Review, 60(3), 1–9.
Gassmann, O., Frankenberger, K., & Choudury, M. (2014). *The business model navigator: 55 models that will revolutionise your business*. Pearson.
Giessmann, A., & Legner, C. (2016). Designing business models for cloud platforms. Information Systems Journal, 26(5), 551–579.
Gordijn, J., & Akkermans, H. (2001). Designing and evaluating e-business models. IEEE Intelligent Systems, 16(4), 11–17.
Gregor, S., & Hevner, A. R. (2013). Positioning and Presenting Design Science Research for Maximum Impact. MIS Quarterly, 37(2), 337–355.
Iansiti, M., & Levien, R. (2004). Strategy as ecology. Harvard Business Review, 82(3), 68-78, 126.
Jacobides, M. G., Cennamo, C., & Gawer, A. (2018). Towards a theory of ecosystems. Strategic Management Journal, 39(8), 2255–2276.
John, T., Kundisch, D., & Szopinski, D. (2017). Visual Languages for Modeling Business Models: A Critical Review and Future Research Directions. ICIS 2017 Proceedings.
Khademi, B. (2020). Ecosystem Value Creation and Capture: A Systematic Review of Literature and Potential Research Opportunities. Technology Innovation Management Review, 10, 16–34.
Kohtamäki, M., Parida, V., Oghazi, P., Gebauer, H., & Baines, T. (2019). Digital servitization business models in ecosystems: A theory of the firm. Journal of Business Research, 104, 380–392.
McIntyre, D. P., & Srinivasan, A. (2017). Networks, platforms, and strategy: Emerging views and next steps. Strategic Management Journal, 38(1), 141–160.
Moellers, T., Burg, L. von der, Bansemir, B., Pretzl, M., & Gassmann, O. (2019). System dynamics for corporate business model innovation. Electronic Markets, 29(3), 387–406.
Moore, J. F. (1993). Predators and prey: A new ecology of competition. Harvard Business Review, 71(3), 75–86.
Osterwalder, A., & Pigneur, Y. (2010). *Business model generation: a handbook for visionaries, game changers, and challengers*. John Wiley & Sons.
Schaffer, N., Pfaff, M., & Krcmar, H. (2019). Dynamic Business Models: A Comprehensive Classification of Literature. MCIS 2019 Proceedings.
Schwarz, J. S., & Legner, C. (2020). Business model tools at the boundary: exploring communities of practice and knowledge boundaries in business model innovation. Electronic Markets, 30(3), 421–445.
Sein, Henfridsson, Purao, Rossi, & Lindgren (2011). Action Design Research. MIS Quarterly, 35(1), 37-56.
Stadtländer, M., Schoormann, T., & Knackstedt, R. (2021). Capturing the Dynamics of Business Models: Towards the Integration of System Dynamics and Reference Modeling. WI 2021 Proceedings.
Sterman, J. D. (2000). *Business dynamics: Systems thinking and modeling for a complex world*. Irwin McGraw-Hill.
Szopinski, D., Schoormann, T., John, T., Knackstedt, R., & Kundisch, D. (2020). Software tools for business model innovation: current state and future challenges. Electronic Markets, 30(3), 469–494.
Talmar, M., Walrave, B., Podoynitsyna, K. S., Holmström, J., & Romme, A. G. L. (2020). Mapping, analyzing and designing innovation ecosystems: The Ecosystem Pie Model. Long Range Planning, 53(4), 101851.
Vaishnavi, V. K. (2015). *Design Science Research Methods and Patterns: Innovating Information and Communication Technology* (2nd ed.). CRC Press.
Weigand, H. (2016). The e3value Ontology for Value Networks: Current State and Future Directions. Journal of Information Systems, 30(2), 113–133.
Williamson, P. J., & Meyer, A. de (2012). Ecosystem Advantage: How to Successfully Harness the Power of Partners. California Management Review, 55(1), 24–46.
Wirtz, B., & Daiser, P. (2018). Business Model Innovation Processes: A Systematic Literature Review. Journal of Business Models, 6(1), 40–58.