

DATA-DRIVEN BUSINESS MODELS – BUILDING THE BRIDGE BETWEEN DATA AND VALUE

Research paper

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Abstract

In the wake of an ongoing digital transformation organizations are seeking to understand and generate new data-driven business models. While data is a key resource, generating value from data is a key challenge for innovating data-driven business models. Extant tools for business model representation offer little help. In this paper, we propose the design of a Data Insight Generator (DIG) artefact that can support the design process of data-driven business models at a crucial step: connecting data to value propositions. The artefact is positioned as a complement to the Business Model Canvas, the most widely used tool for business model representation. The DIG connects two key elements of the business model, namely key resources and value proposition through six data-specific elements. Further, the DIG supports an iterative process of discovery for these elements as a boundary object between business and data science/IT participants of business model innovation. Based on a formative evaluation we demonstrate the usability and utility of the DIG.

Keywords: data-driven business models, artefact, value proposition, action design research

1 Introduction

The strategic importance of information technology is growing, which is in turn causing an ever increasing number of business innovations (Morabito 2015). Organizations have turned away from product-based offerings toward complex, service-oriented business models (Weiner and Weisbecker 2011). As data capabilities are increasing exponentially, they are also causing data-driven innovations in business models (Zolnowski et al. 2016). Also, research points to an increase of data-driven innovations in commercial and non-commercial fields. The development of data-driven business models (DDBMs) is being driven by this trend and is accordingly of growing importance in research (Schüritz and Satzger 2016). By collecting, extracting, and analysing data, an organization can drive its development further, which is necessary for survival in the current competitive environment (Hunke et al. 2017). When companies do not explore their own potential based on the data available, they tend to risk losing chances and opportunities that can be embraced by their competitors (Brownlow et al. 2015). Nevertheless, organizations that integrate data as one of their key resources can gain a significant advantage compared to the general competition (Bulger et al. 2014; Muhtaroglu et al. 2013). An example of this development is Rolls Royce. Instead of offering a product-based aerospace jet turbine, they sell a “power by the hour” service. Customers pay only for the hours during which they operate the machine, not for the machine itself. As performance data from turbines are available, Rolls Royce can offer such a service without charging for maintenance time of the turbine. Such a performance-based service is only possible with data, which are collected by several sensors in the machine (Schüritz and Satzger 2016).

Therefore, a business model representation can be a helpful strategic tool for making important decisions regarding external factors (Osterwalder and Pigneur 2010). In general, there is no shortage of methods and tools for the development and representation of business models. Many of these artefacts are shaped by the field of research in which they originate (Beha et al. 2015). However, detailed knowledge of the development processes and tools needed for designing and implementing DDBMs is comparatively limited, and this is because the field is still relatively new (Williams et al. 2008). While the first proposal for the development of DDBMs (Mathis and Köbler 2016) pointed in the right direction, it lacked a comprehensive conceptual underpinning. The development discussed in the proposal focuses on data as the main resource in a DDBM. No connection is made to other important factors of a business model, such as value proposition yet (Osterwalder and Pigneur 2010). This connection is by no means trivial. Communication between data scientists (data side) and business departments (value proposition side) is complicated due to the intervening steps between data and value proposition. Therefore, this paper seeks to provide an artefact which goes a step further by integrating value proposition as another important factor of a business model.

Despite the relevance of DDBMs in research and practice, no framework exists which would motivate employees with different backgrounds in organizations to determine the connection between their data and a new value proposition for their business model (Westerman et al. 2012) and to make this linkage transparent to all stakeholders of the DDBM. Thus, we addressed the following research question:

RQ: How can the purpose of data as part of data-driven business models be made to enable a value proposition for customers?

Therefore, this paper develops an artefact via an action design research process that links the two perspectives - data and value proposition - of a DDBM. The artefact deepens understanding of DDBMs and shows the relations between different constructs. Within this contribution, we focused on the two perspectives, key resources and value proposition, of the Business Model Canvas (BMC) (Osterwalder and Pigneur 2010) and did not address issues like general strategy or technical methods within DDBMs. Other perspectives of business models, such as key activities and revenue models (Osterwalder and Pigneur 2010) are also not addressed in this paper. Instead, we recommend using tools like the BMC for addressing these other important issues in business models. However, with this implication of using BMC perspectives, we can support developing DDBMs.

To clearly outline these findings, the paper is structured as follows: First, conceptual foundations with regard to service business models, boundary objects, and data-driven innovation are outlined to provide a common understanding. Second, the research methodology is described to ensure the transparency of the paper and the research upon which it was based. On this basis, the artefact and evaluation are subsequently presented and discussed. As a summary, the paper provides a conclusion as well as an outlook for further research.

2 Foundations

2.1 Service Business Models and Their Representations

During the 1990s, the pure sale of products became increasingly non-profitable for organizations, primarily because the manufacturer was too far away from the customer and did not realize the real demand. Due to this development, more and more organizations decided to offer services related to their products (Oliva and Kallenberg 2003).

This shift demonstrated a change in perspective from those of organizations to those of customers. Instead of buying products customers buy services, which in turn creates value for both customers and organizations (Gummesson 1995). The creation of value can be seen as a collaborative process between more than one actor (Vargo and Lusch 2008). This can include the customer, the supplier or other involved partners. The so-called Service-Dominant logic is the co-creation of value with several actors applying their different competencies to benefit from other actors in the network. This can also

be seen as a service-for-service exchange (Vargo and Lusch 2014). A service is defined as a set of different activities in a business which together constitute a process between different entities with the aim of supporting the customer in his or her everyday practice (Grönroos 2008; Vargo and Lusch 2008).

The term business model is used frequently. However, different definitions and understandings of what represents a business model exist (Sorrentino and Smarra 2015; Zott et al. 2011), most of which share several characteristics. One of the key messages of a business model is value creation for the customer (Lund and Nielsen 2014). Inputs and business activities are the key components of business models (Sorrentino and Smarra 2015). Due to different definitions of business models, many varying representations for business models have been developed (Osterwalder et al. 2005; Zott et al. 2011). A business model representation should demonstrate a real business entity. Such a representation could be represented textually, conceptually and/or graphically (Al-Debi et al. 2008). Examples of these developments of business model representations include e3value (Gordijn 2002) and the BMC (Osterwalder and Pigneur 2010). The BMC is one of the most prominent examples of a strategic management template (John and Szopinski 2018). It displays nine different building blocks for representing the business model in a nutshell: partners, key activities, key resources, value proposition, channels, customer relationships, customer segments, cost structure and revenue streams (Osterwalder and Pigneur 2010). As we focus on key resources and value proposition in this paper, we define these ones as follows: Key resources are all the most important assets required to enable the business model (Osterwalder and Pigneur 2010). Value proposition describes products and/or services which generate value for a defined customer group (Osterwalder and Pigneur 2010).

In recent years, the focus of value creation has changed from selling pure products to selling services (Grönroos 2008). Such business models show special characteristics (Vargo and Lusch 2014). In comparison to a product-based offering, a service focuses on interaction with customers. These service business models include the customer and partner more than do traditional models and enable value co-creation between the customer and the organization (Lusch and Nambisan 2015). As such specific characteristics of service business models require an adjusted representation: the Service Business Model Canvas (SBMC) (Zolnowski et al. 2014). This canvas was developed to augment the BMC (Osterwalder and Pigneur 2010) for services. The SBMC integrates the customers' and partners' perspectives in addition to those of companies with the seven main blocks of the BMC: cost structure, key activities, key resources, value proposition, channels, relationships and revenue streams (Zolnowski et al. 2014). Such business model representations can be seen as boundary objects which are described in the next section.

2.2 Business Model Representations as Boundary Objects

As the development of services, including the associated business models, is a complex organizational activity, it can involve different stakeholders in the process. Artefacts which support communication between such a pool of different stakeholders are called boundary objects. An information technology artefact is "intended to solve identified organizational problems" (Von Alan et al. 2004, p. 77). Such artefacts could include models, methods, constructs and instantiations (Von Alan et al. 2004). Boundary objects are plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to adapt to maintain a common identity across sites" (Star and Griesemer 1989, p. 393). Thus, the term boundary objects refers to a broad range of artefacts, such as design drawings, accounting ledgers and standardized reporting forms (Levina and Vaast 2005).

In information systems development, different project-related artefacts can be seen as boundary objects between heterogeneous groups, each of which has different knowledge backgrounds. Such boundary objects can be shared between such groups improving communication and coordination toward different purposes, interests, and viewpoints (Barrett and Oborn 2010). Boundary objects support a common reference for a shared understanding between different project participants without enforcing a special shared meaning between them (Sapsed and Salter 2004). For example, a representation of a DDBM can support project members in creating new ideas and in framing

problems as well as in collaboratively discussing the solution to these problems. Boundary objects can also play a conceptual role during an information systems project by defining the problem and solution boundaries (Gasson 1999).

Different stakeholders are involved during the development of a DDBM, data scientists, specialised business departments, customers, and management (Brownlow et al. 2015), to name a few. Thus, a boundary object in the format of an artefact could support shared understanding and transparency between the different stakeholders. To better understand DDBMs, their representations are described in the next section.

2.3 Representations for Data-driven Business Models (DDBMs)

As the service-oriented paradigm appeared, new services were developed based on both science data and data from practice such as “Data-as-a-Service” or “Analytics-as-a-Service” (Chen et al. 2011; Hartmann et al. 2014). These new business models, called data-driven business models (DDBMs), form a subset of service-oriented business models (Zolnowski et al. 2016). Such business models constitute the next step from servitization to datatization (Schüritz et al. 2017b). A key resource of major importance to such a business model is data (Hartmann et al. 2014). However, there is no defined data threshold when comparing traditional business models with DDBMs (Schüritz et al. 2017a). For this reason, we define data-driven business models as business models which use data as a key resource to create new insights for a value proposition for customers.

The implementation of data as a focus of the business model can have effects on value proposition, value capturing, and value creation (Schüritz et al. 2017a). On the one hand, these effects can occur separately - for example, only an effect on value capturing. On the other hand, they can be combined, i.e., have effects on value proposition, value capturing and value creation (Schüritz et al. 2017a). As we considered the value for customers, we focused our paper on the effects on value proposition. Based on value proposition, four different patterns are evident: (1) cooperative value innovation, (2) cooperative productivity improvement, (3) customer-centric value innovation, and (4) company-centric productivity improvement (Zolnowski et al. 2016). All in all, a transformation toward a data-focused offering or an improvement in productivity can be influenced by data-driven innovations (Zolnowski et al. 2016). In this paper, data-driven innovations are defined as business innovations which use data or data analysis as a key resource for advancing growth and ensuring business success (Jetzek et al. 2014).

To identify representations of such DDBMs in the literature, we additionally conducted a structured literature review.

Following the structured literature review given by vom Brocke et al. (vom Brocke et al. 2009), our literature review identified all relevant literature in the field of DDBM representations. As DDBMs are a new research field at present (Brownlow et al. 2015), the relevant literature is thus far very limited, and only a few peer-reviewed articles exist. As a consequence, the literature review also included white papers. Publications on websites or forums were not considered.

A keyword search was conducted in the following databases: (1) AIS Electronic Library, (2) Google Scholar, (3) IEEE Xplore, (4) ScienceDirect, and (5) Web of Science. These databases were chosen because they contain not only relevant peer-reviewed journals and conference proceedings but white papers as well. We did not set a filter by published year. The keyword search included the keywords “data-driven business model” and “data-driven service”. Besides the term “data-driven” sometimes the terms “data-based” and “data-infused” are occasionally used. As these terms can be considered synonyms, we integrated them into the searched keywords as well. Since the term “data-driven” is common in the DDBM field, we included it in the title of the paper. We also integrated a combination of “canvas”, “artefact” or “boundary object” into our research to identify all artefacts in the field of DDBMs. Other synonyms were not identified. Lastly, we also integrated term “data-driven service” as a broader term into our research, because we did not want to skip any potentially interesting artefacts which did not use the common terms for a valuable visualization.

<i>Keyword</i>	<i>Database</i>	<i>Hits</i>	<i>Relevant</i>
("data-driven" OR "data-infused" OR "data-based) AND ("business model" OR "canvas" OR "artefact" OR "boundary object")	AIS Electronic Library	26	1
	Google Scholar	271	2
	IEEE Xplore	2	1
	ScienceDirect	19	0
	Web of Science	4	1
("data-driven" OR "data-infused" OR "data-based) AND "service"	AIS Electronic Library	29	1
	Google Scholar	580	1
	IEEE Xplore	14	0
	ScienceDirect	1	0
	Web of Science	0	0

Table 1. Literature review.

We reviewed the titles and abstracts of all hits in the databases and identified relevant articles as relevant per the following criteria: (1) a DDBM or service should be the focus of the article, and not a secondary aspect; (2) the article should concern at least one canvas field of the BMC as a main characteristic of a business model representation; and (3) the paper should provide a visualization as the representation perspective. The results of this review can be seen in Table 1 above.

All in all, three publications were identified as relevant (excluding double matches in different databases, illustrated in Table 1). Following this, we proceeded with a forward and backward search with the identified articles (Webster and Watson 2002); however, we did not identify any more relevant articles by doing so.

In sum, we identified three different articles, which are described in the next section. According to our literature review and the different perspectives on business models from the BMC (Osterwalder and Pigneur 2010), we identified several research work which focused on one perspective of the BMC.

Mathis and Köbler (2016) introduced the Data Canvas, which helps to organize data as a key resource. The authors identified two different perspectives on data: external and internal data, and regular and sequential data. Together, these two perspectives comprise four fields for organizing data: external and regular data, external and sequential data, internal and regular data, and internal and sequential data. Although, this fourfold representation could help organizations structure their data, it does not reveal the purpose of using these data. Thus, this tool cannot help to solve the identified challenge.

Hunke and Wambsganß (2017) presented a framework that helps organize key activities within a DDBM. The model should support organizations in structuring their key activities in DDBMs and define which stakeholder (customer, company, or partner) should perform these activities. The tool differentiates between the following activities: data collection, data organization, data selection, data pre-processing, data transformation, data mining, and interpretation. Due to the tool's focus on activities, data and customer value are excluded. Thus, this tool also cannot be used to render transparent the purpose of the DDBM for all stakeholders.

Zolnowski et al. (2017) developed a cost-benefit model for DDBMs. This model is represented as an UML diagram, which contains an offer, savings and cost items. As this model concentrates on costs and does not integrate any data or customer value, it, too, cannot be used to solve the identified challenge.

Most other literature about the DDBMs concerns about patterns in different fields but does not present a visualization which can help generate understanding about the DDBMs: e.g., Schüritz and Satzger (2016), Zolnowski et al. (2016), Hartmann et al. (2014). The three identified articles each concentrate on a single characteristic of the business model each. Thus, the resources, key activities, and cost structure are represented in the literature yet.

All in all, the connection between data and value proposition has not yet been visualized, despite the fact that data are the key resource in a DDBM (Kühne and Böhmman 2018). The connection between

data and the value proposition remains unclear because of intervening steps between these two fields (e.g. key activities (Hunke and Wambsganß 2017)). This connection is a crucial part of a data-driven business model as value creation out of the data is not self-explaining. As the BMC is a holistic representation of a business model, it cannot represent the requisite steps between data as the key resource and value proposition. Consequently, key resources and value proposition are not connected in the BMC, and therefore an organization cannot create a suitable value proposition with their data without considering these steps. We identified, via interviews, the ambiguous connection between data and value. For example, poor data quality could result in the promised value proposition remaining unfulfilled. Thus, an organization should know that it can fulfil its promised value proposition with given or acquired data (e.g., from data quality point of view). As the literature review shows, no artefact has as of yet sufficiently solved this problem. Therefore, in the following sections, we developed an artefact which does sufficiently solve the problem.

3 Methodology

3.1 Research Approach

Our research follows the action design research approach (see Figure 1) introduced by Sein et al. (2011). This method constitutes a process for action design methodology. When using action design, a research project should (1) address a practical problem faced by an organization or people, (2) design a solution for the given problem, and (3) evaluate the solution and reflect the results (Sein et al. 2011). All in all, an action design research project focuses strongly on artefacts which can solve underlying problems.

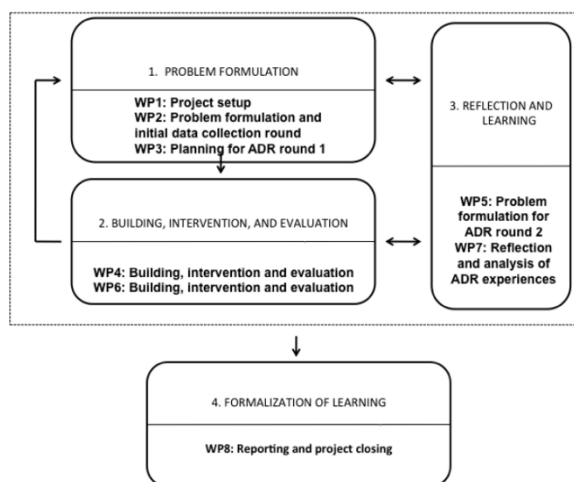


Figure 1. Action design research according to (Sein et al. 2011).

We chose this method for two reasons: (1) First, the method focuses on the development of an artefact which can support an integrated view of technology features in an environment with heterogeneous stakeholders. This can be especially helpful in the development of artefacts which constitute information technology and social environment action design research (Sein et al. 2011). Thus, action design research is well suited for generating prescriptive design knowledge by developing and evaluating artefacts (Orlikowski and Iacono 2001). (2) Second, action design research supports the generation of theoretical contributions and solves practical problems faced by practitioners in the field (Benbasat and Zmud 1999; Rosemann and Vessey 2008). Thus, action design research supports the creation of knowledge through the development and evaluation of an artefact. During the execution of the development and evaluation process, the method not only improves the artefact but also permits the generalization of the results of the analysis. Overall, business model representation tools are meant

to support the interaction between different stakeholders of an organization as well as other stakeholders outside the organization (Osterwalder and Pigneur 2010). As action design research should support this process by building artefacts, we considered this method to be a suitable approach for our research project.

Following the action design research approach, our research project consisted of the following three major steps. As a first step (problem formulation), we systematically framed the problem situation, which is described in the introduction of this article, and established the motivation behind our research question. Further, we conducted semi-structured interviews about the challenges and obstacles of DDBMs (see section 3.2). The foundation section defined the background of the given problem statement and, as such, allowed us to design our research project.

In a next step (Building, Intervention, Evaluation), we designed, presented, and evaluated the artefact, called the Data Insight Generator (DIG), in two cycles (see sections 4 and 5). We used these cycles to ensure that the artefact could be used as an instrument to solve the underlying research problem (Sein et al. 2011).

Parallel to the Building, Intervention and Evaluation cycle, the Reflection and Learning step focused on reviewing the several design steps. As the last step (Formalization of Learnings), we generalized our learning during the research process. During this step, we identified the theoretical and practical contributions of the research project. A description of this step can be found in the discussion section of this paper (section 6).

3.2 Semi-structured Interviews

Following the action design research methodology, experts from different industries were interviewed to formulate the problem statement. The interviews were based on a semi-structured interview guide (Myers and Newman 2007). Thus, answers to earlier questions were used to formulate later questions. In this way, experts could freely discuss their experiences and were encouraged to provide more information than would be expected in a strictly structured interview (Myers and Newman 2007).

The interviews took between one and three hours and were structured according to the following topics: value proposition, value creation, and value capturing (Schüritz and Satzger 2016). This structure was chosen because these three topics comprise the main effects of resource data on business models (Schüritz and Satzger 2016). Thereby, the interviewees reported current initiatives regarding data-driven services and business models. Challenges within development and implementation projects were also outlined. Additionally, the interviews revealed necessary data and competencies as well as changes in strategy, process, and organization. Table 2 illustrates the distribution of experts from the different industries and organizations. We chose these organizations because of their expertise in the field of DDBMs, which was based on their completion of long-term projects in this field. All in all, 20 experts from seven different companies and five industries were interviewed. All interviewees had extensive experience in digital and data-driven innovations in their organizations.

<i>Industry</i>	<i>Number of organizations</i>	<i>Number of experts</i>	<i>Positions</i>
Banking	1	1	Product Owner
Engineering	2	10	Innovation / Product Management
Energy	1	4	Product / Project Management
Maintenance	1	1	CEO
Consulting	2	4	Digital Consultants

Table 2. Interviewed experts by industry.

All interviews were independently paraphrased and coded according to Mayring (2007) by two different researchers. The goal of this coding was to identify the main challenges and obstacles appearing in data-driven projects. Toward this end, we reiteratively coded the paraphrases into categories (e.g., data, stakeholder) in order to identify all matching categories. Courtesy of these categories, we summarized the paraphrases into main challenges and obstacles. The coding results of both researchers were compared, discussed, and then merged.

As a result, we identified several challenges and obstacles, most of these ones (61 %) were located in the field of key resources of the BMC (Osterwalder and Pigneur 2010); however, these were not mentioned in all the interviews. The concentration in the field of key resources is unsurprising, because data are the main resource in the DDBM (Schüritz and Satzger 2016). The other identified obstacles were located in the customer relationships, channels, revenue streams and key activities fields. However, not all interviewees viewed these challenges as obstacles.

Overall, we identified one main challenge that was mentioned in all the interviews: The purpose of data use and data analysis should be transparent and clear to all stakeholders of the data-driven service. Of course, the purpose of using data in a DDBM is the creation of a value proposition for the customer (Schüritz and Satzger 2016). For example, some interviewees stated that the purpose of the data analysis should be clear, or that the purpose for which the data are used should be transparent. Other interviewees emphasized the connection to the customer, stating that the value of data analysis, as well as the purpose for which customers' data are used, should be clear for the customers themselves. Furthermore, the limitations of data use - and, therefore DDBMs - should also be clear for management. Thus, they should understand easily the limitations of DDBMs.

To demonstrate the purpose of the data in a DDBM, it is necessary to make the connection between data and value proposition clear. However, when using the BMC or SBMC as an example for business model representations, this connection is not clear because the data in the key resources field and the customer's value in the value proposition field are separate. Accordingly, for a business department, manager, or customer, it would be difficult to understand why the data used were necessary. As a consequence, the connection between these two fields of the canvas is clearly not trivial. Rather, the interviews show that the connection between these two canvas fields is unclear for stakeholders because they only state which data are used and then, disconnected from the data, describe a desirable value proposition. On the one hand, stakeholders can be internal to the organization, such as data scientists and business departments. On the other hand, they can be external, such as cooperating partners of the customers themselves. Thus, we identified the need to address this challenge with an artefact that links data, as the key resource, with value proposition in a DDBM.

4 Data Insight Generator (DIG)

To link the key resource data and value proposition in a workshop setting, we developed the Data Insight Generator (DIG) which is presented in Figure 2. The DIG is based on the literature on DDBMs as well as on the challenges mentioned in the interviews (see section 3.2). The artefact can be used as a working tool between data scientists and specialised business departments. Furthermore, it can be presented to all other stakeholder groups of the DDBM, such as partners, managers, or customers. The transparency of a DDBM is ensured by demonstrating the purpose of the data. Thus, the DIG can be seen as a boundary object in the field of DDBMs.

The DIG can be used when an organization proposes an initial idea about a new DDBM. This initial idea, as well as the relevant data and value proposition, should be on hand before working with the artefact in a workshop setting. However, it is possible that some necessary data are not yet available or that new value propositions may come to participants' minds while using the DIG. As the goal is to generate potential ideas for new data and value propositions, the workshop should focus on one value proposition and then address other ideas in additional workshops. The DIG can be overloaded and rendered non-transparent if different value propositions and data combinations are approached with the artefact simultaneously. We experienced this issue during the first evaluation phase.







	Data	Data Quality	Combination /Pipes	Analytics	Insight	Value
	-set of values of qualitative or quantitative variables	- Completeness and consistency	- Combination of data sets - Infrastructure / interfaces	- Tools to analyze the data sets	- Outcome provides new insights / information	- Value proposition for a customer
THINK	Which data can be used in the business model?	Is that data complete and consistent? Is that appropriate for my business model?	How can I combine the different data sets to receive new information? Which interfaces can I use to combine this data?	How and with which tools can I analyze the data?	Does this analysis create new information which is helpful for my business model?	Which value can I provide a customer with this new information?
VALIDATE						
KNOW						

Figure 2. Data Insight Generator (DIG).

The DIG consists of vertical and horizontal elements. The vertical columns between data and value help organizations to link these two fields. In a workshop setting, the organization should work through the columns one by one, from left to right. The columns are explained below in detail.

The vertical columns are as follows: as (1) data are the key resources of DDBMs (Schüritz et al. 2017a), this is the first canvas field in our artefact. The organization can compile all relevant data that constitute an essential key resource for their new business model in that field. If the data are not available, then the “Validate” column is used. Thus, the organization can validate before the following iteration whether the data needed can be made available to the organization. The second canvas focuses on (2) data quality, which depends on confidentiality, integrity and availability. If the quality of the data as the main resource cannot be ensured, then a negative effect on the value proposition will result (Bulger et al. 2014). Thus, data quality is an important issue that must be checked at the beginning of the process. (3) Combination and pipes concern how different data sources can be combined to gain new information and which type of infrastructure is needed to support such combinations. These are important issues because a false combination of different data sources can yield no or false insights for the value proposition of the customer. After the sources are combined, (4) analytics can commence. The organization should know which tools are necessary as well as how to interpret the data (Dremel et al. 2017). If the organization does not have the capacities to do so, partners can become involved (Zolnowski 2015). The analysis should provide new information that results in (5) new insights. Such insights should represent new information which is not available in the pure data sources. If these insights fit the purposed value proposition, then the link between data and value is constructed. Thus, the new insights make the offering of the value proposition possible.

The horizontal rows (Think, Validate, Know) are intended to support an iterative process. These rows were developed based on the queues in the Kanban board (Ohno 1988). At the beginning of the process, the lines “Validate” and “Know” are hidden from the participants. We decided to hide these lines because the DIG is an iterative tool. The participants should only see the relevant elements at the beginning and thereby avoid being overloaded with too much information. The line “Think” is used for ideas proposed by participants during the workshop. After going through each vertical column

from left to right and saving participants' ideas in the "Think" line, the other two lines, "Validate" and "Know" are revealed. Now, the participants can begin sorting their ideas from the first line ("Think") into the "Validate" or "Know" lines. The "Validate" column is used for facts about which the participants are uncertain, but which should be validated after the workshop. The last line "Know" can be used for facts about which the participants are sure and therefore do not need to be validated. Thus, the DIG can be used in iterations, because the organization cannot know all the facts in one workshop setting. For example, some data may be available but may have insufficient quality, and thus the organization could validate this issue.

As the DIG works in iterations, the process is successfully complete if and when all ideas are indicated in the "Know" line and the link between the columns' data and value propositions is consistent. If some points cannot be validated, even with a prototype, then the underlying idea of the DDBM should be adjusted or skipped. In this case, the idea would not work because the connection between the data and customers' value is not possible. After completing the DIG, the organization can use the BMC (Osterwalder and Pigneur 2010) to define other important characteristics of the new DDBM. The BMC is a suitable representation tool for understanding the business models of organizations (John and Szopinski 2018; Joyce and Paquin 2016; Wallin et al. 2013). The value proposition of the BMC constitutes the interface between the BMC and the DIG because the value proposition can be imported from the DIG to the BMC without changing it. Other results of the DIG can be used to fill out the canvas field key resources (with data, analysis tools). Afterward, the organization can work through all canvas fields to define their new DDBM.

5 Evaluation

One step in the action design research process is the evaluation phase, for which different strategies exist. Peffers et al. (2012) differentiated between ex-ante, ex-post, naturalistic and artificial evaluation frameworks. We decided to use an ex-post and mixed approach for our evaluations.

5.1 Consulting Organization

The first evaluation was completed in a workshop setting with one consulting company and four participants. The participants were all in management positions at the organization. The participants were separated into two groups (2 participants per group) with different use cases by each group. The goal of this evaluation was to demonstrate that the DIG can be used to link data with a value proposition. Furthermore, we inspected whether the different characteristics of the DIG are suitable for achieving this goal.

During the process, each group was observed by one researcher, who took notes on the process. We decided to proceed with the first evaluation without a facilitator in order to demonstrate the feasibility and self-explaining of the artefact.

One group completed the process without difficulties because they were focused on one value proposition. The other group tried to link different data with different value propositions using the DIG. This group had difficulties completing the whole process for the following reasons: (1) They tried to find greater numbers of ideas concerning data combinations and possible value propositions. Thus, these participants constantly returned to the first column and therefore did not complete the whole process. (2) Due to a diversity of ideas for different value propositions, participants in the second group collected extensive information in one column, consequently overloading the process and preventing a precise overview of all linkages in the DIG.

As a consequence of this evaluation, we decided that the DIG should be used only for one value proposition at one time. Thereby, we limited the value proposition to one idea in the next evaluation.

5.2 Cross-Industry Evaluation Workshop

The second evaluation was completed in a workshop setting with participants from organizations of different sizes and branches. An overview of the participants can be found in Table 3 below. All in all, 12 participants took part in the evaluation. All participants had different organizational backgrounds.

<i>Industry</i>	<i>Number of employees</i>	<i>Number of participants</i>
Consulting	1-20	2
	50-100	3
Insurance	>1.000	2
University	50-100	1
	>1.000	1
Technical Certification	>1.000	1
Hotel	50-100	1
Port	>1.000	1

Table 1. Number of Participants.

The participants were separated into two groups (6 participants per group) for the workshop. During the workshop, one moderator for each group explained the artefact and its intention. Next, the facilitator provided information about the general case which was to be applied by the artefact. The case was the same for each group because of the different backgrounds of the participants. The participants received a set of data concerning railway customers as key resources and rail delay insurance as a possible new value proposition. With the support of the moderator, they worked with the artefact to determine how best to link the data with the value proposition. Because the participants did not know each other, a facilitator was added. This provided a structure for the groups without influencing the evaluation of the artefact by group-forming processes (e.g., finding a facilitator).

Each group was observed by two independent researchers, who took notes about problems and questions faced while using the artefact. Furthermore, the researchers focused on how much support from the moderator was needed to work through the artefact. Additionally, the participants were asked for feedback about the DIG after the workshop.

Overall, both groups used the DIG with the moderator remaining relatively independent. The moderator guided the participants through the different canvas fields and asked questions. More help was needed, and more questions were asked, in the data quality canvas field. Both groups were able to link the given data about railway customers with the value proposition of delay insurance should the train arrives late. Thus, it was possible for the participants to demonstrate that the value proposition could be realized with the given data. Also, some participants found other interesting data and value propositions for the case, thereby showing how the artefact is open to new ideas regarding DDBMs.

The structure and methodology of the DIG was transparent and clear for the participants. The artefact supported them by linking data and value and they did not forget the important steps occurring between these two BMC (Osterwalder and Pigneur 2010) fields. In both groups, problems arose with the data quality canvas field. The question was raised of whether they were the right participants to evaluate data quality. In response, it might be helpful to integrate a data scientist in future workshops. Additionally, another artefact, one which scores data quality, could be helpful for specifying what should be included in the term data quality. Some other questions concerning the given scenario about travel insurance arose. These questions can be prevented in future workshops by providing the moderator with a more detailed scenario, one which is not connected to the artefact itself.

In summary, the DIG is a helpful tool for stakeholders of various backgrounds. That said, these evaluation phases have some limitations, the first of which is the scenario given to the groups during the second evaluation round because of the participants' diverse backgrounds. Thus, the artefact was tested using only one scenario with different organizations, and with only one organization using

different scenarios. This could be evaluated in another workshop by including groups comprised of individuals from the same organization who can choose the scenario for themselves. Another limitation was that the participants were limited by branch and organization size, even though other branches and sizes exist through which the artefact should also be evaluated. However, the present evaluation showed that the DIG can act as a supporting tool to link data and value in a DDBM.

6 Discussion

DDBMs are a new development in the research field of business models. At the moment, some published articles have analysed DDBM patterns like Schüritz and Satzger (2016), Hartmann et al. (2014), and Brownlow et al. (2015) revealed patterns in the different fields of business models, such as different revenue streams or data sources. Moreover, some tools exist, such as cost structure (Zolnowski et al. 2017) or the Data Canvas (Mathis and Köbler 2016), which can help develop special parts of the business model. However, no publication has yet taken a perspective on the connection between key resources and value proposition in DDBMs - a connection that would not only improve transparency but also achieve the purpose of a DDBM for heterogeneous stakeholder groups. As the connection between data and the generated value proposition in a DDBM, is not self-explaining, we developed a sufficient artefact for that.

The presented DIG should provide such an artefact to support the integration of data-driven innovations into business models. The structure of the artefact assists organizations in identifying the link between the data and the value proposition in their DDBM and makes this connection transparent to other stakeholder groups. For example, different data sources can be perfect in quality, and their combination can be easily achieved by a company. Nevertheless, the analysis of the data may not generate new insights for the organization, which would in turn make the data combination useless for a new business model. Another strength of the artefact is that it works in iterations. After an initial workshop, the organization can validate some important issues before using the artefact again.

The presented research supports the existing literature by deepening understanding of DDBMs. First, the different perspectives and questions offered by the DIG can enhance understanding of DDBMs. Evaluations with different organizations of different sizes showed that the artefact can help link data and value propositions. Importantly, the connection between data and value was shown to be non-trivial in a DDBM. Second, the artefact also supports the development of a whole business model according to the BMC (Osterwalder and Pigneur 2010). The DIG can be used as complementary tool with the BMC and can support the development of DDBMs.

As formalization of learning steps in the action design research process (Sein et al. 2011), our findings can be generalized according to the Business Model Research Schema (Lambert and Montemari 2017). Business model research has demonstrated a connection between a value proposition and a resource via resource type (Andersson et al. 2006). In our case, the resource type were data, and the DIG artefact outlined the different steps between the value proposition and this special resource-type data in order to make the linkage transparent to stakeholders of a DDBM. Thus, our research demonstrates other possible connections between the value proposition and special resource types. Generally speaking, a specialized artefact supports generalized representations of a business model for a defined resource type. Our research supports this hypothesis via the resource-type data. Furthermore, our research indicates that such an artefact can be used as a boundary object (Star and Griesemer 1989) in the development process of DDBMs. The DIG can ensure that the purpose of using data and data analytics is transparent to the stakeholder of a DDBM. This in turn ensures that the main challenge identified in the semi-structured interviews is fulfilled. Thus, we have shown that a boundary object like the DIG can support transparency in such DDBMs. This is in line with existing literature on boundary objects in the field of information systems (Levina and Vaast 2005). Further research can build such artefacts as boundary objects for other resource types in specialized business models as well.

However, our research has some boundaries. The correlation between data and value with the other perspectives of the BMC (Osterwalder and Pigneur 2010) is not part of the artefact. Furthermore,

regularities and external influences for example, special legal issues were not part of this research. These topics have not yet been integrated into the research and should therefore be evaluated in further research.

7 Conclusion and Outlook

This paper developed an artefact which can support organizations in bridging the gap between key resource data and the value propositions of their DDBMs. With the help of the DIG and its integrated questions, organizations can find the link between their data and new value for their customers.

The contribution of the paper is threefold. First, it provides a new artefact to support organizations in developing DDBMs in the fields of key resources and value proposition. Second, it deepens understanding of DDBMs in the research field. Third, it emphasizes that boundary objects can support generalized business model representations if the business model relies on a special resource type.

Nevertheless, our findings have some limitations. First, the focus on two business model perspectives of the BMC (Osterwalder and Pigneur 2010) is a limitation, since this research employed the DIG only on these two perspectives. This is a consequence of the interviews, in which it was stated that one of the main challenges is the linkage between data and value. However, the BMC (Osterwalder and Pigneur 2010) is often used in research, practice and education. Thus, these perspectives tend to be essential for business models. Other perspectives and relations must be addressed by further research. Second, the evaluation of the DIG is not yet complete. Thus, the evaluation should be finished in a future research project by adding more qualitative evaluation phases. This could involve for example, some long-term projects in which the DIG is used as an iterative tool.

Nevertheless, the findings point to further research opportunities on DDBMs. First and foremost, these opportunities pertain to the development of suitable tools and methods for designing and implementing DDBMs, such as boundary objects. Further research can encompass perspectives which have not been regarded in research yet, such as channels or relationships (Osterwalder and Pigneur 2010). The present evaluation demonstrates the need for another artefact which can help in the evaluation of data quality. Moreover, new designs of a business model representation for DDBMs could be introduced by adding or changing the perspectives of current business model representations (Schoormann et al. 2016).

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