DATA INNOVATION EXPLORER: DESIGN OF A DATA-DRIVEN BUSINESS MODEL TOOL

JOSCHKA ANDREAS HÜLLMANN,[1] TORSTEN GOLLHARDT,[2]
ANDREAS HERMANN,[2] PAUL KRUSE[2]

[1] University of Twente, Faculty of Behavioral, Management and Social Sciences, Enschede, Netherland
j.huellmann@utwente.nl
[2] University of Muenster, Department of Information Systems, Münster, Germany
{gollhardt, hermann, kruse}@ercis.de

We are now living in the data economy with data as the central fuel for operating data-driven business models. Especially incumbent companies are constantly challenged by rapid technological change and emerging business models that utilize data for value creation. Consequently, every company must rethink and, possibly, renew its business model over time to remain successful. Various tools have been proposed by practice and academia in order to enable and facilitate business model innovation. Although IT tools for supporting business model innovation proved to be meaningful, IT tools for data-driven business model innovation are relatively scarce. Hence, we aim for the design of an IT tool to enable and facilitate data-driven business model innovation. To reach the research objective, we employ a design science research approach accompanied by an experimental evaluation design. In this research, we propose four design features for IT tools supporting data-driven business model innovation.

Keywords: digital transformation, business model innovation, data-driven business model, business model tool, design science research

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1 Introduction

We are living in the data economy, where almost all aspects of everyday life are increasingly digitized, and a plethora of data is stored for analysis and subsequent value generation. The emergence of new technologies leads to an exponential increase in available data (Spiekermann 2019). At the same time, advances in data analysis, data storage, data sharing, and computing power accelerate the rise of the data economy (Zuboff 2019). The data economy depicts an economic perspective that understands data as an economic good with two primary purposes: the use and the trade of data (Bründl et al. 2015; Hüllmann et al. 2021). We focus on the use of data, where data is monetized by building a value chain around it (Spiekermann 2019). Consequently, data-driven business models are Business Models (BMs) that create value from data and data processing. Prominent sources of data include sensors, financial transactions, social media logs, or web-tracking. These data sources enable organizations to explore new data-based ways of creating value–ultimately allowing them to rethink and renew their traditional BMs toward data-driven BMs (Barann et al. 2019). However, innovating an organization's BM toward a data-driven BM is a nontrivial undertaking (Barann et al. 2019; Foss and Saebi 2018).

As a remedy, IT tools may facilitate the process of data-driven BM innovation (Bouwman et al. 2020). Fruhwirth et al. (2020) have already explored existing tools for ideating and evaluating data-driven BMs. Although various propositions (e.g., taxonomies, patterns, and visual tools) have been found in the literature, IT tools for supporting data-driven BM innovation remain scarce (Fruhwirth et al. 2020). IT tools can be useful for supporting BM innovation processes in many forms (e.g., Hermann et al. 2021; de Reuver et al. 2016; Spiekermann et al. 2018). However, creating value from data is fundamentally different from digital business models, which merely understand IT as an enabler. It remains unclear how a data-driven perspective can be integrated into such IT tools to provide meaningful support for creative tasks like data-driven BM innovation (cf. Fruhwirth et al. 2020; Szopinski et al. 2020). Hence, we address one research gap emphasized by Fruhwirth et al. (2020, p. 16) and aim to design "software tools as an IT support for developing, evaluating[,] and managing […] [data-driven BM innovation] based on information systems design methods."

To address this research gap, we employ the design science research methodology by Peffers et al. (2007), which is appropriate for addressing real-world problems in the area of digital business models. We use and enhance the literature review by Fruhwirth et al. (2020) and analyze existing contributions concerning the design of an IT tool to support data-driven BM innovation. Based on these insights, design features are articulated and transferred into mockups. These features are integrated on a conceptual level into an existing software tool previously developed by the focal research team. The next step is evaluating the design features regarding user satisfaction and how they support innovation and creativity during the ideation process. We contribute to both academia and practice. First, the design features extend the design knowledge with respect to IT tools supporting data-driven BM innovation. Second, practitioners gain a better understanding of the interplay between their BMs as well as the available and necessary data for data-driven BM innovation. The contributions are helpful for people collaborating on the design of data-driven business models.

2 Related Work

2.1 Data-driven Business Models

Data-driven innovation represents a significant shift away from traditional approaches to BM development, where technology is viewed primarily as an enabler rather than a source of value creation. Creating value from data requires a fundamentally different approach, one that goes beyond simply integrating IT systems and instead focuses on leveraging data as a strategic asset. In this respect, three different types of data-driven innovation can be distinguished (Barann et al. 2019). First, data can be utilized to improve the organization's business processes, which can enable subsequent innovation (Heberle et al. 2017; Schüritz and Satzger 2016; Sorescu 2017). Second, data-driven innovation may occur by enhancing individual BM components with data-driven aspects, e.g., product or service innovation (Heberle et al. 2017; Wiesböck and Hess 2020). Third, data-driven innovation can lead to entirely novel data-driven BMs (Barann et al. 2019; Schüritz and Satzger 2016; Sorescu 2017). Organizations no longer think of data as merely a by-product (Hess and Lamla 2019) but use it to invent new ways of value creation, which involve the generation, collection, storage, processing, search, analysis, and possibly the trade of data (Hartmann et al. 2016). The value generated by collecting

and processing data can be captured through novel products and services. Compared to traditional value chains, data scales up and never depletes (Shapiro and Varian 1999; Spiekermann 2019). Just how lucrative data as an economic good is, is being showcased by the financial success of major players (e.g., Google and Facebook) and start-ups that purely operate on data and deliver data-related products and services (Klein and Hüllmann 2018).

2.2 Tools for Data-driven Business Model Innovation

Recently, researchers have been focusing on data-driven BM innovation for incumbent organizations (Fruhwirth et al. 2020). In a comprehensive literature review, Fruhwirth et al. (2020) identified tools for ideating and evaluating data-driven BMs. Recurring types of contribution, among others, are taxonomies, frameworks, patterns, types, and visual tools (Fruhwirth et al. 2020). Taxonomies and frameworks support structuring and analyzing an organization's BM regarding existing key concepts of data-driven BMs (Fruhwirth et al. 2020; Hartmann et al. 2016). Patterns and types can help position an organization's BM and "serve as an inspiration and blueprint" (Hartmann et al. 2016, p. 1400) for data-driven BMs. "Visual tools mediate collaboration and support ideation for data-driven innovations" (Fruhwirth et al. 2020, p. 14).

Other contributions, which are underrepresented in the literature, are IT tools for data-driven BMs innovation (cf. Fruhwirth et al. 2020). IT tools have proven useful to support creative tasks in the context of innovating an organization's BM (Ebel et al. 2016; Osterwalder and Pigneur 2013; Veit et al. 2014). Furthermore, academia has proposed different design possibilities concerning IT tools for supporting BM innovation, i.e., BM development tools (e.g., Ebel et al. 2016; Schoormann et al. 2021; Szopinski et al. 2020). Szopinski et al. (2020) elaborated a taxonomy of 43 functions of BM development tools. These functions provide a useful template for designing IT-supported BM tools. However, digital BMs and data-driven BMs have a significant difference. A digital business model creates value through using (innovative) digital technologies. The means of production typically focus on software and information systems. Conversely, a data-driven BMs creates value through data and data processing (Spiekermann 2019). The means of production are not about software but statistics and data science. Key activities include collection, preprocessing, analysis, presentation of data. Since the key resources and activities

differ between BMs and data-driven BMs, BM tools are not very helpful for innovating an organization's business logic toward a data-driven BM (Fruhwirth et al. 2020). At the same, research on IT tools that support data-driven BM innovation is scarce. We address this lack and design an integrated IT tool for supporting data-driven BM ideation and evaluation.

3 Research Approach

We employ the design science research methodology by Peffers et al. (2007), which is suitable for tackling real-world design problems. Our research plan is visualized in Figure 1, with preliminary results and future research indicated by checkmarks and empty circles, respectively. In this paper, we derive design features from the literature for an IT tool supporting data-driven BM innovation. The IT tool extends an existing tool that has been developed by the focal research team. The design features are conceptualized and visualized as mock-ups. In follow-up work, the features shall be implemented as a software prototype, iteratively improved by feedback retrieved through focus groups. Afterward, the prototype shall be evaluated in a laboratory experiment as an artificial evaluation episode (cf. Venable et al. 2016). Finally, a naturalistic evaluation period shall test the prototype in digital innovation projects with small and medium-sized enterprises (SMEs) (cf. Venable et al. 2016).

To better inform our design science research plan, we opt for identifying the state of the art of data-driven BM tools. Thus, we perform a systematic literature review that extends the results by Fruhwirth et al. (2020) from May 2019. Our literature review methodology follows the recommendations by Webster and Watson (2002) and vom Brocke et al. (2009, 2015). We update the set of relevant articles within the time frame from early 2019 until October 2021 (see Appendix). The search string is adopted from Fruhwirth et al. (2020) and queried in the AIS Electronic Library, IEEE Xplore, Science Direct, Scopus, and Web of Science. For Google Scholar, a simplified search string ("data-driven business model") is used. The articles are filtered according to literature valuation by Fruhwirth et al. (2020) and extended by a forward and backward search (Webster and Watson 2002). Based on the literature review, three researchers elaborated the design features for the intended IT-supported data-driven BM tool within four workshops. More specifically, the researchers jointly analyzed the literature to abstract recurring tool concepts into design knowledge for data-driven BM tools and, afterward, derive design features.

Thereby, the resulting design features had to comply with two meta-requirements: First, potential features should support the ideation or evaluation of data-driven BM innovations. Second, potential features should integrate well into the existing concept of the already implemented IT tool.

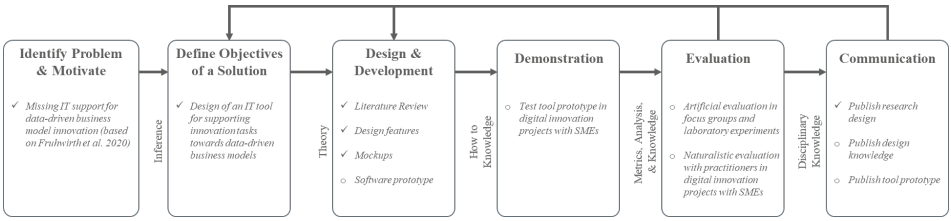

Figure 1: Research Approach adapted from Peffers et al. (2007)

4 Designing Tools for Data-driven Business Models

4.1 Initial Artifact

Following the objective to extend the existing IT-supported BM tool by Hermann et al. (2021) with a data-driven perspective, this section gives an overview of the initial tool's logic and composition. PlanDigital has been developed in the course of multiple small-scale digital innovation projects in SMEs. PlanDigital integrates three selected BM tool concepts into one comprehensive toolset, i.e., a roadmapping tool, a BM documentation tool, and a tool for documenting company goals. The roadmapping tool can be considered the tool's nexus, connecting the two other tools. On a roadmap, the user can orchestrate new BM innovation ideas along four time ranges: as-is, short-term, mid-term, and long-term. The continuous implementation of new ideas brings along changes to (components of) a company's BM. To depict such changes, the user can model explicit links between innovation ideas on the roadmap and affected BM components. Moreover, PlanDigital lets users document various versions of a company's BM. Besides the effects on a company's BM, digitalization ideas are ultimately meant to contribute to the company goals. Company goals describe contextual boundaries that new ideas must adhere to. PlanDigital provides features to define company goals and assign new ideas from the roadmap to the fulfillment of those. These core features of PlanDigital are implemented as two different modes, i.e., (1) an explorative, single

page dashboard-like view and (2) a stepper view that navigates the user in a wizard-like fashion.

4.2 Data-driven Design Features

In our literature review, we found additional 40 articles. With the 33 articles already identified by Fruhwirth et al. (2020), in sum, 73 articles are considered relevant for our research objective (see appendix for further details). Despite numerous articles published only in the past two years, the results reflect previous findings by Fruhwirth et al. (2020). First, there is an imbalance between tools supporting ideation and those supporting idea evaluation tasks. Second, while most types of contributions are somewhat equally distributed in the literature, IT tools are again underrepresented. Next, we present new features that are planned to be integrated into the *Data Innovation Explorer* to enable and facilitate data-driven BM innovations (see Figure 2). Data-driven BM innovation needs to consider different perspectives, such as data (DF1) and business (DF2) while incorporating the temporal dynamics (DF3). DF4 brings everything together in an overview with best practices.

1. **Describe and assess the potential of available data sources:** According to the initial version of the software tool (cf. Section 4.1), every digital innovation is connected to an enabling technology. Those innovation-technology combinations continuously generate data available for new data-driven innovations. Since BM elements are explicitly linked to digital innovations (cf. Section 4.1), each element is, in turn, linked to those available data. Thus, existing data sources can be visualized for the various BM components. To include the underlying data in developing new data-driven innovation ideas, the *Data Innovation Explorer* integrates features that enable the description and assessment of existing sources. Such sources are depicted in the form of a dedicated data potentials profile. The profile reports on data origin (e.g., Hunke et al. 2019), data format (e.g., Kronsbein and Mueller 2019), source technology (e.g., Rizk et al. 2018), data entity (e.g., Weking et al. 2020), and data quality (e.g., Kühne and Böhmann 2019).

2. **Document data requirements and relevant capabilities for new data-driven innovation ideas:** It is usually more cost-effective for organizations to exploit the current resource base instead of starting on the green field.

Therefore, the *Data Innovation Explorer* integrates features for evaluating the gap between available and required data and capabilities, following a bottom-up approach for generating new data-driven innovation ideas (Barann et al. 2019). The *Data Innovation Explorer* visualizes the gap between existing and required data regarding the dimensions data origin, data format, source technology, data entity, and data quality (e.g., Kayabay et al. 2022). A green color indicates a match, and a red color highlights a gap. For every new idea, the *Data Innovation Explorer* shows which data sources are considered for assessing the (mis-)match.

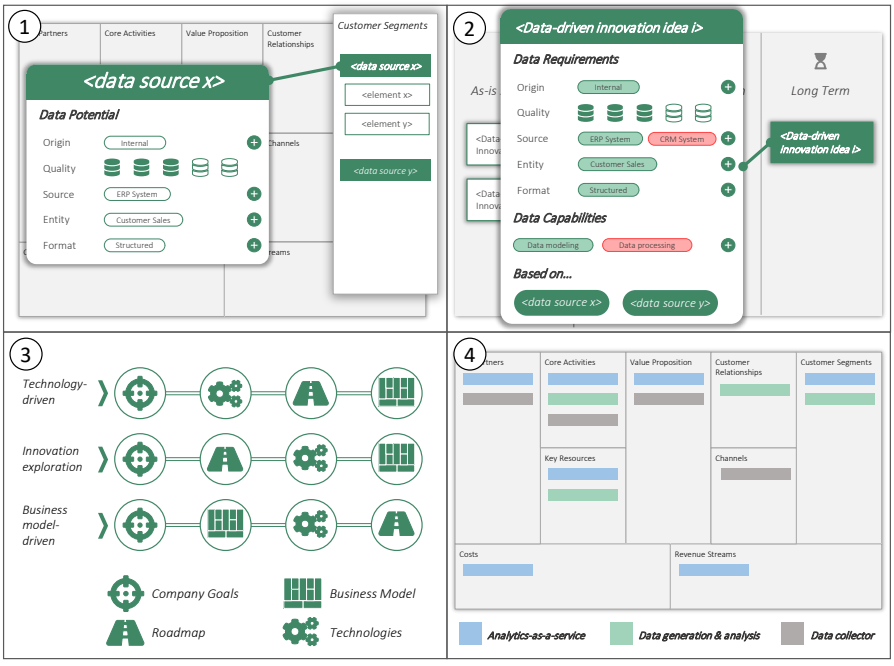

Figure 2: Mock-ups of the Design Features
Source: Own

3. **Enable different entry points for defining data-driven innovation ideas:** To account for the dynamics of creative ideation processes (cf. Section 2.2), the *Data Innovation Explorer* offers three different paths for the generation of new data-driven ideas: idea generation may be technology-driven, BM-driven, or driven by innovation exploration (e.g., Rashed and

Drews 2021). This feature is integrated into the *Data Innovation Explorer* by pre-configuring the stepper-view (cf. Section 4.1). For instance, if idea generation follows a technology-driven approach, existing technologies are documented and analyzed early in the process, that is, immediately after defining company goals. Defining company goals is fixed as the first activity to set the contextual boundaries of the innovation process (e.g., Benta et al. 2017).

4. **Provide templates of best practice data-driven BMs:** Since the generation of data-driven innovation ideas is a creative and non-routine process, the *Data Innovation Explorer* integrates a collection of best practice data-driven BM types (e.g., Hartmann et al. 2016). Especially in early ideation activities, organizations benefit from overviews of best practices and pre-filled tools (e.g., Barann et al. 2019). The set of pre-filled canvases is thought of as a source of inspiration and orientation for developing data-driven BMs.

5 Evaluation

We plan to evaluate our prototype in an iterative two-phase process for the artificial evaluation phase. The first phase consists of developmental feedback for improving the prototype and is based on conducting focus group discussions. After polishing the prototype, we plan to implement a controlled laboratory experiment to quantify the outcomes of user satisfaction as well as creativity and innovation support.

5.1 Focus Group

Our approach to focus groups follows established methodological recommendations (Crossley 2002; Krueger and Casey 2015). Inviting up to ten experts with experience in digital transformation, data-driven BMs, and data analytics, we conduct a focus group session lasting about 1-2 hours. During this focus group session, we divide the group into two subgroups and devise a hypothetical scenario in which we describe an existing business. The groups are assigned the task to develop and flesh out a data-driven BM based on the description of the business and using the tool's various perspectives and features. The data-driven BM should incorporate the existing technologies and capabilities and propose

a mechanism for generating and capturing value. A guide is assigned to each group to help and advise concerning the tool's features or the task's peculiarities. Then, the groups are pooled, and in a focus discussion with all participants, further feedback is gathered and discussed. The discussion is recorded, transcribed, and coded (Kuckartz 2014; Saldaña 2015). The research team derives insights regarding the design features from the coded results and adapts the design and implementation of the tool accordingly.

5.2 Experiment

After implementing the suggested changes derived from the focus group discussion, we set up an experiment. We adapt the same scenario that is used in the focus groups, making changes as necessary to reflect updates in the tool. Participants (n=50) work in groups of five for about 2-3 hours. They develop and flesh out a data-driven BM based on the description of the business according to the scenario depicted before. The experiment follows the randomized controlled trial protocol (Schulz et al. 2010) and randomly allocates the groups to a treatment or control intervention, equally distributed. The treatment groups make use of the newly implemented version of the tool. In contrast, the control groups use the initial artifact of the tool that does not have any specific features supporting data-driven BM innovation. We record important control variables such as age, gender, colocation, and job role, to account for confounding effects (Maier, Laumer, Tarafdar, et al. 2021; Maier, Laumer, Thatcher, et al. 2021). The outcome variables are user satisfaction and innovation & creativity support, collected through a survey instrument. For user satisfaction, we adapt the SUS user satisfaction scale by Brooke (1996), which has been empirically validated extensively (Bangor et al. 2008; Borsci et al. 2015). For innovation and creativity support, we aggregate and adapt the scales from Lukes and Stephan (2017), Janssen (2000), and Zhou and George (2001). We further model an interaction effect for IT affinity towards both user satisfaction and creativity and innovation support. The hypothesized model is illustrated in Figure 3. We estimate the model using SEM-CB, which is adequate for exploring causal inferences from survey data (Bollen and Pearl 2013). Since the participants are assigned to groups, we model unobserved group effects by adding a group fixed effect.

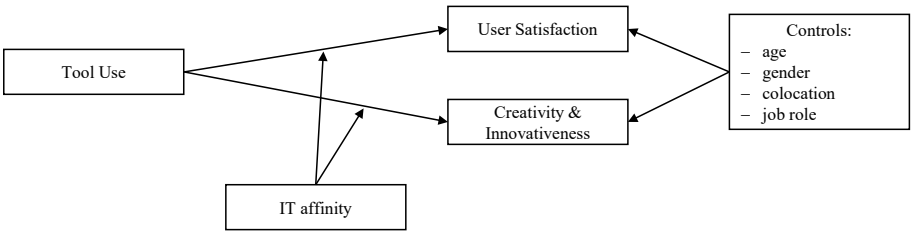

Figure 3: Hypothesized Evaluation Model
Source: Own

Follow-up interviews provide qualitative insights into how the participants experienced working with the tool. Drawing upon the quantitative and qualitative results, we conclude about the effectiveness of the designed and implemented prototype regarding user satisfaction and its effect on supporting creativity and innovation for developing data-driven BMs. Furthermore, we identify further potential for improvement left for the natural evaluation episode.

6 Concluding Remarks

The ideation phase of the BM innovation process has received considerable attention in academic literature (Foss and Saebi 2018). Recently, scholars have focused on the emerging sub-domain of data-driven BM innovation (Fruhwirth et al. 2020). While there are many tools for supporting the ideation of digital BM innovations, tools for supporting data-driven BM innovation are scarce and only lately being designed and developed (Fruhwirth et al. 2020). In this paper, we use the literature review by Fruhwirth et al. (2020) to derive four core features of IT-supported data-driven BM innovation tools that can be integrated into PlanDigital: (1) describe and assess existing data potential, (2) document data requirements and relevant capabilities, (3) enable different entry points for data-driven innovation, and (4) provide templates of best practice data-driven BMs.

The *Data Innovation Explorer* shall increase the effectiveness of the data-driven BM innovation process and lead to higher success rates in developing new data-driven BMs compared to using no such tool. Until today, we have developed a conceptual design for the *Data Innovation Explorer*, comprising a definition and graphical representation of the four features. Therefore, the effectiveness of the *Data*

Innovation Explorer has not been proven yet. Following Venable et al. (2016), we intend to evaluate a prototype in an artificial evaluation episode by conducting focus groups and a laboratory experiment. With the experiment, we estimate how the prototype improves user satisfaction and supports creativity and innovation. Finally, rather than proposing a new tool to support data-driven BM innovation, we integrate propositions from the literature into an already existing IT solution to ultimately help practitioners in ideating and evaluating new data-driven BMs.

The limitations of our study include that the prototype is in development but not yet finalized. Consequently, the design is conceptual and has not been empirically evaluated yet. Since there are no comparable data-driven BM tools available, there will be no baseline to compare the evaluation results. Although the scientific risk includes the possibility of negative evaluation, the *Data Innovation Explorer* builds upon a previous iteration of PlanDigital which was positively evaluated. Furthermore, the *Data Innovation Explorer* builds upon standard frameworks and packages. By building the tool, design knowledge about data-driven BM tools is generated. The evaluation of the *Data Innovation Explorer* generates theoretical insights about the success factors of data-driven BMs and their components.

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Appendix

Table 1: Identified Artefacts in the Literature Review

Title	Author	Outlet	Fruhwirth et al. (2020)	Design Feature (DF)
A Simple Tool to Start Making Decisions with the Help of AI	Agrawal et al. 2018	Harvard Business Review	X	4
Process Model for Data-Driven Business Model Generation	Benta et al. 2017	21st International Conference on Engineering Design	X	1 & 2
Towards a Taxonomy of Digital Business Models - Conceptual Dimensions and Empirical Illustrations	Bock and Wiener 2017	38th International Conference on Information Systems	X	1
Mapping Business Model Risk Factors	Brillinger 2018	International Journal of Innovation Management	X	2
Data and Analytics - Data-Driven Business Models - A Blueprint for Innovation	Brownlow et al. 2015	Working Paper	X	2 & 3
Capturing Value from Data - Exploring Factors Influencing Revenue Model Design for Data-Driven Services	Enders er al. 2019	14th International Conference on Wirtschaftsinformatik	X	2
Understanding The Anatomy Of Data Driven Business Models - Towards An Empirical Taxonomy	Engelbrecht et al. 2016	24th European Conference on Information Systems	X	1
Data-driven Business Model - A Methodology To Develop Smart Services	Exner et al. 2017	23rd International Conference on Engineering, Technology and Innovation	X	2 & 4
Understanding the Role of Data for Innovating Business Models - A System Dynamics Perspective	Förster et al. 2019	14th International Conference on Wirtschaftsinformatik	X	3
Capturing Value From Big Data – A Taxonomy Of Data-Driven Business Models Used By Start-up Firms	Hartmann et al. 2016	International Journal of Operations & Production Management	X	1 & 4
Smartere Produkte durch analysebasierte Dienstleistungen – Ein methodisches Werkzeug zur strukturierten Entwicklung	Hunke and Schüritz 2021	IoT – Best Practices. Edition HMD. Springer Vieweg, Wiesbaden	X	3
Turning Data into Value: Towards an Ideation Tool for	Hunke and Wambsganß 2017	Karlsruhe Service Summit	X	3

Title	Author	Outlet	Fruhwirth et al. (2020)	Design Feature (DF)
Key Activities of Data-Driven Business Models				
Towards a Process Model for Data-Driven Business Model Innovation	Hunke et al. 2017	19th Conference on Business Informatics	X	3
Understanding the Anatomy of Analytics-Based Services - A Taxonomy to Conceptualize the Use of Data and Analytics in Service	Hunke et al. 2019	27th European Conference on Information Systems	X	1
Leveraging The Value Of Data-driven Services Systems In Manufacturing - A Graph-based Approach	Kammler, 2019	27th European Conference on Information Systems	X	1
Data Science as an Innovation Challenge. From Big Data to Value Proposition	Kayser, 2018	Technology Innovation Management Review	X	2 & 3
Data Thinking: A Canvas for Data-Driven Ideation Workshops	Kronsbein & Müller, 2019	52nd Hawaii International Conference on System Sciences	X	4
Requirements for Representing Data-Driven Business Models - Towards Extending the Business Model Canvas	Kühne & Böhmann, 2018	24th Americas Conference on Information Systems	X	2
Data-Driven Business Models - Building the Bridge Between Data and Value	Kühne & Böhmann, 2019	27th European Conference on Information Systems	X	1 & 2
Data-Need Fit – Towards Data-Driven Business Model Innovation	Mathis & Köbler, 2016	Service Design and Innovation Conference	X	1
The Data Value Map: A Framework for Developing Shared Understanding on Data Initiatives	Nagle & Sammon, 2017	25th European Conference on Information Systems	X	1 & 2
Towards a Taxonomy of Data-driven Digital Services	Rizk et al., 2018	51st Hawaii International Conference on System Sciences	X	4
Charting the Emerging Financial Services Ecosystem of Fintechs and Banks - Six Types of Data-Driven Business Models in the Fintech Sector	Schmidt et al., 2018	51st Hawaii International Conference on System Sciences	X	4
Patterns of Data-Infused Business Model Innovation	Schüritz & Satzger, 2016	18th Conference on Business Informatics	X	4

Title	Author	Outlet	Fruhwirth et al. (2020)	Design Feature (DF)
How To Cultivate Analytics Capabilities Within An Organisation - Design And Types Of Analytics Competency Centers	Schüritz et al., 2017	25th European Conference on Information Systems	X	2
Capturing Value from Data - Revenue Models for Data-Driven Services	Schüritz et al., 2017	50th Hawaii International Conference on System Sciences	X	4
A Metadata Model for Data Goods	Spiekermann et al., 2018	Multikonferenz Wirtschaftsinformatik	X	1
On the Utility of E-Health Business Model Design Patterns	Sprenger & Mettler, 2016	24th European Conference on Information Systems	X	4
Design, Implement, Repeat: Essays on Business Model Management in Offline-Born Organizations	Terrenghi, 2019	PhD Thesis	X	1
Data Value Assessment: Recognizing Data as an Enterprise Asset	Wixom & Markus, 2015	MIT CISR Research Briefing	X	2
Making Money from Data Wrapping: Insights from Product Managers	Wixom & Schüritz, 2018	MIT CISR Research Briefing	X	2
Business Model Transformation Patterns of Data-Driven Innovations	Zolnowski et al., 2016	24th European Conference on Information Systems	X	4
Towards a Cost-Benefit-Analysis of Data-Driven Business Models	Zolnowski et al., 2017	13. Internationale Tagung Wirtschaftsinformatik	X	1
Archetypes For Data-driven Business Models For Manufacturing Companies In Industry 4.0	Müller & Buliga, 2019	40th International Conference on Information Systems, Special Interest Group on Big Data Proceedings		4
DDI: A Novel Technology And Innovation Model For Dependable, Collaborative And Autonomous Systems	Armengaud et al., 2021	Design, Automation & Test in Europe Conference & Exhibition		3
Decision Framework for Engaging Cloud-Based Big Data Analytics Vendors	Ayaburi et al., 2020	Journal of Cases on Information Technology		1
A Taxonomy for Data-Driven Services in Manufacturing Industries	Azkan et al., 2020	24th Pacific Asia Conference on Information Systems		1 & 2
Accountable Algorithms? The Ethical Implications Of Data-driven Business Models	Breidbach & Maglio, 2020	Journal of Service Management		2

Title	Author	Outlet	Fruhwirth et al. (2020)	Design Feature (DF)
The Data-Driven Business Value Matrix - A Classification Scheme for Data-Driven Business Models	Breitfuss et al., 2020	32nd Bled eConference Humanizing Technology for a Sustainable Society		3
AI-Enabled Business-model Innovation And Transformation In Industrial Ecosystems: A Framework, Model And Outline For Further Research	Burström et al., 2021	Journal of Business Research		4
Creating Value From Energy Data: A Practitioner's Perspective on Data-Driven Smart Energy Business Models	Chasin et al., 2020	Schmalenbach Business Review		4
What Makes A Data-driven Business Model? A Consolidated Taxonomy	Dehnert et al., 2021	29th European Conference on Information Systems		1 & 2
32 Ways to Innovate Business Models Through Data: Emerging Data-Driven Solution Business Model Patterns From a Study of 471 Late Stage Data-Driven Startups	Eber et al., 2021	54th Hawaii International Conference on System Sciences		4
A Systematic Mapping Study on Business Ecosystem Types	Faber et al., 2019	25th Americas Conference on Information Systems		2
The Data Product Canvas - A Visual Collaborative Tool for Designing Data-Driven Business Models	Fruhwirth et al., 2020	BLED		1 & 2
To Sell or Not to Sell_ Knowledge Risks in Data-Driven Business Models	Fruhwirth et al., 2019	Pre-ICIS SIGDSA (Symposium on Inspiring mindset for Innovation with Business Analytics and Data Science)		2
A Network-based Tool for Identifying Knowledge Risks in Data-driven Business Models	Fruhwirth et al., 2021	54th Hawaii International Conference on System Sciences		1
Applying Frameworks for Cognitive Services in IIoT	Gain, 2021	Journal of Systems Science and Systems Engineering		3
Developing Data Driven Business Models for Interactive Media Companies	Haaker et al., 2019	30th ISPIM Innovation Conference:		2

Title	Author	Outlet	Fruhwirth et al. (2020)	Design Feature (DF)
		Celebrating Innovation - 500 Years Since Da Vinci		
Please Tell Me What to Do – Towards a Guided Orchestration of Key Activities in Data-Rich Service Systems	Hunke et al., 2020	Designing for Digital Transformation. Co-Creating Services with Citizens and Industry. DESRIST 2020. Lecture Notes in Computer Science		1
Pathways from Data to Value: Identifying Strategic Archetypes of Analytics-Based Services	Hunke et al., 2020	Wirtschaftsinformatik (Zentrale Tracks)		4
The Role Of Analytics In Data-driven Business Models Of Multi-sided Platforms: An Exploration In The Food Industry	Isabelle et al., 2020	Technology Innovation Management Review		1
Data Science Roadmapping: An Architectural Framework For Facilitating Transformation Towards A Data-driven Organization	Kayabay et al., 2021	Technological Forecasting and Social Change		2
Realizing Value with Data and Analytics - A Structured Literature Review on Classification Approaches of Data-Driven Innovations	Kayser et al., 2021	54th Hawaii International Conference on System Sciences		2
Data Collection Map - A Canvas for Shared Data Awareness in Data-Driven Innovation Projects	Kayser et al., 2019	Pre-ICIS SIGDSA Symposium		1
Formative Evaluation of Data-Driven Business Models–The Data Insight Generator	Kühne & Böhmann, 2020	53rd Hawaii International Conference on System Sciences		1 & 2
Making Data Tangible for Data-driven Innovations in a Business Model Context	Kühne et al., 2019	25th Americas Conference on Information Systems		1
From Ideation to Realization - Essential Steps and Activities for Realizing Data-Driven Business Models	Lange & Drews, 2020	22nd Conference on Business Informatics		1
Business Model of Energy Big Data Service Based on Business Canvas Theory	Li et al., 2020	4th Conference on Energy Internet and Energy System Integration		4

Title	Author	Outlet	Fruhwirth et al. (2020)	Design Feature (DF)
A Data-driven Reversible Framework For Achieving Sustainable Smart Product Service Systems	Li et al., 2021	Journal of Cleaner Production		3
Operationalizing Business Model Innovation through Big Data Analytics for Sustainable Organizations	Minatogawa et al., 2019	Sustainability		2
Data-driven Business Models in Logistics: A Taxonomy of Optimization and Visibility Services	Möller et al., 2020	53rd Hawaii International Conference on System Sciences		1 & 2
Trading Social Visibility for Economic Amenability: Data-based Value Translation on a "Health and Fitness Platform"	Ochs et al., 2021	Science, Technology, & Human Values		2
Pathways Of Data-driven Business Model Design And Realization - A Qualitative Research Study	Rashed & Drews, 2021	54th Hawaii International Conference on System Sciences		3
How Does Enterprise Architecture Support the Design and Realization of Data-Driven Business Models? An Empirical Study	Rashed & Drews, 2021	International Conference on Wirtschaftsinformatik		3
Implications of Service-related Business Models on Product Development Processes	Riesener et al., 2019	26th CIRP Conference on Life Cycle Engineering		2
Big Data Business Models: Challenges And Opportunities	Schroeder, 2016	Cogent Social Sciences		1
How AI Capabilities Enable Business Model Innovation - Scaling AI Through Co-evolutionary Processes And Feedback Loops	Sjödin et al., 2021	Journal of Business Research		3
Redesigning Business Models For Data-driven Innovation: A Three Layered Framework	Troisi et al., 2020	Research and Innovation Forum		3
Industrial Data-Driven Business Models- Towards a Goods-Service-Data Continuum	Voigt et al., 2021	Book Section		1 & 2
Leveraging Industry 4.0 - A Business Model Pattern Framework	Weking et al., 2020	International Journal of Production Economics		4
Opportunity Complementarity in Data-Driven Business Models	Xu et al., 2020	Journal of Business Models		4

Title	Author	Outlet	Fruhwirth et al. (2020)	Design Feature (DF)
Innovation Capabilities As A Mediator Between Big Data And Business Model	Ylijoki et al., 2018	Journal of Enterprise Transformation		1