Towards a Cost-Benefit-Analysis of Data-Driven Business Models

Andreas Zolnowski[1], Jürgen Anke[2], and Jan Gudat[3]

[1] Universität Hamburg, Germany
`andreas.zolnowski@uni-hamburg.de`
[2] Hochschule für Telekommunikation Leipzig, Germany
`anke@hft-leipzig.de`
[3] Capgemini Deutschland Holding GmbH, Germany
`jan.gudat@capgemini.com`

Abstract. The emergence of data-driven business models calls for their systematic design and evaluation. In this paper, we focus on a first step towards a Cost-Benefit-Analysis of data-driven business models. Within data-driven business models, data act as enabler for the development of innovative services. However, to justify internal funding of new services, an assessment of the financial impact for the service at hand is often required. We approach this by identifying drivers of cost and benefit based on the Service Business Model Canvases of twenty cases. Based on the results, all drivers and their associated models for quantification were consolidated into a single meta-model. With this, we provide a basis for the economic assessment of service ideas and their refinement during the design process.

Keywords: Data-driven Business Models, Profitability, Service Engineering, Cost-Benefit-Analysis, Smart Services

1 Introduction

Many services have been proposed to transform product-oriented into service-oriented businesses [1, 2]. To systematically design and communicate ideas for new service business models, the Service Business Model Canvas (SBMC) has been proposed by Zolnowski [3]. With the ongoing digitization of service delivery processes, a new class of data-driven services has emerged [4]. While the SBMC is not restricted to data-driven services, it obviously can be used for this purpose as well.

One of the key characteristics of component based business model representations [5], like the Business Model Canvas (BMC) [6] or the SBMC [3], is their qualitative nature, which is very suitable for developing and refining the business logic of an idea [3, 7]. However, to justify internal funding of service engineering initiatives, an assessment of the financial impact for the planned service is required. To this end, various cost items for service provision have to be considered as well as savings through process improvements and revenues through additional offers to customers. Assessing these factors in early stages is challenging but helpful for decision making.

In this paper, we develop a concept for the quantification of data-driven business models (DDBMs). For this, we provide a basis for the economic assessment of service ideas and their refinement during the design process. Hence, we answer the question "What factors need to be considered in a Cost-Benefit-Analysis of a data-driven business model?" To answer this question, we analyze twenty case studies to identify factors that are relevant to describe and evaluate business models. Based on the results, all factors and their associated models for quantification were consolidated into a single meta-model. With this, we strive to improve the overall service design process in practice.

Within this contribution, we focus on a refinement and assessment of business model ideas but do not address the issues of finding a good value proposition, price model or partners. However, with our integrated model, we can support showing the (financial) impact of the design decisions made in the SBMC.
Furthermore, we acknowledge the relevance and importance of non-financial benefits [8-10], especially for innovative offers such as data-driven services. However, in this paper we focus explicitly on the financial dependencies in a DDBM.

The paper is structured as follows. Firstly, we introduce our conceptual foundations with regard to a DDBM. Then we explain the research methodology and introduce the applied case studies. This is followed by the results of the analysis of the cases. Thereupon, a cost-benefit analysis model for a DDBM is proposed and discussed. The paper ends with a conclusion and an outlook.

2 Conceptual Foundation

2.1 Service Business Models

Considering business models, there is a variety of different understandings and definitions [3, 7, 11]. Due to the lack of definitional clarity, alternative conceptualizations of business models exist (e.g. [12-14]) that result in conceptual diversity like a variety of ontologies and representations. Common ontologies for business models are e3-value Ontology [15] and the Business Model Ontology [16]. Representations can be distinguished in two research streams. The first research stream comprises a more flow-oriented perspective on business models. A prominent example for this stream is the e3-Value method [15]. The second research stream comprises a system-level holistic view on the business logic of an economic entity or offering [7]. The most prominent example for this stream is the (BMC) [6].

Fostered by a service based change in value creation [17, 18], business models are also discussed in service research [3, 19, 20]. Service business models are different from product based business models because of the specific characteristics of service. In general, service is a process between interacting parties for the benefit of another party. Especially, the interaction is of high relevance. Known as value co-creation, it is one key aspect of service [18, 21]. Additionally, service value has a unique and phenomenological character [18, 22]. Furthermore, the interaction of service results in

a mutual integration of resources and activities. Possible resources that have to be integrated are e.g. skills, knowledge, physical resources and decisions [23, 24].

Because of their specific characteristics, representations for service business models differ from representations for traditional business models [3, 25]. One service specific business model representation is the SBMC. The SBMC highlights the integration of different actors within a service business model and thus, allows focusing on the strategic relevant co-creation in the business logic of service-based business models. As overall logic, the SMBC focuses on the contribution to and benefit of each actor. This logic is applied in the seven dimensions value proposition, relationship, channels, revenue stream, key resources, key activities, and cost structure. In the dimensions customer and key partners, the different actors are defined [3]. The SBMC is displayed in **Figure 1**.

	Customer Customers in the business model						
Customer perspective	Costs borne by customers	Resources provided by customers	Activities carried out by customers	Value proposition for customers	Contribution of customers to maintain the relationship	Channels provided by customers	Revenues captured by customers
Company perspective	**Cost Structure** Costs borne by the focal company	**Key Resources** Resources provided by the focal company	**Key Activities** Activities carried out by the focal company	**Value Proposition** Value propositions of the focal company	**Relationship** Contribution of the focal company to maintain the relationship	**Channels** Channels provided by the focal company	**Revenue Streams** Revenues captured by the focal company
Partner perspective	Costs borne by partners	Resources provided by partners	Activities carried out by partners	Value propositions for partners	Contribution of partners to maintain the relationship	Channels provided by partners	Revenues captured by partners
	Key Partner Partners in the business model						

Figure 1: Service Business Model Canvas [3]

2.2   Data-driven Services

Based on the service oriented paradigm new services like data-as-a-service or analytics-as-a-service emerge [26, 27]. Within DDBM, data act as enabler of such innovative services. With enabling technologies, like sensor technology and cloud computing, companies can exploit data from and about their customers. In their own environment companies get enabled to generate new profitable know-how based services [28, 29].

Requiring such new technologies Veit et al. [30] state that "a business model is digital if changes in digital technologies trigger fundamental changes in the way business is carried out and revenues are generated." The BITKOM [31] quotes in their report a similar definition whereupon business models are digital if changes of digital technologies do have fundamental consequences for the business processes and the revenues of the company.

According to Hartmann et al., DDBM is defined as "a business model that relies on data as a key resource" [26]. Brownlow et al. [32] similarly state that "data is

obviously fundamental to a DDBM" and Bulger et al. [33] agree, that "data should be central to the business." These definitions are rather simple and differentiate business models on their use of data or not. A more complex perspective on DDBM is proposed by Schüritz and Satzger [4]. According to this, there is no DDBM per se; rather, there is a continuum of options how to provide data-driven service. Hence, there is a smooth transition between business models that use little data and those that enrich all areas of its business model with data analysis [4]. Thereby existing data or new data can be used to either create new business models or enhance existing ones [31]. In the latter case either the value creation, the value proposition or the value capturing or combinations of these can be enhanced by data [4]. For the purpose of our research, a complex differentiation of DDBM is not necessary. Thus, we chose to define DDBM according to Hartmann et al. [26].

The most relevant aspect during the design of a DDBM is the value that should be attained by the data analysis. Hence, the why and how [33] need to be examined. This includes defining the used data. For this purpose, Mathis und Köbler [34] developed a data canvas. The canvas distinguishes between batch and stream as well as internal and external data. Internal stream data do provide the most value since they allow a constant monetization and the data are accessible at any time without any restrictions" [34]. However, to be able to exploit the analysis potential data needs to be well integrated into the business model [33].

2.3   Cost-Benefit Analysis

To make the decision if to invest in a project, a Cost-Benefit-Analysis (CBA) can be performed [35, 36]. A CBA is an established tool for assessing the economic benefit of an investment. As such, it can support decision making on whether a service provider should proceed with the engineering and implementation of a new data-driven business model or not [35, 36]. Due to the complexity of service [37], a systematic capture and analysis of CBA-related factors is a desirable goal. To facilitate end-to-end engineering of smart services, we propose to enrich the qualitative perspective of component based business model representations, in particular the SBMC, with quantitative information. Existing work dealing with business models do not provide means for quantification. Moreover, currently profitability modelling does not include the customer perspective in detail.

One example of a method for assessing data-driven services for connected products was proposed by Anke and Krenge [38]. They propose a meta-model for "Smart Services" from which a business case is derived during the modelling process. In their work "Smart Services" are understood as digitally provided services for connected products. Therefore, "Smart Services" are data-driven services that rely on data which is at least partly provided from connected products, i.e. the Internet of Things. While the meta-model of Anke and Krenge is not directly related to a business model, it provides a connection between service design and its financial evaluation. We therefore will use it as foundation for the concept presented in this paper, as we consider the data-driven business model that might consume data from sensors and the Internet of Things as well.

3 Methodology

In order to design a framework for early-stage profitability assessment, this research applies the following method: first, we identify quantifiable influence factors from a consolidated list of influence factors of digital services on service business models. This list was gained through a multiple case study [39], conducted by Zolnowski et al. [40]. The focus was placed on international companies that successfully developed and implemented successfully data-driven innovations.

The identified cases cover (1) the improvement of the customer orientation, (2) process optimization, (3) optimization of resource consumption, and (4) the collection of information to complement and accelerate decisions. In sum, twenty cases from seven industries were selected and analyzed. Thirteen cases were identified from data of a consulting company and seven cases were derived from literature and public information. The chosen cases cover data-driven innovation projects in different industries (see **Table 1**).

Table 1. Description of the analyzed cases

Companies	*Company description &* *Examples for implemented data-driven innovation projects*
Three automotive companies	**Two** German automotive manufacturers >70,000 employees (2014)
	One from the automotive parts industry >30,000 employees (2014)
	Project: Predictive Maintenance by expansion of sensors on assets; Optimization of processes by data integration
Seven manufacturing companies	**Three** German companies >6,000 employees **Two** German companies >63,000 employees **Two** American companies >80,000 employees
	Project: Predictive Maintenance by expansion of sensors on assets; Service innovation and use of Internet of Things; Optimization of processes by data-driven forecasting
Five logistics and transportation companies	**One** joint venture, 51-200 employees (2014)
	Four companies, 1800-5.000 employees (2014)
	Project: Coordination of infrastructure by real time data of players; Tracking of assets by expansion of sensors
Two retail companies	**One** German retail company >17,000 employees (2014)
	One Swiss food company >300,000 employees (2013)
	Project: Optimization of disposition by analysis of market data
One insurance Company	**One** American start-up, 201-500 employees
	Project: Product innovation in car insurance by use of Internet of Things
One energy company	**One** German electric utility company > 50,000 employees (2014)
	Project: Predictive Maintenance by expansion of sensors on assets
One telecommunication Company	**One** Swiss telecommunication provider >20,000 employees
	Project: Coordination of infrastructure by data of passenger traffic

The results of this work are shown in **Figure 2**. This figure shows the identified influence of data-driven innovation projects on the business models of the analyzed companies. The effects are symbolically illustrated by gray boxes and grouped if being similar with bold titles describing aggregated types of effects. Because of the networked character of a DDBM, all influences are differentiated according to their impact on customer, company, or partner. Thus, elements that have a direct influence on the customer, are classified to the customer perspective.

	Finance	Infrastructure		Value	Interface		Finance
	Cost Structure	*Key Ressources*	*Key Activities*	*Value Proposition*	*Relationship*	*Channels*	*Revenue Stream*
Customer Perspective	**positive** Reduction of internal costs / **negative** Acquisition and operating costs	**data** Use and allocation of data and systems / **material** Reduction of inventory personal and goods	**data** Monitoring and analysis of data and resulting actions / **others** Elimination of active requests	**infrastructure** Optimization of internal processes or resources / **relation to actors** Increasing own satisfaction / **relation to actors** Increasing customer satisfaction	**positive** Changing relationship to customer, partner or internal / **negative** Change of relationship	**data** Change of channels	**positive** Increase in sales
Company Perspective	**positive** Reduction of internal costs / **negative** Acquisition and operating costs	**data** Sensors, gadgets, data, and systems / **material** Reduction of inventory personal and goods	**data** Use of data and systems / **others** Elimination of active requests / **others** Optimizing the marketing	**infrastructure** Optimization of internal processes or resources / **relation to actors** Increasing customer satisfaction / **relation to actors** Development of new markets and new services	**positive** Control of employees, partner or customer / **positiv** Increasing customer, partner or internal satisfaction	**data** Change of channels	**positive** Sale of new services / **positive** Sale of data / **positive** Customer satisfaction
Partner Perspective	**positive** Reduction of internal costs / **negative** Acquisition and operating costs	**data** Use of data and systems / **material** Reduction of inventory personal and goods	**data** Monitoring and analysis / **data** Extension of sensors / **others** Elimination of active requests / **others** Optimizing the marketing	**infrastructure** Optimization of internal processes or resources / **relation to actors** Increasing sale because of customer satisfaction / **relation to actors** Loss of control	**positive** Changing relationship to company, customer or internal / **negative** Loss of control	**data** Change of channels	**positive** Sale of new service / **positive** Customer satisfaction / **negative** Loss of control
legend	**categoy** Effect	Identified effects on data-driven business models grouped by categories					

Figure 2: Identified effects of data-driven innovation projects [40]

In the next step, we analyzed the identified influence factors according to their quantitative or qualitative nature. This was necessary to identify those factors that have a quantitative influence on the costs and benefit of the DDBM. Based on this information, we were able to determine the influence factors for a CBA of a DDBM on an empirical basis. To summarize, the proposed CBA model adapted for the DDBM is developed in the following steps:

1. Categorization of quantitative influence factors from twenty case studies into cost, revenue and savings.
2. Development of a parameter set to simplify the capture of relevant inputs and derive the financial values for identified influence factors.
3. Integration of the parameter sets into an integrated meta-model, based on the meta-model proposed by Anke and Krenge [38].

The remainder of this paper is structured as follows: In section 4, we conduct step 1 and 2, while section 5 covers step 3 followed by a discussion of the results. The paper concludes with an outlook on further research questions.

4 Case Analysis

4.1 Identification and classification of CBA-related parameters

In our multiple case analysis, we were able to differentiate between qualitative and quantitative influence factors on the business models. Qualitative factors comprise effects like increasing customer satisfaction or change of relationship that cannot be translated directly to a countable metric. However, influence factors with a quantitative nature enable a direct analysis of countable and monetary consequences. These factors comprise effects like reduction of internal costs or sensors, gadgets, data, and systems. As already stated, we acknowledge the relevance and importance of non-financial benefits [8-10]. Nevertheless, in this paper we focus on quantitative influence factors and exclude qualitative influence factors intentionally. Within these factors we are able to distinguish between three classes of effects. In the following, we present the results of our multiple case analysis according to the identified classes (1) costs, (2) revenues, and (3) savings.

4.2 Costs

There are a variety of costs that can be directly related to the development and management of a DDBM. This includes all necessary preparation and the use of data and systems (including the influence factors different use of data and systems; monitoring and analysis of data, actions; and extension of sensors in the key activities and use and allocation of data and systems; sensors, gadgets, data, and systems; use of data and systems in the key resources). Especially in the development phase, the improvement or implementation of infrastructure is an important cost factor. For example, in a manufacturing case, customers have to implement remote services hardware in their machines to collect data and enable the connectivity between the customer's machines and the provider's servers. A driving force for the improvement or implementation of new infrastructure is the lack of sensors, actuators, and connectivity in older machines. Highly depending on the industry, these elements can already be part of an existing infrastructure or they need to be added. However, all three elements are enabling technologies for the DDBM. Sensors are necessary to

monitor machines and collect data. Connectivity establishes a link between the systems of the customer and provider to transmit the collected data, and actuators enable the provider to remotely take control or even change things automatically based on data. If relevant infrastructure is missing, companies having no or limited experience and are often surprised about the advancement in sensor technology. Off-the-shelf products can cost a few cents per sensor. Even equipping an existing product with an additional sensor can result in marginal extra costs. However, if customized sensors are required, development costs can reach several hundred thousand Euros.

Besides the infrastructure, specialized software can be necessary for a DDBM. As our cases show, such software can be developed, purchased, or leased. Alternatively, cloud services can be applied. According to the respective decision, in many cases the costs occur on-demand, recurring, or for the development of the software. Integrated in this software, algorithms enable the processing of the data. These algorithms can be highly individualized and need to be developed, maintained, and processed by the provider or other partners. This also applies to the resulting reports of this process.

To enable the whole DDBM, the connectivity between all actors and their infrastructure and software is of high relevance. According to the type of connectivity, e.g. permanently or recurring, the actors have to calculate with different pricing models.

According to our analysis, the influence of infrastructure, software, and connectivity have an important influence, with a direct effect on the focal company, the customer, and partner. Hence, in order to introduce a DDBM, invests into all factors are needed in the entire service system.

4.3 Revenues

As our cases show, in a DDBM, revenues can be enabled for any actor. From a company perspective, revenues can be generated from sales of new services and possibly also from the sale of data to third parties. Despite an existing relation to a customer, an increase in revenue is not mandatory with existing customer satisfaction. In our cases we were able to identify companies that establish completely new DDBMs that were offered to the customers. For example, a manufacturer facilitates higher safety standards by offering the tracking of tools in the maintenance process of the customer. This leads to an increase of responsibility through employees and avoids occurrence of abandoned tools.

But also customers and partners are enabled to generate additional revenues. By facilitating existing or enabling new processes, they can improve their existing or establish completely new business models. Target of these operations is to increase sales or to exploit economies of scale.

4.4 Savings

Beside of revenues, another positive economic effect are savings. In particular, the implementation of a DDBM allows for optimization of processes or reduction of assets, which both lead to lower costs by the reduction of inventory (key resources).

From a company's, partner's, and customer's perspective, DDBMs have direct influence on the operational processes. The processes can be optimized in a different manner. In one case, the provider gathered data about his and the customer's processes. Based on his knowledge, he was able to provide consulting services to his customer and to optimize his processes. Another case illustrated the elimination of active requests. Within this case, manual requests and process executions were replaced by automatized processes. This led to a reduction of operating costs.

Additionally, a reduction of inventory, personnel, and goods is possible. In particular, we observed a reduction of resources by an optimization of resource planning and hence, adjusted resource utilization.

5 A Cost-Benefit-Analysis Model for DDBM

5.1 Parameter Categories and financial quantification

In general, a CBA considers all costs and benefits to assess the economic value of an investment project. Cost refers to the financial effort required to build and operate a DDBM system. For all effects created by the investment project at hand, monetary values have to be assigned. Benefits can be either additional revenue or cost savings, e.g. through improved process efficiency. In the context of business models, we expect a CBA to support in experimentation and finding better solutions through an additional evaluation criterion. As a foundation for the CBA model, we use a series of payments, which contains the net cash effect per planning period.

As we take the perspective of the service provider, we build our model based on the quantitative factors of the focal firm identified in the previous section. The required elements and their relationships will be expressed as a UML class-diagram meta-model, which is why we use the terms class and attributes in the description below. The complete meta-model is shown in the next section.

Cost is already expressed in monetary values. However, it is usually difficult to estimate a total value. Therefore, we propose to break down cost into various more concrete items, which can be estimated with higher confidence. As we have identified cost items that are relevant for a DDBM, this helps to create a CBA model for these scenarios. We differentiate between one-time, recurring constant, and recurring-growing cost. For simplification, growth rates are fixed per period (see Table 2).

Table 2: Translation of costs into the capture model

SBMC Factor	*Capture Model*
Acquisition and operating costs	Operating costs are recurring, and can be both constant and growing. We use the `OperationCost` class to describe cost of various `CostTypes` and `PaymentIntervals`. For all costs related to the use of external services, such as weather info, messaging etc., we provide the `ServiceVariableCost` class. It relates to the `Functions` and their usage of `ExternalService`. `Functions` can also use `DataPoints` from connected `Devices`. As the latter are provided from connected products, these can be modeled as `Device` with attributes for `costPerMBTransfer`, `devicePrice`, `initialDeployment` and `growthPerYear`.
Sensors, gadgets, data and systems	Equipment of all kind has to be purchased (one-time cost), so type of equipment, price and quantity capture these cost. In the model, these are captured in the `InitialInvest` class.

Revenue is created by providing value to customers. It is also already expressed in monetary values. As with costs, we propose to break down revenue into more concrete offers with a single price. This helps decision makers to describe the service in a more specific way and see the impact of various configurations (see Table 3).

Table 3: Translation of revenues into the capture model

SBMC Factor	*Capture Model*
Sale of new services	An `Offer` can be modelled with a `offerName` and `price`, which can be interpreted as subscription or transaction-based price. The quantity is defined using the `CustomerDemand` class, which contains attributes for `customerGroupName`, `initialYear` and optional `growthRatePerYear`.
Sale of data	

Savings refer to reduction of cost at the service provider. They can be created through process efficiencies, reduction of stock, resource consumption etc. To quantify these effects, the internal organization of the service provider has to be known in great detail. However, this would increase the complexity of the CBA model greatly. Therefore, we propose to model savings as relative improvement to a certain level, which can be expressed by three simple parameters. In the following table, we list the identified SBMC parameters by category, and show how we quantify them. Please note, that the factor "Reduction of internal costs" is not explicitly mentioned, as it is covered by the four factors listed in the table (see Table 4).

Table 4: Translation of savings into the capture model

SBMC Factor	*Capture Model*
Reduction of inventory, personnel and goods	To quantify these effects, we use the Savings class, which can be instantiated for every relevant savings effect. It is modelled with the name of the factor, its `initialLevel` as monetary value and the `reductionInPercent` to capture the savings effect.
Elimination of active requests	
Optimizing the marketing	
Optimization of internal processes or resources	

5.2   Integrated Meta-Model

All factors and their associated models for quantification were consolidated into a single meta-model, which is depicted as a UML class diagram. Class diagrams are an established way of representing the structure of domains semi-formally. Classes represent entities and their attributes. Relations are expressed with associations, which can also be qualified with cardinalities to show how many instances of one class can be related to a certain number of the associated class.

Our integrated meta-model is depicted in **Figure 3** below. It adapts and extends the smart service and business case model proposed by Anke and Krenge [38]. All white classes are part of the quantification model described in the section above. The classes with grey a background are used to describe the basis for calculating the CBA. From the original model, we mainly reused the parts concerning the `DataPoints` from `Devices`, their usage in `Functions` which are subsequently bundled in `Offers`. Furthermore, the concept of `ExternalServices`, their usage as well as `Projects` were part of the original model. Our extensions are mainly related to `Savings`, the `SMBC_Factor` relation and `InitialInvest`. Also, the modelling of cost was extended to enhance flexibility.

The starting point is a `Project`, which contains a number of `planningYears`, a `name` and a derived attribute `financialResult`. It is calculated from a series of payments, which is represented by `ProjectYears`, which in turn contain derived attributes for `revenue`, `cost` and `savings`. Costs can either be manually specified `OperationCost` or automatically calculated using the class `ServiceVariableCost` for data transfer and external services. This only applies to services (Offers), which are modeled using `Functions`, `DataPoints`, `Devices` and `ExternalServices`.

For a concrete project, the meta-model has to be instantiated. The service designers start with a qualitative design of the DDBM in a SBMC. Each factor in the SMBC can

then be represented by either an Offer, Savings or Cost item. The quantification of each item is achieved through the parameters described in section 5.1.
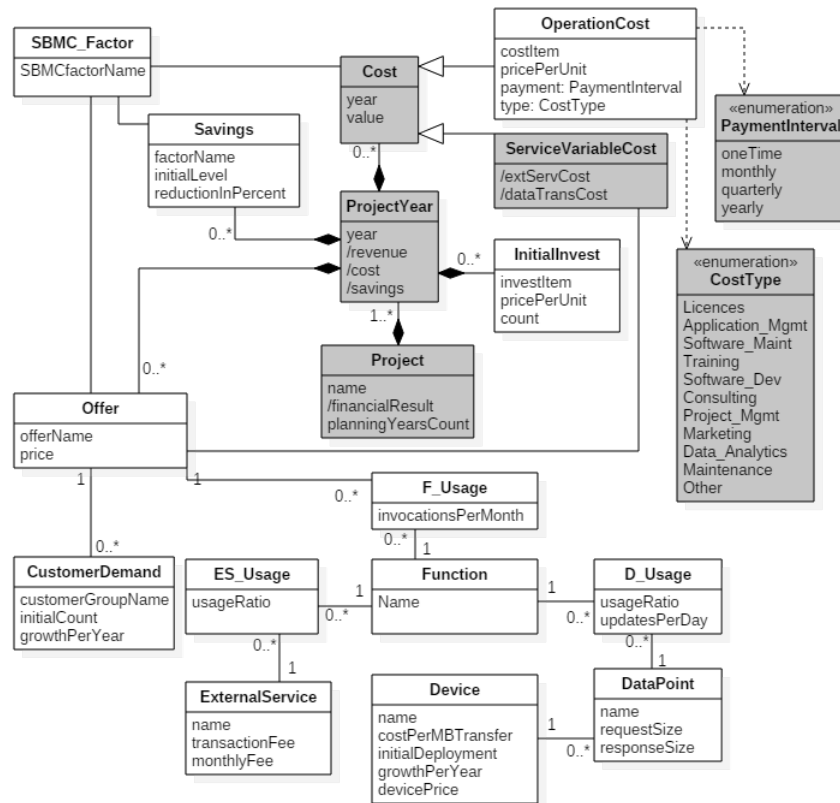

Figure 3: Integrated Meta-Model

5.3 Discussion

The high complexity and qualitative nature of service make it difficult to judge the financial impact of services, like of a DDBM, in early conception stages. While methods for financial decision making, like Net Present Value or Return on Investment, are well established, they are rather generic and not linked to the specific development of business models. Our proposed meta-model establishes links between the qualitative dimensions of the SBMC and main drivers of business value in a DDBM, i.e. new offers, savings and associated cost. To support the refinement of a SBMC, the model includes parameters (e.g. prices, costs and quantities), which are sufficiently detailed to allow for a first estimation during the design process. As these factors were derived from case studies focusing on data-driven innovation projects, our meta-model is designed to facilitate the development of a DDBM. This is expressed through dedicated elements that must be considered during the development.

In summary, an integrated meta-model divided into three states was derived. To apply this meta-model, firstly, a user has to develop a business idea and fill out a SBMC. Based on this information, a refinement of the business model with Cost-Benefit-Analysis related parameters has to be conducted. To allow an assessment of a DDBM innovation project, we propose concrete influence factors (see `CostTypes` and `PaymentIntervals`) that have to be considered in its specific CBA. In addition to the costs, we were able to derive potential savings and revenues in DDBM initiatives. Finally, a business case can be derived and decision can be taken, whether to proceed with the implementation of this service or not. To improve the creation and refinement of models as well to perform calculations, a software tool can be of great benefit. We see the development of the meta-model as a starting point to develop such a tool in the future.

6   Conclusion and Outlook

In this paper we propose a first step towards a Cost-Benefit-Analysis of data-driven business models and therewith address an important issue of companies in the field of existing service development and service engineering initiatives [35, 36]. We analyzed twenty case studies on data-driven innovation projects and derived influence factors that have an impact on a business model. A set of parameters was developed that allow identifying relevant inputs and deriving financial values for the included factors. As an extension of the existing smart service model [38], an integrated meta-model was derived that if being applied allows for the quantitative evaluation of a DDBM. This method enables decision makers to evaluate and calculate their business case for a data-driven innovation through refinement of a business model.

Our integrated meta-model provides a theoretical contribution as it helps researchers by fostering the understanding of financial dependencies in data-driven innovation processes towards new business models. By analyzing data-driven innovation projects, we were able to determine quantitative influence factors that have a direct monetary impact on a DDBM. Based on this knowledge, it is possible to create, shape, and improve tools and methods that foster service innovation and the design of a new DDBM. Practitioners can utilize these results in order to foster the development of data-driven innovations in their servitization efforts. Moreover, they can analyze different innovation projects in regard to their financial effects and thus, better intercept business potentials.

Nevertheless, also some limitations have to be considered. Firstly, this paper focuses on quantitative influence factors in the development of a new DDBM. This decision was made purposely and need to be addressed in further research. Hence, qualitative influence factors must be considered and their impact added to the meta-model. This includes qualitative criteria, such as improved customer satisfaction, loss of control, competitive advantage. The twenty case studies on data-driven innovation projects analyzed in this paper could be extended with new cases in further research.

Besides addressing these limitations, further research should focus on the practical application in a field experiment and/or lab experiment to evaluate the meta-model

and its benefits. Equations need to be developed allowing the computation of the overall benefit. Subsequently, instructions describing how to apply the meta-model in a concrete scenario could be developed.

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