Exploring Design Principles for a Business Model Mining Tool

Short Paper

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Abstract

Organizations increasingly need the ability to respond to ever-changing environments. Resulting transformations require organizations to possess a solid knowledge of the status-quo of existing business models to transform them towards future target models. However, business model creation in established frameworks is a manual, time-consuming, highly subjective and error-prone process. Following a design science approach, this short paper proposes the development of an artefact in form of a business model mining tool to overcome weaknesses of manual approaches to business model derivation by deriving business models from data stored within organizational information systems. This short paper further introduces a set of meta-requirements, design principles and a preliminary prototype such as enterprise resource planning systems. For the design and the evaluation of the artefact, an industry cooperation with a manufacturing corporation was formed to gain access to real-world data.

Keywords: Business Model, Business Model Mining, Business Model Canvas, Design Science, Development Tools.

Introduction

Increasing global competition and recent business opportunities enabled by a growing number of (digital) services force organizations to adapt their business models (BM) to the new environment (Teece 2010). Current developments such as globalization, the ubiquitous pressure for cost reductions, the need to reduce time-to-market, and technological innovations such as “big data” or the “internet of things” fundamentally change the boundary conditions for organizations. Such external shocks and unexpected changes in competitive conditions force companies to adapt their business model rapidly (Magretta 2002; Chesbrough 2007). Organizations have to rethink their traditional way of doing business (Piccinini et al. 2015) and increasingly engage into redesigning BMs to redefine the way value is created (Osterwalder, Pigneur (2010)). However, as described by Johnson et al. (2008) and Demil, Lecocq (2010), the transformation of BMs requires organizations to exhaustively capture the present state of their status-quo BM(s) for solid transformation decision-making.

However, current approaches to BM derivation, largely build on manual top-down procedures which are subject to several weaknesses. The current approaches suffer from drawbacks as they are time consuming, biased and often the unsuited people are invited. In general, deriving BM manually is a time-consuming process which does not fully exploit the potential given by the large pools of data stored in enterprise information systems (IS). Thus, the idea underlying this paper is to enrich current manual top-down approaches by bottom-up data-driven approaches. Modern organizations are largely driven by enterprise IS such as enterprise resource planning (ERP), business process management (BPM), business intelligence (BI), customer relationship management (CRM) or supply chain management (SCM) systems. As these systems store large amounts of information related to BMs, organizations possess large data pools which can be employed as data foundation for automatic bottom-up, data-driven mining of BMs. For example, ERP systems contain information about the BM dimensions by Osterwalder, Pigneur (2010) including customers, suppliers, resources, revenues, costs, or sales channels as well as business processes. Second, manual BM mining approaches likely yield BM representations which are highly subjective and biased. As the information in these approaches relies on top-down input from individuals, resulting BM representations might not be fully objective. Third, the subjectivity of BMs prohibits comparison of several BMs with each other. However, data-based BMs can increase the comparability between different models. In sum, these weaknesses of current approaches to BM derivation result in significant potential for improvement. Therefore, this research focuses on the following key research question:

Which design principles need to be followed to support business model mining from information systems to increase efficiency and effectiveness of status-quo business model creation?

By addressing this research question, we contribute to several research gaps as well as practical needs (Pagani 2013). To the best of our knowledge, this is the first contribution which proposes the development of a design science approach to develop a BM mining artefact to automatically create BMs from existing enterprise IS. Further, data-driven "de-facto" BM representations increase the organizational capability to transform BMs by providing well-funded analyses of large amounts of data in contrast to subjective perceptions by individuals. Furthermore, we contribute to the design knowledge base for building BM representation tools (Wirtz 2011).

One of the key dimensions of the BMC by Osterwalder (2004) are key activities by organizations. To mine key activities performed by the organization, we draw on process mining as a collection of techniques and algorithms to automatically detect business processes within transaction data stored in enterprise systems (e.g. van der Aalst et al. 2007; Li et al. 2008). Thus, our research will incorporate process mining as research stream to mine key activities, which we perceive as the main business processes executed by organizations.

To operationalize the idea, this paper consults research on approaches to BM representations such as the widely accepted "Business Model Canvas" by Osterwalder, Pigneur (2010) to derive the dimensions of the construct "business model" which need to be proxied by data from enterprise systems. The respective proxies which translate the dimensions of BMs into items which can be found and computed from data from IS are derived from BM and data mining literature.

The remainder of this paper is structured as follows: In section 0, we provide an overview of the related work. In section 0, we describe the design science research methodology to develop the BM mining artefact. Further, we derive meta-requirements and proxies for each dimension of BMs in section 4. In section 5, we provide a preliminary instantiation and a prototype developed based on the meta-requirements and proxies from section 4. Finally, we and provide a short summary and an outlook of future work.

Foundations and Related Work

This section introduces basic concepts of our work and introduces related literature of associated research. Following the introduction of key constructs, current tools and approaches to BM derivation are introduced.

The construct "business model" has been extensively researched in literature, with several authors such as Gordijn et al. (2000), Petrovic et al. (2001) or Veit et al. (2014) introducing own definitions. One possible candidate definition by Timmers (1998) perceives business models as

"an architecture for the product, service and information flows, including a description of the various business actors and their roles; and a description of the potential benefits for the various actors; and description of the sources of revenue".

To support the derivation of BMs, research developed a rich pageant of modelling methods, techniques and tools (Ebel et al. 2016). To visualize BMs, scholars developed more than twenty BM frameworks with different purposes and in different fields of study (Lambert 2010; Wirtz 2011). As a common feature, all of these frameworks have six key decision areas (Morris et al. 2005) and 17 different evaluation criteria for the classification of the BMs (Burkhart et al. 2011).

Among these, the most well-known visualization approach is the "Business Model Canvas" (BMC) by Alexander Osterwalder (2004). The BMC serves two key purposes. First, the BMC visualizes the current BM of a company in a standard and easy-to-use template along key dimensions such as key partners, activities, resources, value propositions, customer relationships, channels, customer segments, as well as cost structure and revenue streams. To support practitioners in using the BMC, Osterwalder, Pigneur (2010) provide a set of guideline questions for each field in the BMC. Therefore, the second purpose of the BMC is to provide a moderation method for the process of visualizing the BM and to serve as a basis for discussion for practitioners.

As a result of the development of the BMC, researchers add further dimensions to transform the flat canvas to a multidimensional cube. Thus, the categories of the BM canvas are rearranged in a way, that they reflect the interlinks and should inter alia support the management in implementing a strategy (Lindgren and Rasmussen, 2013). Practical tools using this BM cube are for example the "NEFFICS platform" (NEFFICS Platform | NEFFICS)or the tool of "VDMBee" (Value Management Platform - VDMbee). These tools use different views on the way of creating value, as there are for example role collaborations, activity networks or value proposition exchanges (NEFFICS Platform | NEFFICS). This reflects the logic, how the value is created, more detailed but also with more modelling effort (Lindgren, Rasmussen 2013). The developers of the tools see herein a chance to make the models more operational and connect different elements of the model (Value Management Platform - VDMbee). Next to these representations, specific representations focus on concrete branches or tasks and provide therefore a suitable representation (Peters et al. 2015). These representations are mostly suitable only for one specific task and therefore hard to generalize. However, these extensions and improvements come at the expense of easy and transparency, which is provided through a BM canvas (Osterwalder, Pigneur 2010).

The introduction of Osterwalders ontology for BMs in (Osterwalder 2004) and (Osterwalder, Pigneur 2010) provided a widely accepted visual representation for BMs. As in the past, the concept of the balanced scorecard was used for such long-term strategy implementations (Bourne et al. 2003; Speckbacher et al. 2003; Norreklit 2000), Osterwalder extends the four dimensions to nine dimensions in his BM Canvas (BMC) (Osterwalder 2004). The BM Canvas is often used in practice and therefore a suitable starting point for an improvement of BM in a way to make BMs more operationalize. The BM Canvas itself is very adequate to visualize a BM of a company and to show the way, how a company is generating value. The canvas contains nine categories as they are "Key Partners, Key Resources, Key Activities, Value Propositions, Channels, Customer Relationship, Customer Segments, Cost Structure and Revenue Streams". In the book "Business Model Generation" (2010) Alexander Osterwalder and Yves Pigneur claim, that the BM canvas can replace a business plan. Because of the high usability, many companies use this method.

He and other researchers also focus on ontologies to order relations between the BM elements (Osterwalder 2004; Osterwalder, Pigneur 2004; Osterwalder et al. 2005; Ilayperuma 2007). With his ontology, he prepares the way for a new way of business modelling, as his work is cited frequently (Lucassen et al. 2012). This reflects the logic, how the value is created, more detailed but also with more modelling effort (Lindgren, Rasmussen 2013). However, these approaches are mainly top-down approaches, as they focus mainly on strategic dimensions and the view of the decision makers (Osterwalder, Pigneur 2010). This is not a general limitation, but a transformation of a company needs a correct percepton of the current state as a solid starting point. However, these top-down views are not always objective. As a result, transformations are not always successful. In contrast, operational data gains a lot of information about how a an organization is actually pursuing organizational goals. This could help to find a correct BM of a company and improve the likelihood of a successful transformation. Furthermore, a bottom-up approach can save time, because modeling a BM is more time costly than just generate it from ERP data. Therefore, the bottom-up view should also be included. Through new technologies and possibilities like business intelligence and data mining, an existing top-down approach of Osterwalder can be extended (Veit et al. 2014).

Methodology

In order to design and develop the "Business Model Miner", which derives business models bottom-up from enterprise IS, we apply a Design Science Research (DSR) approach based on Vaishnavi, Kuechler (2015).

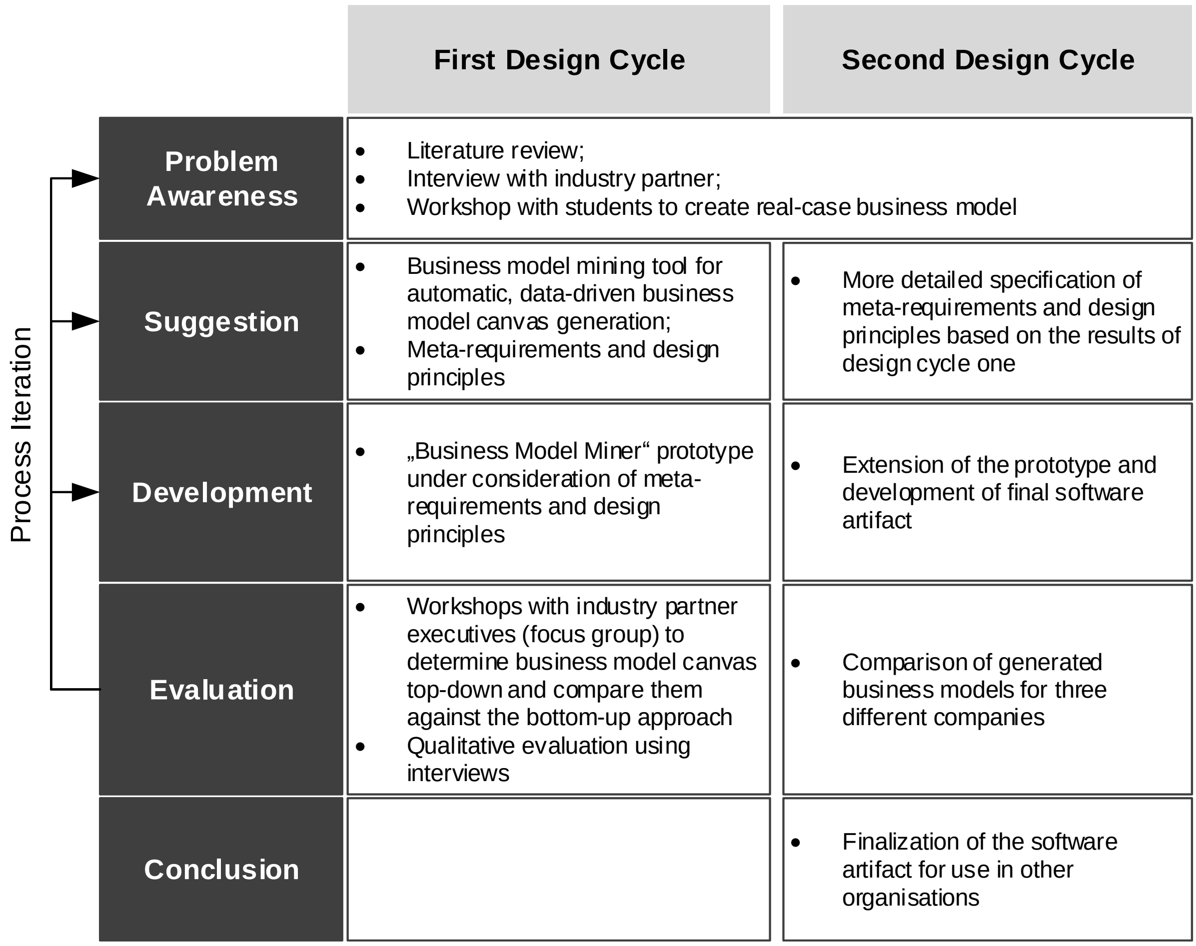

Figure 1. Design Science Research Cycles (according to Vaishnavi, Kuechler 2015)

We plan the DSR project according the proposal by Vaishnavi, Kuechler (2015) in design cycles as shown in Figure 1. Each design cycle consists of a problem awareness phase to determine the need for objective bottom-up derivation of BMs to overcome the weaknesses of currently prevailing approaches. In the problem awareness phase of cycle one we selected our business partners because of its' knowledge in BMs, for the access to real-world data and the possibility to evaluate the design artefact with real users in interviews and comparisons of the design artefact against manual derivations of BMs. The problem awareness phase was primarily conducted by consulting literature. However, we also plan to validate the practical need by leading interviews at the research sites of the industry partners and in workshops with students to create real-case BMs. The suggestion phase of cycle one provided a set of meta-requirements and a technical conceptualization of the tool to further concretize the idea of an automatic BM mining tool. Following the meta-requirements and the technical concept, we developed an initial prototype under the consideration of the meta-requirements. The evaluation phase of cycle one will be performed by conducting workshops with managers at the industry partners to derive BMs manually and compare them against BMs derived automatically using the design artefact. We further plan to conduct interviews to evaluate the artefact in dimensions such as quality, usability, efficiency, or efficacy (e.g. Venable et al. 2016). Thereby, we compare the automated BM Canvas with the BM Canvas, which was created by the BM specialists of our partner company. Thereby we will focus on how fast a BM will be created, how similar they are and compare it with reference models of other companies in the same branch. This will be some kind of benchmarking between different BMs. The goal is to prove that the BM Mining method can be helpful by finding the BM of a company.

Design cycle two will further concretize the practical and theoretical need for BM mining based on the learnings from the first cycle. In particular, based on the experiences made we want to lead an additional round of interviews and workshops to further improve the specification of the meta-requirements and design principles in the suggestion phase of cycle two. Therefore, we will use the insights of workshops, we have done before (e.g. Augenstein et al. 2016). The extended meta-requirements and experiences will be used in the enhancement of the prototype to a full software artefact for BM mining to realize a running version of the BM Miner. In the evaluation phase of cycle two, a further workshop-based evaluation of the software artefact will be conducted with managers from different companies to further compare the performance of the artefact in different companies in different industries. In addition, design cycle two also contains a conclusion with the distribution of the artefact to a relevant audience. The outcome of the project then will be both design knowledge about the creation and the functioning of the tool, as well as a running BM mining tool. Following the outline of the DSR project, we want to introduce the concepts in the following chapters.

Data

We decided to involve a real-life organization into our research and to collaborate with the IT service company of a large multinational manufacturing corporation consisting of several sub-companies. Thus, this research gains access to data from three SAP R/3 ERP systems. The industry partner provides the ability to retrieve BM data from the different tables within the ERP system plus the possibility to conduct interviews and surveys with experts across different departments. The manufacturing corporation is active in several industries and recorded a turnover of about 1bn Euro in 2014 with about 8.500 employees in more than 20 countries.

The statistical method will use the related data of the ERP system. Thereby information of the different ERP data will be used, for example for the "Key Partners" data from the suppliers will be used. In general, the categories "Customer Segments, Channels, Customer Relationships, Revenue Streams, Key Resources, Key Partnerships and Cost Structure" can be filled in easily. Therefore, we only have to consolidate the relevant data of the ERP system, as they are for example the suppliers' or customers' information. For the "Key Activities and the Value Proposition", mining algorithms are important, to find the relevant information for the business model. Thereby we focus on the different processes. This is similar in each company, because of course each company has processes. Having a look at the different processes, we define the most frequently executed processes as reference for key activities and value propositions. In general, we strongly follow the suggestions of Osterwalder, Pigneur (2010) how to fill in the BMC. So we make sure, that the automated BMC is similar to a BMC, which is filled out manually. This supports also a better comparability between the automated and non-automated model for a good evaluation.

To the best of our knowledge, we are the first study being able to perform BM mining on such data. As an advantage, the possibility for data triangulation with the different forms of qualitative and quantitative data, and the different data collection techniques including transaction data from ERP systems and interviews with different groups of people across the companies add validity to the contribution (e.g., Orlikowski 1993; Remus, Wiener 2010).

Conceptualization

In our exploratory interviews, we discovered that the use of the BMC is quite common in today's business. However, BMCs are not created objectively, but in a top-down approach, which is depending on the knowledge of the modeler. Existing research addresses challenges such as the formation and adaptation of BMs in different business areas (Veit et al. 2014). In general, it is very common in todays' companies to model a current state with the BM canvas (Osterwalder, Pigneur 2010). However, there is no evaluation step included. Therefore, companies do not know if their model is right and really reflecting the current way of how the organization executes business. Therefore, data from organizational information systems should be used. Due to the organization wide employment of information system such as resource planning (ERP), such data provides a comprehensive data source to mine objective data-driven BMs. Appropriate data thereby means that the included data is correct and only data is chosen, which provides detailed information about the actual value creation process. A key challenge in creating BMs from organizational information systems will be to identify appropriate data sources containing relevant information of the organizational BM. We address this in the first meta requirement (MR):

MR1: To enable bottom-up creation of a business model, appropriate data needs to be identified and accessed.

In conjunction with this MR1, comparability of results is very important. Especially for the evaluation, being able to compare a bottom-up with a top-down approach is very important. Furthermore, comparing different BMs, as for example a current and a target state BM in transformation phase is very important. A defined structure of the extracted data is contributing to the understandability for its users. Therefore, we address MR2:

MR2: To guarantee comparability of top-down and bottom-up business model creation approaches, extracted data should be structured in a unified way.

At the core of BM mining is the way how the data is represented. To reduce an information overload, the given information should be processed in a way such that the user has the necessary information in an aggregated form. Furthermore, the aggregated information should be organized along the structure of MR2. Therefore, we address MR3:

MR3: To report only relevant information, the collected data should be aggregated.

In order to realize BM mining, it is of specific importance to use appropriate data which reflects the logic of how a company is creating value. Additionally, it is important, that the data is correct and complete. To address meta-requirement MR1, we propose to use data from existing enterprise IS. This data is typically based on transactions and represents unbiased real world data. Therefore, we articulate the first design principle (DP):

DP1: To address the demand for appropriate data, existing raw data from enterprise IS should be extracted.

Next to using the appropriate data, the way it is structured is important as articulated in MR2. As the BM canvas is often used in practice and cited frequently (Lucassen et al. 2012), we found the BMC categories as an adequate structure for the proposed BM mining approach. Through this structure, users can find relevant information following the established BM canvas concept. Therefore, we articulate DP2:

DP2: To address the demand for a uniform structure, the business model canvas structure should be used.

Consolidating data is important to avoid information overload for users. Additionally, not all of the data can be captured by the model. As it is the aim of the BM canvas to give the user a fast and comprehensive overview about their BM (Osterwalder, Pigneur 2010), the extracted data should be consolidated. As criteria for this consolidation, the different categories of the BM canvas should be automatically filled out with aggregated information. This information can be achieved through leveraging calculation and aggregation procedures as part of the BM mining process. For example, key customer segments can be defined as a segment, with which a company gains most of revenue. Therefore, we articulate DP3:

DP3: To address the demand for relevant information, calculation and consolidation functions need to be provided.

Furthermore, data related to business models is distributed across different storage locations within information systems. Thus, the artefact needs to possess knowledge concerning which different tables need to be merged to gather relevant information of the business model. Thus, DP4 requires the artefact to provide proxies for how the dimensions of a business model can be retrieved, and to possess knowledge from which data sources and tables within the enterprise system the information can be retrieved.

DP4: To address the demand for relevant business model data retrieval, the artefact needs to possess a knowledge base on the sources of business model information, and a merging logics to recombine the information.

These four design principles contribute to an automatic creation of a BM. Reducing effort and increasing accuracy are the key two advantages of this approach. In the following section we show, how the proposed design principles can be instantiated.

Instantiation

The following section describes the technical concept of the artefact consisting of different layers and our initial prototype of the BM Miner. Figure 2 depicts the data flow from the enterprise IS to the final graphical representation using the BM canvas. In the enterprise IS layer, the raw data from the tables is downloaded and saved to .csv files in the export layer. All data tables are subsequently imported into a database in the database layer. The consolidation layer provides the fields in the BMC by computing the proxies via SQL queries. Finally, the visualization layer provides a graphical user interface which is structured identically to the BMC by (Osterwalder and Pigneur, 2010).

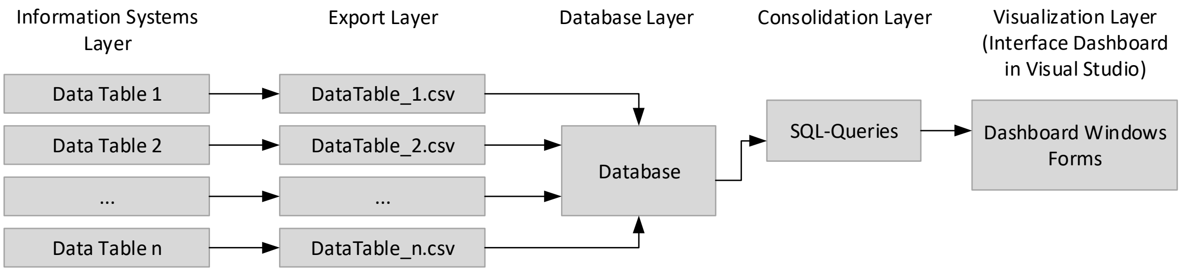

Figure 2. Technical Concept of the Business Model Mining Tool

Figure 3 illustrates the graphical interface in form of a dashboard (visualization layer). The mock-up was created in Microsoft Visual Studio and is intended to be converted into a web application in the course of this project. The hardcoded dashboards and visualizations of the proxies within the fields of the BMC are planned to be implemented more flexibly such that users might perform operations on the data.

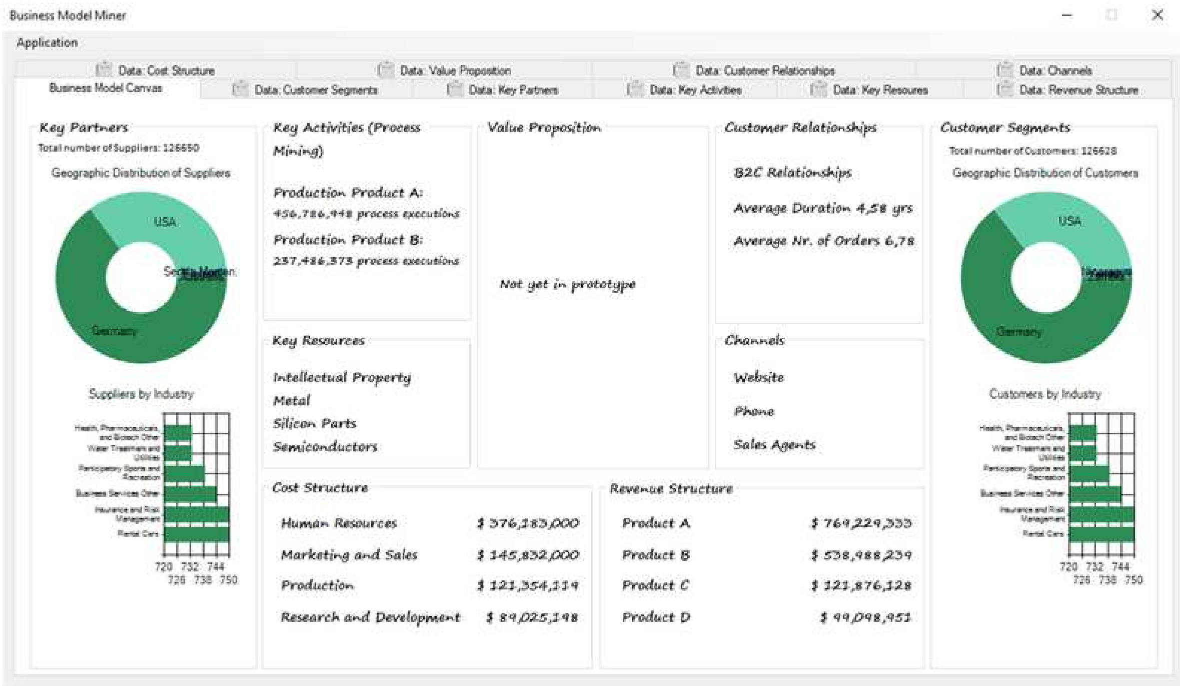

Figure 3. Prototype of the Business Model Mining Tool (Graphical User Interface)

Conclusion

Business models are vitally important for decision-makers to understand how organizations intend to be successful. With our research endeavor, we want to satisfy the demand for an efficient and effective modelling method which is superior to existing approaches in terms of objectivity, effort, costs, and flexibility. In this paper, we present our research to explore design principles in order to improve existing approaches to business model visualization. The design artefact automatically discovers the current business model of an organization from enterprise information systems which store large amounts of business model-related data. In our design science project, we use the business model canvas by Osterwalder (Osterwalder 2004) as a representation of business models which is widely accepted by scholars and practitioners. We started developing a prototype which automatically derives a business model canvas based on data from an SAP R/3 ERP system provided by an industry partner. By relying on data as a bottom-up approach to visualize business models, we aim to satisfy the demand for higher objectivity and correctness of business models to overcome the weaknesses of current top-down approaches, which primarily rely on top-down, subjective inputs from humans.

By contributing to the current absence of research on data-driven visualization of business models under the heading of "business model mining", we contribute to several areas. In addition to generating knowledge about the organizational way of creating, delivering, and capturing value, business models are required as important input for the strategic transformation of organizations and business models (Osterwalder, Pigneur 2010; Wirtz 2011). Furthermore, we enlarge the existing knowledge body of business modelling by providing design knowledge for further tool developments.

However, our work in its current form encounters several limitations. Besides this, the necessary data for the tool needs to be consistent. While downloading and consolidating the data from the information system is a minor challenge in the tool development, the real challenge is how to identify business model-relevant data within the individual tables. In order to be able to compute business models from data, our approach needs to "proxy" the elements and dimensions of a business models from data. Further literature works and workshops with our industry partner are required to develop solid and appropriate metrics which adequately represent business models from data. Besides, multiple business models potentially coexist within one organization. Furthermore, the current state of the prototype is not able to distinguish between the different business models in one information system, as well as to reunite business models from different ERP systems. Thus, a challenge will be to find a way to select and distinguish among different business models, and to merge multiple sub-business models from multiple information systems.

Furthermore, the approach presented in this paper relies on data and automatically presents the user a business model, without the need to visualize business models manually. However, this process of deriving business models also entails a learning process for the creator, who might become aware of relationships, connections and elements of the actual value creation process when visualizing the business model. As our approach automatically provides a business model, this advantage of the business model canvas as a moderation method is neglected, and the learning process might be less intense.

Future work will include the theoretical derivation of the proxies as well as the completion, evaluation and improvement of our current tool prototype. After deriving the additional proxies, we want to implement these metrics into the prototype and add an additional layer which allows users to flexibly query the data, such as more flexibility in the dashboards and the possibility to drill down the data. Thereby we will have a look at different mining techniques too. As a further part of design cycle 2, we plan to evaluate the actual performance of the "Business Model Miner" prototype with our industry partner. We will compare the business model generated by our prototype using the SAP R/3 ERP data with the manually derived business model canvas by experts from our partner, who have to model the current business model based on their top-down knowledge. It is also thinkable, that the method can function as a decision support system. The BM of a company can be supervised steadily and changes in the BM can be seen easily. As a result, managers can instruct changes, to achieve the determined goals. Questions, we want to answer are thereby: How do business models change over time? And how does the automated method capture and present these changes?

To conclude, we believe the proposal for a business model mining approach significantly improves the organizational capability to generate knowledge about the organization itself, and provides a solid base for transformation decisions by providing an alternative to "de jure", top-down models in "de facto" and bottom-up models.

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