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A METHOD FOR SIMULATING CLOUD BUSINESS MODELS: A CASE STUDY ON PLATFORM AS A SERVICE

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Abstract

Cloud computing has changed how software is produced, distributed, consumed, and priced. The cloud paradigm has had a disruptive effect on existing business models and elicited a need for more thoroughly defined business models as well as the tools to represent and compare business models. In this paper, we address this research gap and present a structured approach that allows a systematic design of business models for cloud computing and provides tools to facilitate the business model design process through simulation. The resulting method is specified by means of a meta-model as well as a procedure model and is demonstrated by a software prototype. The developed method has been evaluated in three case studies in the context of Platform as a Service business models.

Keywords: Business Model, Cloud Computing, Simulation Method.

1 Introduction

Cloud computing and the utility-based on-demand provisioning of computing services requires novel business models. The cloud paradigm has had a disruptive effect on existing business contexts with respect to how computational infrastructures are conceived and architected. It has elicited the need for innovation in business models across the software industry. Where previously infrastructure and platform providers dealt with on site solutions, today highly standardized and scalable data centres aim to rapidly provide resources on-demand. Cloud platforms are now a commonly known concept, which brings more transparency into the cloud market as well as the ability to leverage transparency and with it comparability as an opportunity for a provider to benchmark their business model with the competition. However, benchmarking in this manner requires thoroughly defined business models as well as the tools to represent and compare business models. Yet, existing research in cloud computing has mainly focused on taxonomies of the technical layers (Rimal, Choi, & Lumb, 2010) or of the revenue model (Eurich, Giessmann, Mettler, & Stanoevska-Slabeva, 2011), but not explicitly considered business models as comparable entities. Much research has dealt with electronic business models (Timmers, 1998), but focus mainly on the classification and definition of business models (Weinhardt et al., 2009), rather than analysing and evaluating them within the context of the cloud paradigm. The ability to inspect and analyse cloud business models is, however, not only useful for providers but also other stakeholders and actors. Consider, for example, brokers, resellers, or platform providers, they need to have various views of the "cloud market" in order to make strategic decisions.

To facilitate the basic ability of market analysis for business models, we present a methodology to compare business models with respect to their expected market share by taking competing business models as well as consumer preferences into account. Our method follows the design science research (DSR) approach of Hevner et al., (2004) and March & Smith, (1995) drawing on the necessary knowledge and experience found in the cloud domain (Hevner, 2007). Accordingly, in the next two sections we present the theoretical background and related work relevant for the research gap addressed in this paper. To come to rigorous and relevant research results, we draw upon Peffers et al., (2007) and followed their proposed DSR methodology: The first activity within the design science process, is problem identification and motivation (Peffers et al., 2007), which we outlined in the first paragraph. The second activity concerns the objective of the solution: Our objective is to address the sketched research gap and present a structured approach that not only allows a systematic design of business models for cloud computing, but also provides tools to facilitate the business model design process through simulation. The resulting artefact is a method following the approach of Brinkkemper (1996), which is specified by means of a meta-model in section 4.1, a procedure model, which is presented in section 4.2 (activity 3: Design and development) as well as a software prototype, to demonstrate the use of the artefact to solve instances of the problem (activity 4: Demonstration). The evaluation of the method, which represents activity 5, comprised three case studies, where the artefact has been demonstrated in the context of three platform as a service (PaaS) business models. As a result, iterations starting from activity 3 had to be performed. Section 5 illustrates the final case study, where our method has been applied. The results of our investigation are discussed in section 6, before the paper closes with a brief summary, limitations of the conducted research and an outlook to further research.

2 Theoretical Background

2.1 Cloud Computing

There is a considerable amount of literature on cloud computing (Armbrust et al., 2010; Marston, Li, Bandyopadhyay, Zhang, & Ghalsasi, 2011; Vaquero, Rodero-Merino, Caceres, & Lindner, 2009;

Weinhardt et al., 2009; Zhang, Cheng, & Boutaba, 2010), but, to date no established definition exists. However, the most generally accepted definition, from the National Institute of Standards and Technology (NIST), is: "*Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction*" (Mell & Grance, 2011).

PaaS is the middle layer connecting the Infrastructure as a Service (IaaS) and Software as s Service (SaaS) layers (see (Höfer & Karagiannis, 2011; Marston et al., 2011; Mell & Grance, 2011; Vaquero et al., 2009; Viega, 2009; Zhang et al., 2010)). The IaaS layer offers computing resources such as processing, storage, networks, and other fundamental computing resources that can be obtained as a service (Mell & Grance, 2011). The SaaS layer is the most visible service layer of cloud computing due to the fact that the software applications are accessed directly by the end-users. Giessmann and Stanoevska (2013) refer to PaaS as *an execution environment in which external developers deploy and run their components. PaaS facilitate the development, testing, deployment, execution, and management of software components, as well as the exchange of knowledge between developers.*

2.2 Business Models

In 1954 Peter F. Drucker posed the following key questions to analyse and design business models: "(1.) What is our business? (2.) Who is the customer? (3.) What is value to the customer? (4.) What will our business be? (5.) What should it be?" (Drucker, 1954). Further studies from Chesbrough, (2007); Johnson et al., (2008); Mahadevan, (2000); Morris et al., (2005); Osterwalder et al., (2005); Timmers, (1998) and Zott et al., (2011) have also noted the importance of actively analysing and designing business models. As a basis for this work, we have used the definition of a business model from Morris et al (2005): *A business model is a concise representation of how an interrelated set of decision variables in the areas of venture strategy, architecture, and economics are addressed to create sustainable competitive advantage in defined markets.* Further definitions are presented in Table 1 below.

Reference	**Definition**
Amit and Zott, (2001)	A business model depicts the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities.
Osterwalder et al., (2005)	A business model is a conceptual tool containing a set of objects, concepts and their relationships with the objective to express the business logic of a specific firm. Therefore we must consider which concepts and relationships allow a simplified description and representation of what value is provided to customers, how this is done and what are their according financial consequences.
Timmers, (1998)	Definition of a business model: - 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 business actors; and - A description of the sources of revenues.

Table 1. Business Model Definitions.

Besides the definition of business models, Pateli and Giaglis (2004) distinguish seven additional areas of business model research that are relevant to our work: 1) Components/fundamental constructs, 2) Taxonomies, used for categorizations of business models, 3) Conceptual models, 4) Design methods and tools, 5) Adoption factors, 6) Evaluation models, and 7) Change methodologies. In this paper, we develop a method for modelling, analysing and simulating business models in cloud computing. Hence, we focus on the fourth research field: design methods and tools. Meaning "building methods and developing tools for designing business models" (Pateli & Giaglis, 2004). For this reason, in section 3 special attention is paid to related approaches that also focus on the design of methods and tools.

3 Related Work

There have been approaches to classify the business models of cloud computing providers. In Weinhardt et al. (2009), a cloud business model framework is suggested, which lists six different categories of business models: storage and computing as part of a IaaS business model, business and development for PaaS; and the application layer is composed of SaaS and on-demand web services. The focus is thus on taxonomies and components, and especially on the value proposition aspect. Frameworks for defining business models have been developed specifically for the software industry (Schief & Buxmann 2012) and for general businesses (e.g. Morris et al. (2005) or Osterwalder and Pigneur (2010)).

Little prior research exists on the analysis and the facilitated design of business models. Tennent and Friend (2005) give advice to practitioners in their guide book to business modelling. They provide detailed instructions on how to create a "spreadsheet model" for a business, including the calculation of financial key figures, forecasts, and project plans. While the approach is very suitable for backing up a business model with quantitative data and making decision based on that, it lacks tools for a higher level business model design and analysis such as qualitative aspects of the value proposition.

A more general approach is the "Business Model Generation" book by Osterwalder and Pigneur (2010) with the accompanying iPad app.[1] It provides a tool for practitioners to draft their business model along the segments given by the business model canvas. The user can quantify certain elements in the building blocks cost structure, revenue structure, and customer segments with monetary amounts or in a relative relation to a user-specified size of the market or its segments. This allows for simple cost-revenue analysis. The high popularity of the business model canvas and the accompanying tool is likely to be based on their strong ease of use and a very practical case-oriented documentation.

A business model framework is introduced in Weiner and Weisbecker (2011) specifically for the Internet of Services. The authors have developed an ontology that covers most of the previously stated elements of business models and offers a number of relationship types. A web-based application [moby:designer][2] is maintained for building business models based on the ontology. Its purpose is to "contribute e.g. to business model design workshops with business owners" (Weiner & Weisbecker, 2011), therefore mainly as a tool to describe and visualize the current state of a business model.

Grasl's analysis method goes beyond financial figures and provides deeper analysis for business models (Grasl, 2009). The method helps practitioners to improve their business model and derive strategic recommendations based on the formalized business model. The proposed use of system dynamics allows for the simulation of specific scenarios and can help answering strategic questions concerning the business model. The analysis methods require a detailed specification of the value network, transactions, the value logic and dynamics as well as details of the company's products with different modelling techniques. Due to the complexity a representation of the business model is only possible with the assistance of an expert.

Existing approaches like Grasl (2009); Osterwalder and Pigneur (2010); Tennent and Friend (2005) or Weiner and Weisbecker (2011) do not consider an evaluation or analysis of business models in the competition or based on empirical and real market data. In this paper we extend prior research by suggesting a systematic yet easy to use method to design cloud computing business models, and include competing business models in a comparable way to facilitate comparison and benchmarking.

[1] http://www.businessmodelgeneration.com/toolbox (Last visited: 3. April 2013)
[2] http://moby-bm.iao.fraunhofer.de/oryx/editor (Last visited: 3. April 2013)

4 Analysing and Simulating Cloud Business Models

4.1 Model Overview

The goal of our method is to enable cloud service providers to design their business models, which includes providing data for simulating business models. A meta-model defines the concepts used in the method, as well as their relationships. The meta-model of our method for simulating cloud business models depicted in Figure 1 is divided into three main parts: 1) the business model concept constitute the heart of the model, 2) analysis and simulation methods for business models and 3) the data set on which analysis and simulation methods are based on. The left part in Figure 1 deals with the representation of a business model. A business model always belongs to one business model type. A business model type describes a business model through defining several attributes. An attribute is either a free text value, or it has two or more attribute levels, i.e., fixed values the attribute could take. Each attribute belongs to one of the six business model components, which have been adopted from Morris et al. (2005).

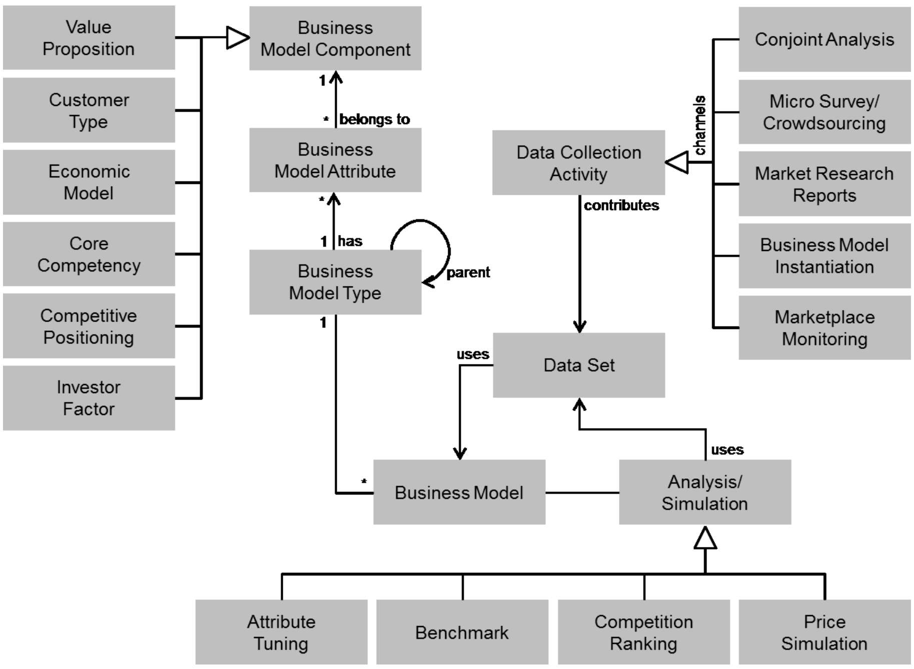

Figure 1. Meta-model of the method

An analysis or simulation of a business model makes use of a data set that categorises the business context in which the business model is active. Several data collection activities contribute to the data set, and a data collection activity can use different channels of data acquisition. The ways to acquire data include fielding a survey, posting micro-surveys, adding competitive business model instances, utilizing usage data from cloud platforms or performing market research activities. An analysis or simulation can be run for a business model. It typically considers a subset of attributes of the business model to be analysed. Four different types of simulation variants exist and are further discussed in section 4.3: Attribute tuning, direct benchmark, competition ranking, and price simulation.

4.2 Representing & Designing Cloud Business Models

The process of representing, designing and simulating cloud business models is specified with the procedure model shown in Figure 2. The procedure model presents all the major activities of the method and their respective order and feedback loops and is divided into three parts: Phase I involves the setup the method by defining business models types as well as the acquisition of data. Phase II facilitates the modelling of business models, which allows the instantiation of business models. In Phase III, service providers analyse, simulate, and optimize their business models. The three phases are explained in more detail in the remainder of this section.

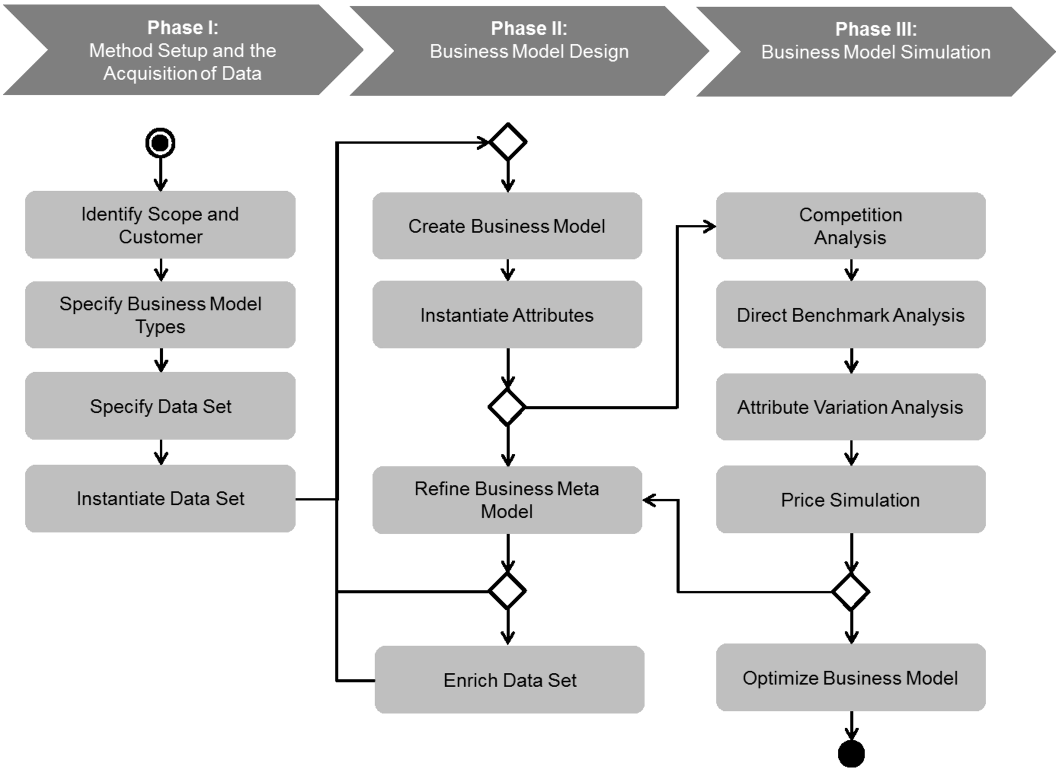

Figure 2. Procedure model of the method

Phase I: Method Setup and the Acquisition of Data

The first consideration to make is to define the target users of the tool, i.e., identify scope and customers. This means deciding what types of business models the method should consider, and how they are hierarchically structured. A business model type can be a sub-type of another business model type. The activity of specifying business model types, means defining attributes and attribute levels, that describe best the respective business model component (see left part of Figure 1). The attribute selection process is critical with regard to the data acquisition. For instance, when conducting a conjoint analysis on a subset of them and several rules, including independence of attributes without overlaps, have to be considered (see Gustafsson, Herrmann, & Huber (2007)).

After having defined the business model types, relevant data sets have to be specified. This means to decide 1) which attributes to consider for a survey as well as for 2) micro surveys, and 3) a selection of measures or variables obtained from market reports and their mapping to attributes. For instance, if revenue is an attribute in the economic factors component, one could specify that the overall market revenue acquired by market research has to be given in the system. The final step of phase I, the instantiation of a data set, actually adds data to the data set according to the prior specification. This means surveys are conducted on the attributes selected above, and imported into the data structure of business model types so that the data can be used as a basis for simulation. Market reports are screened to extract the information previously specified.

Phase II: Business Model Design

In phase II, cloud service providers now can model their business model by selecting a name and description, and assigning a business model type to it. The selection of the business model type may be modified when the service provider notices that the set of attributes in another similar type suits better to describe their service. The second step is to set the attributes, i.e., to select the attribute levels for all the attributes that are determined through the business model type. For this step, it is critical that the above criteria for both attributes and attribute levels to be mutually exclusive and collectively exhaustive are held. The better this requirement is fulfilled, the more complete, comprehensive and unambiguously the business model can be defined.

After phase II, when the cloud service provider has thought through their business model, it can be assumed that the wish to express more aspects about the business model may occur. This has been one of the most important requirements, which was also verified in expert interviews with the case studies. For this case, the procedure model defines the first feedback loop, which permits the suggestion and addition of new attributes and attribute levels to their respective business model type. After refining the business model type, the cloud service provider may also want to enrich the data set, in order to make use of the newly defined attributes and attribute levels.

4.3 Simulating Cloud Business Models

Phase III Business Model Simulation.

The final phase, builds upon the data specified and instantiated in phase I, as well as on existing instances of business models created in Phase II. A cloud service provider can run different kinds of simulations, which can give hints on potential improvements of the business model. Depending on the underlying data set, the potential number of simulation techniques is large. Currently, four specific kinds of simulation are suggested: 1) competition analysis, 2) direct benchmark analysis, 3) attribute variation analysis and 4) price simulation.

With the competition analysis, cloud service providers can compare their own business models with all the business model instances of the same type. The restriction on the same type enables a one-to-one comparison of all the attributes. The first main output this type of simulation generates is the similarity in percentage of the competing business models. The second output is a set of market shares for each business model of the respective type. The assumption here is that business models of the same type are in direct competition to each other and split the market among them. The calculation of virtual market shares requires a set of virtual consumers who can vote for the business model that maximizes their utility. Any kind of method that creates individual utility vectors on a subset of the meta-model's attribute levels would be suitable here. Market simulations using results of a conjoint analysis are widely used in marketing (Johnson, 1974; Orme, 2002).

The direct benchmark analysis is a special case of the competition analysis. Cloud service providers can compare their own business model with another business model. Just like in the competition analysis case, the other business model has to be of the same type, and the result is one similarity value and two market shares. This kind of analysis allows for more detailed attribute-wise comparison views between two business models.

The attribute variation analysis is an extension of the competition analysis: The user can select one or more attributes of an existing business model and see how the market share would change when the attribute levels change. Each combination of attribute levels, for the selected attributes, creates one temporary business model, which is then used in the simulation. For each of these combinations, the user is then provided with the value of the predicted market share.

The price simulation takes the price plan into account and can be provided with data on the anticipated usage. Also, the dependency of other services that are subject to a price plan can be included. Outputs of a price simulation are expected revenues, third party costs, and the profit. Also, setting optimal price model parameters such as prices based on an optimization goal (e.g. profit maximization or usage maximization) can be done.

As the preliminary final step from the cloud service provider's point of view, the optimization of the business model can be done. This step is meant to lead to the actual improved business model. It mainly means an adaptation of one or more attributes, if it turned out reasonable given prior analysis. In case of the attribute variation analysis where different variants of the provider's own business model are created and compared, the variant that is favoured can simply be selected. Obviously, the steps to implement changes of the business model are the cloud service provider's responsibility.

5 A Case Study on Platform as a Service

In line with Hevner`s design cycle (Hevner, 2007), the method represented by a software prototype has been evaluated against the real world by its reapplication in the context of three PaaS business models. Modifications of the originally purely linear procedure model such as feedback loops were implemented based upon expert opinions through structured interviews with potential users from the PaaS field. In this section, we present a case study of the 4CaaSt platform.[3]

Phase I: Method Setup and Acquisition of Data

The goal of our method is to enable cloud service providers to design their business models. Hence, the scope of our method is cloud computing and our customers are cloud service providers. Based on the architectural concepts for clouds (see Section 2.1) we specified three business model types: SaaS, PaaS and IaaS. The attributes assigned to the new PaaS business model type, are grouped into the six components of a business model, introduced in see Section 5.1 and are displayed on the left part of Figure 3. In order to provide an initial data-set, data of a conjoint study on consumer`s preferences on PaaS is used, as well as instances of existing, competing PaaS business models.

Conjoint analysis questionnaires in essence consist of asking for preferences between two or more alternative conjoint sets of attribute levels rather than asking for preferred attributes and attribute levels themselves. In the procedure model terms, setting up a conjoint analysis on the business model attributes is done in activity 3 (specify data set). The conjoint survey contained 10 attributes together with a total of 26 corresponding attribute levels. The resulting data consists of estimates for each respondents of the utility for each attribute level. More details on the dataset can be found in Giessmann and Stanoevska (2012). The data set instantiation activity is the actual fielding of the survey data into the business model method/tool.

Phase II: Business Model Design.

The service provider of the 4CaaSt platform specifies their PaaS business model and sets the attribute levels for all the attributes that are determined through the PaaS business model type. On the left-hand side of Figure 3 the business model for the 4CaaSt platform is presented. Based on this representation of the business model, the service provider can run different kinds of simulations in phase III.

Phase III: Business Model Simulation.

Within the competition analysis, the business model of 4CaaSt has been compared with all the business models of the same type. The following business models have also been assigned to the PaaS business model type: Microsoft Windows Azure,[4] Google`s App Engine,[5] CloudBees[6] and SAP

[3] http://www.4caast.eu/ (Last visited: 3. April 2013)
[4] http://www.windowsazure.com/en-us/ (Last visited: 3. April 2013)
[5] https://developers.google.com/appengine/ (Last visited: 3. April 2013)
[6] http://www.cloudbees.com/#slide-1 (Last visited: 3. April 2013)

HANA Cloud.[7] The first outcome of the competition analysis is the similarity of competing business models in percentage relative to 4CaaSt`s business model. The 4CaaSt business model has a similarity of 45% to Google`s App Engine. 40% to Microsoft's Windows Azure platform, 50% to CloudBees and 55% to SAP's HANA Cloud. The virtual market shares for the five investigated PaaS business models are as follows: Google`s App Engine would have a market share of 4.85%, Microsoft's Windows Azure would have a market share of 34.95%, CloudBees would have a market share of 55.34% while SAP HANA Cloud`s business model would reach only 0.97% and 4CaaSt would obtain 3.88% of the market.

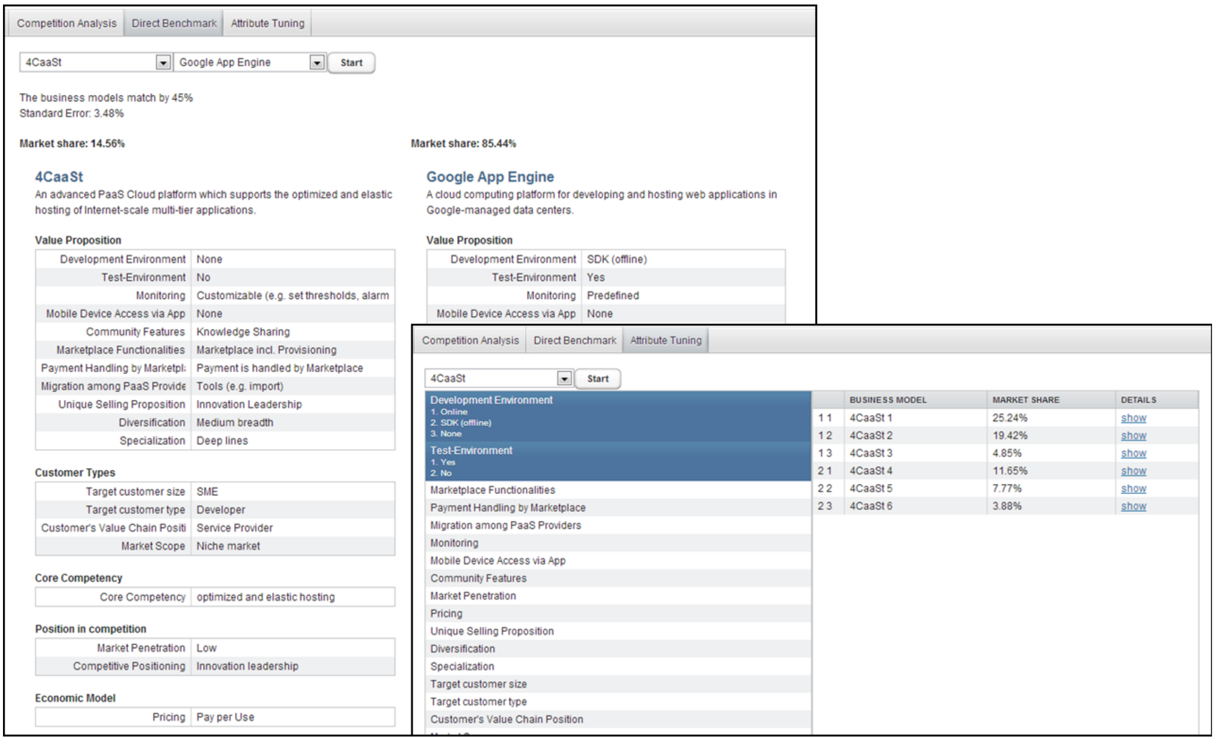

Figure 3. Business Model Simulation – Direct Benchmark & Attribute Variation Analysis

Within the direct benchmark analysis, the business model of 4CaaSt has been compared to the business model of Google`s Apps Engine (see Figure 3). Although, the two business models match by 45%, Google's App Engine business model reaches a virtual market share of over 85.44% compared to 4CaaSt. In order to analyse these competitive disadvantages, the direct benchmark analysis allows an attribute-wise comparison between the two business models. For example, the analysis shows that 4CaaSt neither offers a development nor a test environment, while Google's App Engine offers both. In order to find out, which attributes of its business model should be considered for improvement, the service provider of 4CaaSt can leverage the attribute variation analysis (see Figure 3), to analyse where their business model can be improved.

Within the attribute variation analysis, 4CaaSt`s service provider selects the attributes development and test environment (see the right side of Figure 3), and simulates possible combinations of attribute levels. Meaning, combinations of the attribute levels: online, offline or none for development environment as well as yes or no for the attribute test environment. For each of these combinations, 4CaaSt`s service provider receives the predicted market share. Figure 3 shows that 4CaaSt could reach a market share of 25.24%, if 4CaaSt offered an online development environment and provided a test environment. Even if 4CaaSt doesn't want to offer an online development environment, they could

[7] http://scn.sap.com/community/developer-center/cloud-platform (Last visited: 3. April 2013)

increase their market share to 19.42% by offering a test environment and providing a Software Developer Kit (SDK).

6 Discussion

The goal of this paper was to design a structured approach that allows a systematic design of business models for cloud service providers. In order to address this, a DSR approach was chosen and the resulting artefact is a method for designing, modelling and simulating cloud business models. The developed method is specified by a meta-model as well as a procedure model and was demonstrated by a software prototype. The business model concept is at the heart of the meta-model, and connects the three main parts of the methods: 1.) The representation of cloud business models, 2.) the underlying data set, that 3.) finally allows the simulation and comparison of business models.

The procedure model guides the cloud service provider in three phases through the process of defining their business model. The setup and data acquisition phase mainly prepares the two later phases by defining business model types as well as specifying and instantiating the data set. In the second phase, cloud service providers are able to create and instantiate their own business model, as well as business models from competitors. Using these business model instances, different analyses can be performed within the simulation phase: The competition analysis allows the comparison of a business model with several business models of competitors, while the direct benchmark analysis comprises a comparison of two business models. The attribute variation analysis allows a simulation of one or more attributes of an existing business model, in order to see how the market share would change when attribute levels change. From a time frame perspective it is clear that the first phase, except for adjustments, runs only once, while the second phase needs to be performed for each business model instance that should be taken into account within the method. The simulation phase can be run regularly in order to provide a solid information basis for the service provider's decisions.

The developed method has been evaluated in three case studies, where several business models have been instantiated and simulated. Each iteration resulted in an improvement of the method, and it is believed, that the method has reached a first stable state. Despite of the promising results, the study has several limitations that might affect the generalizability of the results and that need to be mentioned. First of all the method has been evaluated in three PaaS case studies. This number is sufficient to assure rigour and relevant results, but limits the generalizability of the study. Furthermore, the method is intended to facilitate cloud service providers in designing their business model, but has mainly been evaluated with PaaS providers. This limits the study as well, since SaaS or IaaS providers might have different requirements. Initial work for SaaS and IaaS providers has already taken place, and shown that some the attributes and the corresponding dataset can be adopted to these business models. One example is the pricing attribute, which belongs to the business model component economic model. With its attribute level; pay per use, subscription and revenue sharing it is also applicable for IaaS providers. Nonetheless, additional research is required to verify and triangulate the achieved results.

7 Conclusion & Outlook

In this paper, we have introduced a method for designing, modelling and simulating cloud business models as an interactive tool for use within the cloud paradigm. It allows users to create simple definitions their business models through an attribute/attribute level based approach. Our method has been conceived as a means to aid in the design as well as study of business models amidst levels of uncertainty concerning what a "good" business model may be. We have embraced the cloud platform scenario for the cloud paradigm, as this context makes cloud service providers more competitive due to increased transparency. This means that cloud service providers have the ability to find out in which markets they are strong and can (via our tool) adapt single attributes of their business models based on predicted raises in market share.

To evaluate our method, we performed case studies with experts representing PaaS business models. We also implemented a prototype tool to provide valuable insights for users in a variety of settings that facilitate decisions on which parts of their business models are merit change. Our novel contribution in this case is the ability to re-engineer aspects of the underlying business model framework and then re-evaluate it. Our approach allows users to include data from multiple sources to analyse and compare business models. This also means that our method becomes more powerful through the inclusion of additional data sets as more utility vectors can be captured. In addition, arbitrary preferences and utilities can be incorporated as long as these values can be mapped to attributes in the meta-model.

The challenge, however, in our approach is acquiring a suitable dataset or set of datasets. In this paper, we leveraged data from a previously performed survey to assess user utilities for an array of PaaS attributes acquired through conjoint analysis, as well as from an extensive market analyses. However, as with many evaluations based upon real data from emerging areas of research, our simulator has relatively low confidence values due to a small data set of 103 respondents. However, as mentioned, our approach can accommodate data from multiple sources, and therefore were we to either acquire additional respondent data, or to have to option to observe a cloud market, we can assume that the simulator's confidence would improve. As future work, we will incorporate more datasets and include actual market shares. Finally, we will approach selected cloud service providers for a pilot study of our tool to monitor their performance and identify potential levers for improvement in their business models.

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References

Amit, R., & Zott, C. (2001). Value creation in e-business. *Strategic Management Journal*, *22*(6/7), 493–520.

Armbrust, M., Fox, A., Griffith, R., Katz, R., Konwinski, A., Lee, G., Patterson, D., et al. (2010). A View of Cloud Computing. *Communications of the ACM*, *53*(4), 50–58.

Brinkkemper, S. (1996). Method engineering: engineering of information methods and tools. *Information and Software Technology*, *38*(4), 275–280.

Chesbrough, H. (2007). Business model innovation: it's not just about technology anymore. *Strategy & Leadership*, *35*(6), 12–17.

Drucker, P. F. (1954). *The Practice of Management*. New York, USA: Harper & Row Publishers.

Eurich, M., Giessmann, A., Mettler, T., & Stanoevska-Slabeva, K. (2011). Revenue Streams of Cloud-based Platforms: Current State and Future Directions. *Proceedings of the Seventeenth Americas Conference on Information Systems (AMCIS)* (p. 10). Detroit, Michigan.

Giessmann, A., & Stanoevska, K. (2012). Platform as a Service – A Conjoint Study on Consumers' Preferences. *Proceedings of the Thirty Third International Conference on Information Systems*.

Giessmann, A., & Stanoevska, K. (2013). Business Models of Platform as a Service Providers: Current State and Future Directions. *Journal of Information Technology Theory and Application*, *13*(4).

Grasl, O. (2009). *Business Model Analysis - Method and Case Studies*. *Business*. University of St. Gallen.

Gustafsson, A., Herrmann, A., & Huber, F. (2007). *Conjoint Measurement: Methods and Applications* (4th editio., p. 373). Berlin Heidelberg: Springer.
Hevner, A. R. (2007). A Three Cycle View of Design Science Research. *Scandinavian Journal of Information System*, *19*(2), 87–92.
Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, *28*(1), 75–105.
Höfer, C. N., & Karagiannis, G. (2011). Cloud computing services: taxonomy and comparison. *Journal of Internet Services and Applications*, *2*(2), 81–94. doi:10.1007/s13174-011-0027-x
Johnson, M. W., Christensen, C. M., & Kagermann, H. (2008). Reinventing your business model. *Harvard Business Review*, (December), 51–59.
Johnson, R. M. (1974). Trade-off Analysis of Consumer Values. *Journal of Marketing Research*, *11*(2), 121–127.
Mahadevan, B. (2000). Business models for Internet-based E-commerce : An anatomy. *California Management Review*, *42*(4), 55 – 69.
March, S. T., & Smith, G. F. (1995). Design and natural science research on information technology. *Decision Support Systems*, *15*(4), 251–266.
Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., & Ghalsasi, A. (2011). Cloud computing — The business perspective. *Decision Support Systems*, *51*(1), 176–189. doi:10.1016/j.dss.2010.12.006
Mell, P., & Grance, T. (2011). *The NIST Definition of Cloud Computing*. *Nist Special Publication* (Vol. 145, pp. 1–2). Gaithersburg, Maryland: National Institute of Standards and Technology.
Morris, M., Schindehutte, M., & Allen, J. (2005). The entrepreneur's business model: toward a unified perspective. *Journal of Business Research*, *58(6)*, 726–735.
Orme, B. (2002). Sawtooth Software Technical Paper Series: Formulating Attributes and Levels in Conjoint Analysis.
Osterwalder, A, Pigneur, Y., & Tucci, C. (2005). Clarifying business models: Origins, present, and future of the concept. *Communications of the Association for Information Systems*, *16*(1), 1–25.
Osterwalder, Alexander, & Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers* (1st editio.). Amsterdam, Netherlands: OSF.
Pateli, A. G., & Giaglis, G. M. (2004). A research framework for analysing eBusiness models. *European Journal of Information Systems*, *13*(4), 302–314.
Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A Design Science Research Methodology for Information Systems Research. *Journal of Management Information Systems*, *24*(3), 45–77.
Rimal, B. P., Choi, E., & Lumb, I. (2010). A Taxonomy, Survey, and Issues of Cloud Computing Ecosystems. In N. Antonopoulos & L. Gillam (Eds.), *Cloud Computing: Principles, Systems and Applications* (pp. 21–46). London: Springer London.
Schief, M., & Buxmann, P. (2012). Business Models in the Software Industry. *2012 45th Hawaii International Conference on System Sciences*, 3328–3337.
Tennent, J., & Friend, G. (2005). *Guide to business modelling*. *Chart* (p. 298). John Wiley & Sons.
Timmers, P. (1998). Business Models for Electronic Markets. *Electronic Markets*, *8*(2), 3–8.
Vaquero, L. M., Rodero-Merino, L., Caceres, J., & Lindner, M. (2009). A Break in the Clouds: Towards a Cloud De nition. *ACM SIGCOMM Computer Communication Review*, *39*(1), 50–55.
Viega, J. (2009). Cloud Computing and the Common Man. *Computer*, *42*(8), 106–108.
Weiner, N., & Weisbecker, A. (2011). A Business Model Framework for the Design and Evaluation of Business Models in the Internet of Services. *2011 Annual SRII Global Conference*, 21–33.
Weinhardt, C., Anandasivam, A., Blau, B., Borissov, N., Meinl, T., Michalk, W., & Stösser, J. (2009). Cloud Computing – A Classification, Business Models, and Research Directions. *Business & Information Systems Engineering*, *1*(5), 391 – 399.
Zhang, Q., Cheng, L., & Boutaba, R. (2010). Cloud computing: state-of-the-art and research challenges. *Journal of Internet Services and Applications*, *1*(1), 7–18.
Zott, C., Amit, R., & Massa, L. (2011). The Business Model: Recent Developments and Future Research. *Journal of Management*, *37*(4), 1019–1042.