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Abstract

Business rule models are widely applied, standalone and embedded in smart objects. They have become segregated from information technology and they are now a valuable asset in their own right. As more business rule models are becoming assets, business models to monetize these assets are designed. The goal of this work is to present a step towards business model classification for organizations for which its value position is characterized by business rule models. Based on a survey we propose a business model categorization that is aligned to different types of assets and business model archetypes. The results show five main categories of business models: The value adding business rule model, the 'create me a business rule model' business model, the KAAS business model, the bait and hook business model and the market place business model.

Keywords: Business models, Business Rules Management, Business Rule Models.

1 Introduction

Everyday objects such as watches, phones, refrigerators, bracelets, diapers, and toothbrushes are becoming smart objects by adding various (information) technologies like embedded sensors and near field communication. A smart object is an object that is aware of events and activities that occur in the physical world and is able to react on it. In addition, more and more smart objects are getting connected to the internet. This paradigm is coined as the "Internet of Things". The internet of things is a network of interconnected (smart) objects that can be uniquely addressed, based on standard communication protocols (Kortuem et al., 2010, Atzori et al., 2010). Kortuem et al. (2010) found that smart objects can be clustered around three main object types: 1) activity aware smart objects, 2) policy aware smart objects, and 3) process aware smart objects. An activity aware smart object is aware of its own usage (e.g. pick up and turn on) and can accumulate such activities over time. A policy aware smart object is aware of its surrounding and can compare if the current situation is compliant with organizational policies. To be able to do so, it uses a set of business rules to create decisions and guide actions. A process-aware smart object is aware of the surrounding and relates to organizational processes. To be able to do so, it uses context-aware process models.

Decisions, context aware processes and data collection can be formulated and restricted by business rules (Zoet et al., 2011). A business rule is (Morgan, 2002) "a statement that defines or constrains some aspect of the business, intending to assert business structure or to control the behaviour of the business." In a survey of 144 context-aware smart objects, 96% applied business rule (models) to reason (Perera et al., 2013). The application of business rules in smart objects is relatively new. More traditional applications of business rules can be found in administrative and production information systems. Examples of business rule model applications in information systems are psychiatric treatment, production planning, teaching, advisory, alcohol production, DNA histogram interpretation, biochemical nanotechnology, and load scheduling (Liao, 2004).

Until recently, business rules in both smart objects as well as administrative systems were hard coded in source code (Boyer and Mili, 2011, Graham, 2006). Business rule models that are hard coded in source code or implemented in stored procedures, manuals and, the mind of humans are called implementation dependent business rules (Zoet and Versendaal, 2013). Implementation dependent business rules are business rules that are written to be executed by a specific actor, where an actor can be a human or automated. The biggest challenge with implementation dependent business rules is keeping them all synced and up to date since multiple implementation of one business rule model exists at once. With the rise of smart objects even more implementations of the same business rule exist at a specific moment. To solve this problem organization now create independent business rules models. This model serves as single point of truth and from this single point of truth implementation dependent models are generated. Still multiple business rules implementations exist, however all are based on a single source. An additional benefit of implementation independent business rule models is that such business rules models can be created and maintained by business users such as marketers, sales persons and, lawyers, this referred to as the tangibilization of business rules (Nelson et al., 2008, Nelson et al., 2010). The transformation from implementation dependent business rules to implementation independent business rules follows the separation of concerns trend that is occurring since the 1960's (Van der Aalst, 1996).

The number of growing applications and devices (smart objects) that use business rule models and the tangibilization of business rules allow organizations to treat business rules as an organizational asset (Blenko et al., 2010, Liao, 2004). To monetize this asset business model are designed around it. Therefore, in this research we look at the following question: Which business models are feasible for organizations for which its value position is characterized by business rule models?

In the remainder of this paper, we first identify and describe relevant literature regarding Business Rules and Business Models. Subsequently, we describe the applied research method, followed the elaboration on the process of data collection. Then, we report on the results derived from the applied data analysis techniques. Finally, a conclusion is provided containing a discussion of our research, design implications and directions for future research.

2 Literature

Breuker and Van de Velde (1994) identified eleven types of analytical tasks in which business rule models are applied: classification, assessment, diagnosis, monitoring, prediction, configuration, design, modelling, planning, scheduling and, assignment. For each type of analytical task, Breuker and Van de Velde (1994) describe the way they work, for a detailed description we refer to their work. Although each task is unique and applies business rules for a different purpose, the tasks apply them in the same manner. To apply business rule models, three elements need to be in place: 1) a business rule inferencing method (engine), 2) a business rule repository, and 3) a business rule authoring service (Breuker and Van De Velde, 1994, Graham, 2006). The relation between these three components and their external environment is shown in Figure 1.



Figure 1: Schematic overview of a business rule architecture

A business rule authoring service is the client or application in which the actual business rule model is formulated. After the business rule model is formulated it needs to be stored. The element that stores the business rule model is called the business rule repository. After the business rule model is stored it can be used for execution. To execute the business rule model a business rule engine is applied. A business rule engine applies inferencing methods such as backward and forward chaining to execute business rules. The business rule inference engine, business rule repository and business rule authoring service are applied to execute logic. In order to be able to function, the business rule architecture requires input (data). This data is delivered by external services. Services in this case can be additional information systems. The same applies to the output of the business rule model which is used by another service. Until recently, each element was hard coded this is in line with the information technology evolution (Boyer and Mili, 2011, Graham, 2006, Van der Aalst, 1996).

One of the underlying characteristics of the information technology evolution has been the separation of concerns (Versendaal, 1991, Van der Aalst, 1996, Weske, 2007). Although various separation of concerns have been proposed, various authors agree on a general evolution of information technology architecture which is depicted in Figure 2. Until recently, business rules were hard coded in the operating system layer. However, now authors propose to separate the business rules from the operating systems and create a separate layer (Boyer and Mili, 2011, Graham, 2006). As a result, standard products to manage business rules are created. A standard software product is defined as a packaged configuration of software components or as

a software-based service (Xu and Brinkkemper, 2007). Examples of standard software to model business rule models are BeInformed (Be Informed, 2014), Corticon (Progress Software, 2012) and, Pega Systems (Pega Systems, 2013). The emergence of standard software has resulted in two separate types of assets for Business Rules Management vendors: the software system and the business rule model created by the software system. For both the software system and the business rule model, different rights are sold. For example, vendors sell standard business rule models for specific solutions such as Fatca or Permit Systems, independent from the sales of the actual system. The type of assets and asset rights involved are two of the fundamental dimensions of a business model (Malone et al. 2006).

OS = Operating System; APPL= APPLication; DBMS = DataBase Management System;
 UIMS = User Interface Management System; WFMS = WorkFlow Management System.

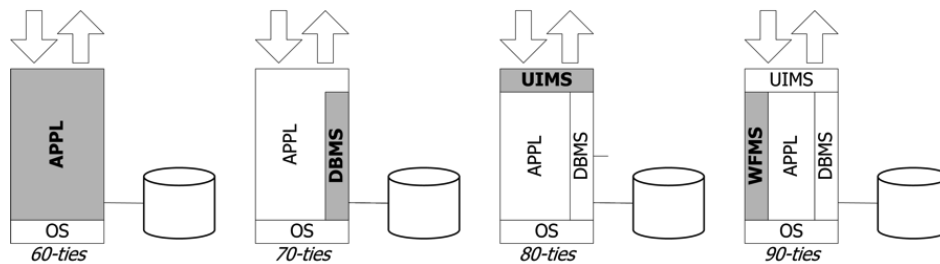


Figure 2: Evolution of Information Technology Architecture (Van der Aalst, 1996)

A business model is defined by Osterwalder (2004) as: "A conceptual tool containing a set of objects, concepts and their relationships with the objective to express the business logic of a specific firm." Osterwalder (2004) presents the business canvas model, an ontology to represent business models. This model can be applied to define a specific business model. Malone et al. (2006) extended the knowledge base by means of a systematic study of business models by defining business models based on two fundamental dimensions: The asset rights that are sold and the type of assets involved (Osterwalder, 2004).

The first dimension concerns the type of rights that are being sold, also called the archetypes. The second dimension considers the type of assets being involved. The combination of these dimensions leads to different business models shown in Table 1. As can be derived from Table 1, there are four different archetypes concerning business models (Malone et al., 2006). A creator archetype transforms goods into a product, where its main task focuses on designing and producing the product. A distributor buys a product and distributes it to its customers. A lessor provides the rights to use but not owns a product or service. An example of a lessor is a cloud solution. A broker facilitates the matching of potential buyers and sellers. A broker never takes ownership of the product and/or service. An example of this can be identified as eBay (Popp, 2011).

The second dimension concerns assets of businesses, which is split into four different categories. Malone et al. (2006) state that four main types of assets are applicable: physical, financial, intangible, and human. Physical assets include durable items (such as cars, computers and phones). Financial assets include cash and other assets like bonds and insurance policies that give their owners rights to potential future cash flows. Intangible assets include legally protected intellectual property (such as patents, copyrights and trademarks). Human assets include employee time and effort, in a way that people's knowledge is being rented for a fee (Popp 2011).

Malone et al. (2006) continued to determine if particular business models financially perform better than others, based on research on roughly one thousand companies. The framework proposed by Malone et al. (2006) contains two business models that are labelled as n/a. These

two business models are included for comprehensiveness of the framework, but are illegal in modern society, where a human creator concerns transactions for giving birth and a human distributor concerns human trafficking. Due to this fact, we do not take these two identified business models into account in the following sections.

		<i>Types of goods/services offered</i>			
		Financial	Physical	Intangible	Human
<i>Business model archetypes</i>	Creator	Entrepreneur	Manufacturer	Inventor	n/a
	Distributor	Financial trader	Wholesaler, retailer	IP distributor	n/a
	Lessor	Financial lessor	Physical lessor	IP lessor	Contractor
	Broker	Financial broker	Physical broker	IP broker	HR broker

Table 1: Business model archetypes and types of goods and services (Malone et al., 2006)

Popp (2011) continued research on business models in the software industry to identify other, nowadays more relevant business models based on the proposed framework for business models by Malone et al. (2006). According to his research, hybrid models that contain elements of multiple business model archetypes and asset types are also possible. A good example of this is a software company that acts like an inventor and IP lessor where combining business models can result in a company offering Software as a Product (SaaP) and/or Software as a Service (SaaS).

3 Data Collection

Selection of respondents and documentation is based on the phenomenon being studied in a group of individuals, organization, information technology, or community that best represents this phenomenon (Strauss and Corbin, 1990). The goal of this research is to identify and explore different business models made possible by applying business rule models. The chosen unit of analysis is therefore a single business model that applies one or more business rule models. One organization can implement multiple business models implying that one organization can contribute multiple units of analysis.

Industry	Number of organizations
Financial	2
Healthcare	13
Consulting	7
Transport	1
Software	34
Retail	15
System integrator	6
Remainder	1

Table 2: Number of organizations per industry

For a case to be included in the study it has to meet two criteria. The first criterion to be included is that an organization must offer services delivered by means of business rule models or that the organization must provide products that embed business rule models or is supported by business rule models. The second criterion is that the organization creates or defines business rule models. Organizations were selected from the multiple sources. The first source was our database with previous research. Secondly, TechCrunch (TechCrunch, 2014) was analysed and thirdly, our personal network of researchers was consulted. This resulted in the analysis of 79 organizations in eight different categories, see Table 2. Data for this study is collected through written documentation, archival records and direct observations.

Business model	Financial - Creator	Financial - Distributor	Financial - Lessor	Financial - Broker	Physical - Creator	Physical - Distributor	Physical - Lessor	Physical - Broker	Intangible - Creator	Intangible - Distributor	Intangible - Lessor	Intangible - Broker	Human - Creator	Human - Distributor	Human - Lessor	Human - Broker
Production & Model	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0
Production & Model	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0
Production & Model	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0
Customer Order	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Customer Order	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Customer Order	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Customer Order	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Customer Order	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Customer Order	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Customer Order	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Customer Order	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Customer Order	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Customer Order	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Customer Order	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Bait & Hook	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0
Bait & Hook	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0
Verticals	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0
Verticals	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0
Marketplace	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Marketplace	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Marketplace	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Customer Check	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Customer Check	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0

Figure 3: Snapshot ordinal comparison table

4 Data Analysis

Multiple methods are available for synthesizing collected data. Dixon-Woods et al. (2005) identified and compared eleven methods to synthesize data. In this study, we want to categorize data, from multiple case studies, based on predefined categories, determine frequencies of this data and identify recurring themes. The analysed data consists of business models applied by organisations and are therefore 'outcome values'. Based on these characteristics, Case Survey is most suitable for our research (Dixon-Woods et al., 2005). Case Survey is a method in which data is extracted from a large number of qualitative cases (Yin and

Heald, 1975). The extraction process occurs by means of a set of highly structured closed questions. After the data is converted from qualitative to quantitative data, a (basic) statistical analysis is conducted (Jensen and Rodgers, 2001).

Data analysis consisted of three phases, namely (1) determine overall business model type(s) per organization, (2) determine categories of business model types, and (3) define business model types. During the first phase, each surveyed case has been classified based on the goods/services it offers as well as the business model archetype it deploys. This occurred by formulating two questions. The first question was: "Which good or combination of goods is offered by the surveyed case?" The possible answers are: financial, physical, intangible, human or a combination of previous mentioned goods /services. The second question was: "For each identified individual good or combination of goods which business model archetype is applied?" After each individual case was classified, they were added to the ordinal comparison table, see Figure 3. An ordinal comparison table exists of exclusive categories. In our ordinal comparison table, these categories correspond to combinations of services and business model archetypes, that either are present (1) or absent (0). Due to space limitations the complete ordinal comparison table could not be added to the paper, a snapshot has been added instead (see Figure 3).

Identified Categories	Business Model Combination	Count	Summarized Categories
1	Intangible Creator, Intangible Distributor, Human Lessor	36	'Create me a Business Rule Model' Business Model
2	Intangible Creator, Intangible lessor, Human lessor	5	Bait and Hook Business Model
3	Intangible Lessor	3	The Market Place Business Model
4	Physical Creator, Physical Distributor, Intangible Creator, Intangible Distributor	24	Value Adding Business Rule Business Model
5	Intangible Creator, Intangible Lessor	8	KAAS Business Model
6	Physical Creator, Physical Distributor, Intangible Creator, Intangible Lessor	1	Value Adding Business Rule Business Model
7	Physical Lessor, Intangible Creator, Intangible Lessor	1	Value Adding Business Rule Business Model

Table 3: Hybrid business model categories

During the second phase, we categorized surveyed cases according unique assets / business model archetype combinations. In total seven categories with a unique combination of assets / business model archetypes have been identified, see Table 3. Two categories, category six and category seven, only occur once. The remainder of the categories occur at least three times, with category 1 (N=36) and category 4 (N=24) as absolute highs. When formulating categories, specific variables must be taken into account: usefulness, actual use, mutual exclusivity and completeness (Hevner et al., 2004). The only way to assess completeness of a categorization is through the use of deduction (Baskerville et al., 2009). To generalize our categorization outside the collected units, further analysis should be conducted; we note that such a deductive validation is outside the scope of this study.

Mutual exclusivity implies that none of the categories overlap. In our dataset, each of the seven categories overlaps partly with another category except for category 3. The reason that the business rule categories overlap is threefold. First, the characteristic "intangible creator" is

present in six out of seven business model categories (BM-categories). Additionally, each BM-category either contains the characteristic "*intangible lessor*" or "*intangible distributor*". This can be explained due to the fact that for a business model an organisations needs to less or distribute a business rule model, which only is possible after they created it. To support usefulness of our BM-categorization, we decided to allow overlap. However after analysing the BM-categories, we merged BM-category six and seven with category four. Category four and six only differ with respect to one business model archetype characteristic: "*intangible lessor*" versus "*intangible distributor*." The difference between category six and seven is caused due to the fact that physical goods are not created but leased by the organization. Both options are added to category "*value adding business rule model*." During the third phase, we described the five remaining categories and their characteristics. Both the categories and their characteristics are described in section 5.

5 Results

In this section first the overall results are presented. Secondly, the identified BM-categories that can be applied for business rule models are presented. For each BM-category, we describe (1) the application of the model and (2) one or two specific examples.

5.1 Value Adding Business Rule Business Model

The first category of business models is the value adding business rule models. Organizations that apply an embedded business rule model deliver additional value by adding a business rule model to a physical product, which they manufacture and/or sell, see Table 4. For both the physical product and business rule model, the organization can be a creator, distributor, lessor or combination of previous business model archetypes.

Two examples of specific instantiations for the business-to-consumer market are the smart diaper and smart toothbrush. The smart diaper contains a chip which collects data about the child wearing the diaper as well as the content of the diaper (Pixie Scientific, 2013). It analyses the data about the content for signs of dehydration and kidney problems. If anomalies occur, a signal is send to the mobile phone of a parent. The smart toothbrush created by Proctor and Gamble collects data about the movement of the toothbrush (Oral-B, 2013). Based on the movement, a business rule model indicates which areas the brusher missed. Additionally, based on historical data, the business rule model develops a fully personalized brushing routine.

An example of a specific instantiation for the business-to-business market is the Safe Watch from Mercy Hospital (Mercy Hospital, 2013). Safe Watch monitors a patient's body functions that are wired to a business rule model. Mercy sells the Safe Watch business rule model to other hospitals that use them in monitoring their patients' body functions to deliver added value. Currently, the technical implementation of this business model can be found in two forms: the first form is applicable when only the data collection happens in the physical device while the analysis of the data happens on a second device with stronger calculation capabilities. The second form is applicable when both the data collection and the data analysis are performed by the physical device.

		<i>Types of goods/services offered</i>			
		Financial	Physical	Intangible	Human
<i>Business model archetypes</i>	Creator	Entrepreneur	Manufacturer	Inventor	n/a
	Distributor	Financial trader	Wholesaler, retailer	IP distributor	n/a
	Lessor	Financial lessor	Physical lessor	IP lessor	Contractor
	Broker	Financial broker	Physical broker	IP broker	HR broker

Table 4: Characteristics value adding business rule model

5.2 'Create me a Business Rule Model' Business Model

The second category of business models is the 'create me a business rule model', as shown in Table 5. This model is applied by organizations that create a business rule model that is ordered by customers. Instantiations of this business model are mostly found at systems integrators, vendors and consultancy partners such as: Capgemini, Ordina, Pega Systems, Rule Management Group and Be Informed. Based on an order by customer they create a specific business rule model. The rights of the business rule model are distributed to the customer. To create the model, consultants and modellers are leased to the customer. Two examples of specific instantiations for the business-to-business market are: (1) BeInformed creates a business rule model for CAK (Be Informed, 2014) and (2) Pega Systems creates a business rule model for Bank of America (Pega Systems, 2013).

		<i>Types of goods/services offered</i>			
		Financial	Physical	Intangible	Human
<i>Business model archetypes</i>	Creator	Entrepreneur	Manufacturer	Inventor	n/a
	Distributor	Financial trader	Wholesaler, retailer	IP distributor	n/a
	Lessor	Financial lessor	Physical lessor	IP lessor	Contractor
	Broker	Financial broker	Physical broker	IP broker	HR broker

Table 5: Characteristics Create me a Business Rules Model

5.3 The KAAS Business Model

The third category of business models is the 'Knowledge as a Service' (KAAS) business model, as shown in Table 6. This model is applied by organizations that offer the result(s) of a business rule model to customers. Organizations host the business rule models but create a service from it, of which customers can access the logic. Instantiations of this model are executed by FashionGirls and Chef Watson (IBM, 2013). In the first case, a business rule model is used to determine the perfect set of clothes for a woman, based on body characteristics, where customers pay per fashion advice. Chef Watson is a business rule model created by IBM. Based on available ingredients it matches chemical flavour compounds and provides a receipt as output. Watson is particular know for creating recipes human chefs not commonly will create.

		<i>Types of goods/services offered</i>			
		Financial	Physical	Intangible	Human
<i>Business model archetypes</i>	Creator	Entrepreneur	Manufacturer	Inventor	n/a
	Distributor	Financial trader	Wholesaler, retailer	IP distributor	n/a
	Lessor	Financial lessor	Physical lessor	IP lessor	Contractor
	Broker	Financial broker	Physical broker	IP broker	HR broker

Table 6: Characteristics KAAS business rule model

5.4 The Bait and Hook Business Model

The fourth category of business models is the 'Bait and Hook' business model, as shown in Table 7. This model is an extension of the KAAS business model. Organizations that apply this business model codify a part of their basic knowledge and provide this to their clients for a small fee or for free. If the customer wants in-depth or additional information, they have to pay an additional fee. Instantiations of this business model are applied by the big four consultancy firms. An example is when an organization wants advice about risk management; it can deliver some specific details about risks for that specific organization. For example, it will provide a free report about the most common risk for an organization with a specific number of employees in a specific branch. If the organizations want more detailed information, they have to pay for additional consultancy hours.

		<i>Types of goods/services offered</i>			
		Financial	Physical	Intangible	Human
<i>Business model archetypes</i>	Creator	Entrepreneur	Manufacturer	Inventor	n/a
	Distributor	Financial trader	Wholesaler, retailer	IP distributor	n/a
	Lessor	Financial lessor	Physical lessor	IP lessor	Contractor
	Broker	Financial broker	Physical broker	IP broker	HR broker

Table 7: Characteristics Bait and Hook business rule model

5.5 The Market Place Business Model

The fifth business model is the 'Market Place' business rule model, as shown in Table 8. By applying this model, an organization facilitates a marketplace that can connect potential buyers and sellers with regard to business rule models. The models are not created by the organizations itself but by third parties. The organizations only act as broker, which generates their turnover. Instantiations of this business model are found at two types of organizations: vendors and independent markets. For organizations, it can be an additional channel to deliver content for their own software. Vendors and independent markets create an I-tunes like market where organizations can buy specific business rule models. For example, organizations have to be compliant to FATCA or HIPAA. Specific firms create business rule models that can check for compliance. They offer these models on specific markets for specific software.

		<i>Types of goods/services offered</i>			
		Financial	Physical	Intangible	Human
<i>Business model archetypes</i>	Creator	Entrepreneur	Manufacturer	Inventor	n/a
	Distributor	Financial trader	Wholesaler, retailer	IP distributor	n/a
	Lessor	Financial lessor	Physical lessor	IP lessor	Contractor
	Broker	Financial broker	Physical broker	IP broker	HR broker

Table 8: Characteristics Market Place business rule model

6 Conclusion

Business rule models are widely applied, standalone and embedded in smart objects. They have become segregated from information technology and they are a valuable asset in their own right. As more business rule models are becoming an asset, business models to monetize these assets are designed. In this paper, we set out to find an answer to the following question: Which business models are feasible for organizations for which its value position is characterized by business rule models? In order to answer this question, we first identified the elements that characterize a business model. This resulted in a framework which is intended for the classification of business models of organizations, which apply business rule models to deliver their value proposition.

From the data, we identified five categories of frequently applied and feasible business models for business rule models: (1) value adding business rule model, (2) create me a business rule model' business model, (3) Knowledge As A Service business model, (4) bait and hook business model, and (5) market place business model. From a practical perspective, our study provides organisations with a diagnostic tool for identifying and describing their business rule model. From a research perspective, our study provides a fundament for identifying and classifying business models for business rule models. Our results serve as input since business rule models are becoming more important with the increasing number of smart objects being added to the internet of things.

Several limitations may affect our results. The first limitation is the number of organizations analysed, this may limit generalization. While we believe our study represents a large number of organisations, more detailed categorization may be realized by applying a factor analysis on a larger data set to identify other possible combinations of business model archetypes and types of assets offered by organizations. The second limitation is the omission of payment models in our model. In addition to the types of services offered and business model archetypes, payment models are the third pillar of business models. Adding payment models will be a part of further research.

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