# An Assessment Framework for Business Model Ontologies to Ensure the Viability of Business Models

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Abstract: Organisations operate in an increasingly dynamic environment. Consequently, the business models span several organisations, dealing with multiple stakeholders and their competing interests. As a result, the enterprise information systems supporting this new market setting are highly distributed, and their components are owned and managed by different stakeholders. For successful businesses to exist it is crucial that their enterprise architectures are derived from and aligned with viable business models. Business model ontologies (BMOs) are effective tools for designing and evaluating business models. However, the viability perspective has been largely neglected. In this paper, current BMOs have been assessed on their capabilities to support the design and evaluation of viable business models. As such, a list of criteria is derived from literature to evaluate BMOs from a viability perspective. These criteria are subsequently applied to six well-established BMOs, to identify a BMO best suited for design and evaluation of viable business models. The analysis reveals that, although none of the BMOs satisfy all the criteria, e3-value is the most appropriate BMO for designing and evaluating business models from a viability perspective. Furthermore, the identified deficits provide clear areas for enhancing the assessed BMOs from a viability perspective.

## 1 INTRODUCTION

Organisations operate in an increasingly dynamic environment, that involve many stakeholders, and that operate in a networked setting. The resulting business complexity requires a change of their current enterprise information systems (EISs), in order to ensure the necessary support of the corresponding new business models. As such, EISs are often featuring service-oriented and distributed architectures, to support the new distributed nature of organisations, and to provide them with the required flexibility.

As an important example of the increased complexity, the energy industry has shifted to a new market setting that involves many different stakeholders and varying roles, in order to support decentralised energy production technologies. The business models span several organisations that deal with multiple stakeholders and their competing interests (Adhikari et al., 2012). Consequently, the EIS infrastructure that supports this new market setting is highly distributed. Furthermore, its components are owned and managed by different stakeholders.

It is essential that such complex enterprise architectures (comprising the business processes and EIS infrastructure) are derived from a viable business model. That is, all the participating organisations and stakeholders are able to capture value, such that they are committed to the business model (Chesbrough et al., 2006). In addition, the envisioned business model should be technologically viable (Kraussl-Derzsi, 2011). However, this new way of doing business in a networked setting dramatically increases the complexity of designing viable business models, due to the competing interests of stakeholders (Chesbrough et al., 2006). Moreover, the EIS infrastructure not only has to align with the overall business model (Kraussl-Derzsi, 2011), in some cases it is an explicit part of the business model.

The design and evaluation of business models is supported by business model ontologies (BMOs). BMOs can be used to conceptualise and communicate business models (Gordijn et al., 2005). Although the existing BMOs are conceived from different perspectives and are used for different purposes, the viability perspective has been largely neglected. As such,

the capabilities of BMOs to support the design and evaluation of viable business models remains unclear, particularly in complex business settings.

Therefore, this paper presents a list of fundamental criteria to which a BMO should comply in order to facilitate the design of viable business models and, therefore, enterprise architectures. These criteria are subsequently used to assess six well-established modelling ontologies. Out of the six ontologies, four were specifically conceived to represent business models (e3-value, VNA, BMC, and EBMS), while the other two (VSM & REA) were conceived for different purposes. However, they could possibly be used as BMOs (for more details we refer to Section 4.2). Therefore, we refer to these modelling ontologies as BMOs.

This was done, in order to select the most appropriate BMO, and to identify the deficits and areas for improvement from a viability perspective. This will allow future research to enhance BMOs to fully support viability as an explicit design focus of business models.

Accordingly, the paper is structured as follows. Section 2 provides a discussion on related work. Section 3 describes the criteria as provided in literature. Subsequently, Section 4 applies the criteria to assess current BMOs. Finally, the paper is concluded in Section 5, along with some directions for future research.

## 2 RELATED WORK

The boundaries of traditional enterprises are shifting from a single organisation to a network of organisations (Lankshorst, 2009). This has led to the enterprise architectures being developed, owned, and operated in a highly distributed manner, which in turn has lead to misaligned and inflexible enterprise architectures (Kraussl-Derzsi, 2011; Ross et al., 2006). Furthermore, for an enterprise architecture to be effective, it has to enable the business strategy. However, the distance between strategy and enterprise architecture is very large, because it is hard to conceive and design enterprise architectures based on general strategy statements (Ross et al., 2006; Engelsman and Wieringa, 2012). Therefore, scholars have argued that the concept of business models helps to address the above challenges by conceptualising and translating the strategy into a blueprint that describes how business is carried out (Osterwalder and Pigneur, 2002; Pateli and Giaglis, 2004; Ross et al., 2006; Al-Debei and Avison, 2010). The business model, as shown in Figure 1, is the linking pin between strategy and the enterprise architecture (Al-Debei and Avison, 2010; Osterwalder and Pigneur, 2002; Pateli and Giaglis, 2004). As such, it is critical that the enterprise architectures are derived from a viable business model.

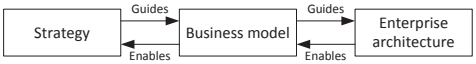


Figure 1: Business model in relation to strategy and enterprise architecture.

An important distinction between a business model and strategy is that business models are concerned with translating strategy into a business architecture, while strategy also includes competition. A business architecture describes how the different components of a business model fit together (Osterwalder and Pigneur, 2005; Pateli and Giaglis, 2004; Al-Debei and Avison, 2010; Teece, 2010). Therefore, we exclude the conceptualisation of strategy.

The business model concept is relatively young and scholars are constantly debating the meaning and scope of the concept (Pateli and Giaglis, 2004; Lambert, 2003). Furthermore, scholars from different disciplines are studying the concept of business models, which makes it difficult to agree on a common definition. There has been considerable interest in integrating the multidisciplinary views and arriving at a common definition (Pateli and Giaglis, 2004; Lambert, 2003; Roelens and Poels, 2013).

Scholars are also interested in the design of viable business models. They focus on identifying the factors, characteristics, and conditions that lead to viable business models. Furthermore, they provide guidelines and evaluation criteria for business models (Sharma and Gutiérrez, 2010; De Reuver and Haaker, 2009; Keen and Qureshi, 2006). The viability of business models is mainly studied from two perspectives. Some use a qualitative approach to conceptualise and analyse viable business models (Sharma and Gutiérrez, 2010; De Reuver and Haaker, 2009), whereas others use BMOs to conceptualise, design, analyse, and evaluate viable business models (Kraussl-Derzsi, 2011; Gordijn and Akkermans, 2003). BMOs are a reliable way of conceptualising, designing and evaluating business models (Pateli and Giaglis, 2004).

BMOs and business models are related, but not the same. A BMO is a language, which can be used to conceptualise and communicate any number of business models. For example, e3-value can be used to conceptualise and communicate business models of companies (Osterwalder and Pigneur, 2005). There has been some interest in the past to compare BMOs for different purposes. In (Gordijn et al., 2005), a framework is proposed to compare BMOs to find sim-

ilarities and differences with the goal of integrating BMOs. In (Mäkinen and Seppänen, 2007), a framework is proposed to assess BMOs from a taxonomical perspective. However, no attempts have been made to assess existing BMOs from a viability perspective.

# 3 DERIVATION OF CRITERIA

This section describes the research design, and how it is applied to distill a set of criteria, which are subsequently used to assess the BMOs.

## 3.1 Research Design

The Conceptual Model Analysis Framework (CMAF) (Lambert, 2003) is proposed to help researchers to compare and analyse the BMOs. The CMAF is a generic and flexible framework, which we will use to derive the criteria from literature in a systematic manner. The literature review will yield a list of criteria that we subsequently use to compare, assess, and select the most appropriate BMO for designing, and evaluating viable business models. Furthermore, the revealed deficits can be used to enhance the BMOs in context of design and evaluation of viable business models.

However, the CMAF framework assumes that the process of comparing and analysing BMOs will automatically lead to the selection of an appropriate BMO. This implies that the user is required to come up with a set of preferences (and hence a subset of relevant criteria) based on which the user will select a BMO. Consequently, there is a need for a set of criteria specifically tailored to assess a BMO on its capabilities regarding the design and evaluation of viable business models. The CMAF framework consists of three dimensions, namely conceptual focus, unit of analysis, and level of analysis.

These dimensions will be used for distilling a set of criteria to assess the BMOs. In addition, we have also made use of the existing literature in the strategic management domain, and the business model domain (also includes BMO literature). Following (Belton and Stewart, 2002), we analyse the literature from the domains mentioned above, and distill a set of criteria that are relevant, understandable, complete and concise, and judgementally independent (i.e. the preference for one criteria should not be dependent on other criteria). Furthermore, the criteria are distilled in such a way that they are operational, which means they are readily applicable to BMOs. Additionally, attention is paid to the simplicity versus complexity condition. In order to ensure simplicity (without sacrificing the complexity) of the criteria and to ensure the criteria are operational, some of the criteria are further decomposed in to a set of lower level criteria. Finally, in Section 4.1 the criteria are checked to ensure that they comply with the redundancy condition.

## 3.2 Conceptual Focus

This dimension helps to synthesize a perspective through which we view business models. It defines the functionality of the BMOs, which components should be modelled and analysed, and the granularity at which they are modelled. Hence, it strongly influences the unit of analysis, and the level of analysis dimensions. Therefore, the goal of this subsection is to synthesize a perspective through which we view business models. The perspective through which we view business models is viability. Consequently, the BMO should focus on design and evaluation of viable business models. In the following, we define the concepts of business model and viability.

**Business Model:** In the continuous debate on the scope of business models, some common ground can be identified on what is a business model (Pateli and Giaglis, 2004). A business model describes how business is carried out; it includes a description of the stakeholders (e.g. customers, and partners), their roles, value proposition for other stakeholders involved, and the underlying logic of value creation, value exchange, and value capture at organisational level and at network level. Furthermore, it defines the business architecture (organising logic of all the key components, such as information, value creation activities, stakeholders, and value exchange relationships) that enables the value creation, value exchange, and value capture logic (Al-Debei and Avison, 2010; Pateli and Giaglis, 2004; Tapscott et al., 2000; Zott et al., 2011).

**Viability:** According to (Kraussl-Derzsi, 2011), a business model should be viable both in terms of technology and in terms of value. A business model is viable in terms of technology when the underlying information communication technology (ICT) infrastructure can support the envisioned business model. This can be achieved by considering which type of ICT infrastructure is needed to support the business model, and how the capabilities of ICT infrastructure could lead to better and new ways of doing business (Ross et al., 2006). A business model is viable in terms of value when all the participating organisations/stakeholders are able to capture value, such that they are committed to the business model (Chesbrough et al., 2006). Value is the core component of a business model, and it plays an important role in

making business models viable (Al-Debei and Avison, 2010). Value is composed of exchange value (e.g. euros, dollars etc.), and use value (e.g. benefits of a product or service enjoyed by a customer, benefits derived by other stakeholders) (Lepak et al., 2007; Bowman and Ambrosini, 2000). Use value is the desired benefits end users and or other involved stakeholders (e.g. governmental organisations, society etc.) derive out of a product or a service, and or by participating in the business model (Bowman and Ambrosini, 2000; Lepak et al., 2007).

## 3.3 Unit of Analysis

The unit of analysis describes the functionality of the BMOs and the components to be modelled. BMOs can model and analyse business models at organisational level, and business network level. The organisational level analysis includes the components within the organisation, such as value creation activities. The business network analysis includes the components within the business network, such as organisations, and relationships among them. The functionality and the components to be modelled are derived from literature, and are directly influenced by the conceptual focus. In addition, the functionality and the components that should be modelled are presented as a list of criteria.

Based on the definition of the business model, we posit that the BMOs should conceptualise, encompass, and model the following concepts, functionality, and components. BMOs should conceptualise and model business models at two levels, namely at organisational level, and at network level (Amit and Zott, 2001; Lambert, 2010). Further, they should conceptualise the stakeholders within the network, and how they create, exchange, and capture value. Additionally, they should be able to represent the business model architecture of viable business models, and the business rules that govern them.

Business models have been studied from different perspectives (Pateli and Giaglis, 2004). Hence, to gain a better understanding of the concepts it encompasses from the perspective of viability, and what it means to BMOs, we further explore these concepts below.

### 3.3.1 Value Creation

Value creation is a central concept in management literature, it is the increased value (exchange value and use value) that two or more parties enjoy when they engage in mutually beneficial transactions (Bowman and Ambrosini, 2000). Furthermore, value could also be created for other stakeholders participating in the business model, even though they do not directly engage in transactional relationships, for example, political stakeholders providing subsidies to green energy producers (Lepak et al., 2007). Business models should be able to generate enough value to keep the stakeholders committed to the business models. If the stakeholders are unable to capture enough value, they will not be committed to the business model, which consequently renders it unviable (Chesbrough et al., 2006). Therefore, value creation is crucial from a viability perspective. In context of business models, value creation cannot be explained by a single theory, such as a resource based view (Amit and Zott, 2001). Therefore, to truly understand value creation in context of business models, a nexus of several theories is necessary (Chesbrough et al., 2006). Hence, several theories have been reviewed that utilise different units of analysis to explain value creation (Amit and Zott, 2001). Further, they argue that the units these theories analyse are the sources of value creation.

Table 1: Sources of value creation.

| Theory | Source of value creation |
|---|---|
| Value chain framework | Value creation activities |
| Resource based view | Resources |
| Business networks | Business networks |
| Transaction cost economics | Transactions (value exchange relationships) |

Following their lead, we posit that the BMO should model and analyse the different sources of value creation, because by definition of business models, it is crucial to understand how value is created. Table 1 highlights the theories and the sources of value creation they analyse.

We acknowledge Schumpeters theory of entrepreneurship, which posits that an entrepreneur is the source of value creation (Amit and Zott, 2001). However, we do not review this theory in context of this research, because the conceptual focus used to view viability of business models is at the organisational and the network level, and not at the entrepreneur level.

Table 2: Assessment criteria concerning value creation.

| No | Criteria | Sources |
|---|---|---|
| **1.** | **Value creation** | (Bowman and Ambrosini, 2000) |
| 1.1. | Model value creation by each stakeholder | (Zott et al., 2011) |
| 1.2. | Model sources of value creation | (Amit and Zott, 2001) |
| 1.2.1. | Value creation activities | (Amit and Zott, 2001) |
| 1.2.2. | Resources | (Amit and Zott, 2001) |
| 1.2.3. | Business network | (Amit and Zott, 2001) |
| 1.2.4. | Transactions | (Amit and Zott, 2001) |

### 3.3.2 Value Capture

Value capture is the amount of value retained by each stakeholder within the business model (Lepak et al., 2007). The amount of retained value is conceptualised in terms of use value, and exchange value. The value captured in terms of exchange value is the total amount of revenue a stakeholder is able to retain (i.e. profit) (Bowman and Ambrosini, 2000). The value captured in terms of use value is the total benefits realized by a stakeholder from a product and/or a service, or by participating in a business model (Lepak et al., 2007).

Table 3: Assessment criteria concerning value capture.

| No | Criteria | Sources |
|---|---|---|
| **2.** | **Value capture** | (Bowman and Ambrosini, 2000) |
| 2.1. | Model value captured by each stakeholder | (Chesbrough et al., 2006) |
| 2.2. | Model captured value in terms of use value | (Bowman and Ambrosini, 2000) |
| 2.3. | Model captured value in terms of exchange value | (Bowman and Ambrosini, 2000) |

Successful business models ensure that the stakeholders participating in the business models are able to capture value, such that they are committed to the business model. If not the business model will not be able to attract and retain competitive stakeholders. Hence, this could lead to the business model being rendered unviable. Consequently, the BMO should be able to model and analyse the amount of value captured by each stakeholder.

### 3.3.3 Value Exchange

Value exchanges are relationships formed among stakeholders to exchange value. At the organisational level, these relationships can be analysed within the organisations, and at a dyadic level. Organisations form dyadic relationships with partners, such as channel partners and customers (Chesbrough et al., 2006). Adopting the business network approach implies that the value exchange relationships are among the basic building blocks of the business network (Gordijn and Akkermans, 2003). Consequently, it calls for a systemic approach, where the value exchanges are analysed not only from a focal organisations perspective, but also from a business networks perspective. This involves the analysis of the entire business network formed to produce, govern, and deliver the products and services to the end user (Chesbrough et al., 2006). Hence, this implies that the BMO should be able to conceptualise and model the value exchanges at organisational level and at network level.

Table 4: Assessment criteria concerning value exchange.

| No | Criteria | Sources |
|---|---|---|
| **3.** | **Value exchange** | (Chesbrough et al., 2006) |
| 3.1. | Model value exchanged at organisational level | (Chesbrough et al., 2006) |
| 3.1.1. | Use value at organisational level | (Bowman and Ambrosini, 2000) |
| 3.1.2. | Exchange value at organisational level | (Bowman and Ambrosini, 2000) |
| 3.2. | Model value exchanged at business network level | (Gordijn and Akkermans, 2003) |
| 3.2.1. | Use value at business network level | (Bowman and Ambrosini, 2000) |
| 3.2.2. | Exchange value at business network level | (Bowman and Ambrosini, 2000) |

### 3.3.4 Business Model Architecture

Business model architecture is the organising logic of how the key components that enable value creation, value capture, and value exchange relationships are organised (Eriksson and Penker, 2000). Visualising the business model architecture helps in gaining a deeper insight into the business model. Further, it is a useful and effective technique used to brain storm and identify alternative configurations of the business model. Hence, in context of designing viable business models, visualising the business model architecture of the business models is an effective tool in organising the components in such a way that it enables viability (Gordijn and Akkermans, 2003). Therefore, the BMOs should be able to visualise the business model architecture.

Table 5: Assessment criteria concerning the business model architecture.

| No | Criteria | Sources |
|---|---|---|
| **4.** | **Represent the business model architecture** | (Eriksson and Penker, 2000) |

### 3.3.5 Design of Viable Business Models

The design of viable business models is an iterative process. Therefore, the ontology should also allow for the manipulation of the business model to achieve viability (Gordijn and Akkermans, 2003). Furthermore, it is crucial to consider the capabilities of the ICT infrastructure while designing business models. Modelling the underlying ICT infrastructure alongside business models is a good way of improving the business and ICT alignment (Kraussl-Derzsi, 2011). Modelling the underlying ICT infrastructure in essence is a cross-domain exercise, which involves professionals from the business domain and ICT domain. Therefore, they need a common language in

order to be effective. Talking about ICT in terms of ICT services gives technologists and business professionals a common language. It facilitates the discussion about business models and their underlying need for ICT (Weill and Vitale, 2002). Hence, it is important to conceptualise and model the underlying ICT services needed to support the business model. Further, conceptualising the underlying ICT services helps technologists to draft requirements for the ICT architecture. The ICT architecture in turn supports the ICT services (Weill and Vitale, 2002). This also helps improve the alignment between business models and ICT (Henderson and Venkatraman, 1993). Therefore, the BMOs should be able to model the underlying ICT services of a business model. Furthermore, business models often embody multiple commodities and include multiple stakeholders (Adhikari et al., 2012). Consequently, the BMOs should also be able to model multiple commodities and multiple stakeholders. Business models span multiple organisations; as a result, a systemic approach should be adopted to design business models. The systemic approach entails designing business models at an organisational level, which involves analysing and modelling the value created and contributed by each individual organisation. It also entails designing business models at a network level, which entails configuring the organisations and the value exchanges among them in a way that enables viability. Therefore, the BMOs should be able to design business models at an organisational level as well as at the business network level.

Table 6: Assessment criteria concerning business model design.

| No | Criteria | Sources |
|---|---|---|
| **5.** | **Design business models** | (Gordijn and Akkermans, 2003) |
| 5.1. | Ability to manipulate business models | (Gordijn and Akkermans, 2003) |
| 5.2. | Model underlying ICT services | (Weill and Vitale, 2002) |
| 5.3. | Model multiple commodities | (Adhikari et al., 2012) |
| 5.4. | Model multiple stakeholders/roles | (Adhikari et al., 2012) |
| 5.5. | Ability to design business models at organisational level | (Zott et al., 2011) |
| 5.6. | Ability to design business models at the network level | (Zott et al., 2011) |

### 3.3.6 Evaluation of Viable Business Models

The BMO should facilitate the evaluation of viability in terms of exchange value and use value. One of the ways it could help evaluate the viability in terms of value is by generating reports on the value captured by each stakeholder. Furthermore, technologists can evaluate the modelled ICT services for technological viability.

Table 7: Assessment criteria concerning viability.

| No | Criteria | Sources |
|---|---|---|
| **6.** | **Evaluation of business models for viability** | (Pateli and Giaglis, 2004) |
| 6.1. | Evaluate use value captured by the stakeholders | (Gordijn and Akkermans, 2003) |
| 6.2. | Evaluate exchange value captured by the stakeholders | (Gordijn and Akkermans, 2003) |
| 6.3. | Visualise the ICT services | (Kraussl-Derzsi, 2011) |

### 3.3.7 Business Rules

Business rules define constraints, conditions, and policies that govern a business model. A business rule can be defined as a statement that affects the value creation, value capture, value exchange, and the underlying business model architecture of a business model (Eriksson and Penker, 2000). Business rules internalise the external requirements put on the business models, such as, governmental regulations, technological limitations (Eriksson and Penker, 2000). In addition, the business rules include the internal requirements on the business model, such as requirements of the strategy on the business model (Eriksson and Penker, 2000). In context of viability the business rules, such as governmental regulation, can hamper or facilitate the viability of a business model. Hence, it is important that the BMO considers the business rules.

Table 8: Assessment criteria for BMOs.

| No | Criteria | Sources |
|---|---|---|
| **7.** | **Embodies business rules** | (Eriksson and Penker, 2000) |

## 3.4 Level of Analysis

Level of analysis corresponds to the level of abstraction or granularity at which the business models are conceptualised. BMOs conceptualise business models on a continuum, which ranges from a high level of granularity to a low level of granularity. The BMOs that conceptualise and analyse business models at a high level represent less information, and the business

models are generalizable. On the contrary, BMOs that conceptualise and analyse business models at a low level represent more information, and the business models are specific to an organisation or a business network. Consequently, they are not generalizable (Lambert, 2010). It is clear from the evaluation criteria derived thus far, that the design and evaluation of viable business models requires large amounts of information. Therefore, the BMOs should model the business models at a relatively low level (Lambert, 2010).

Table 9: Assessment criteria concerning level of analysis.

| No | Criteria | Sources |
|---|---|---|
| 7. | **Model BMOs at low level of granularity** | (Lambert, 2010) |

# 4 BMO ASSESSMENT

The criteria presented in the previous section can be used to assess how well BMOs support the design and evaluation of viable business models. The criteria can be applied qualitatively to assess the characteristics of the BMOs. The challenge of assessing BMOs based on a set of criteria can also be framed as a classic multi-criteria decision analysis (MCDA) problem (Belton and Stewart, 2002)[p.1-2].

## 4.1 Restructuring the Criteria

As mentioned previously, for the criteria to be usable they have to meet the following conditions (Belton and Stewart, 2002)[p.55-58]: value relevance, understandable, measurability, non-redundancy, judgemental independence, balancing completeness and conciseness, operational, and simplicity versus complexity.

We reviewed the criteria in light of the above conditions. To satisfy the condition of non-redundancy, we have eliminated the criteria of business network and transactions. The business network concept emerges under the category of design of business models, where we assess whether the business model is conceptualised at organisational level and at business network level. Similarly, the idea of transactions (value exchange) appears under the concept of value exchange.

## 4.2 Selected BMOs

Our search lead to six well established BMOs that focus on value. The following BMOs will be assessed using the above criteria.

**e3-Value:** The e3-Value adopts a value constellation (business network approach), where business models span multiple organisations. e3-Value aims at conceptualising business models and evaluating them for viability (Gordijn and Akkermans, 2003). Further, it aims to create a common understanding of the business models among collaborating firms (multi-stakeholder environment) by explicitly visualising the business models. It aims to improve the alignment between business and ICT. e3-Value has its roots in computer science and management science (Gordijn et al., 2005).

**Value Network Analysis (VNA):** VNA is rooted in the principles of living systems. It views business models as a pattern of exchanges between stakeholders. It focuses on both the tangible (e.g. money, and products) and the intangible (e.g. knowledge) value exchanges among stakeholders (Allee, 2002). VNA aims to incorporate a systemic view (business network) of business models, and the intangible values into the mainstream business model analysis.

**Business Modelling Canvas (BMC):** The BMC views business models in terms of 9 building blocks. The BMC conceptualises business models on the level of a single organisation and not on the level of a business network. However, the BMC does identify key partners (Osterwalder and Pigneur, 2010). The BMC is rooted in information systems and management science. Their main goal is to help companies conceptualise how they create, deliver and capture value (Gordijn et al., 2005).

**Value Stream Mapping (VSM):** VSM is rooted in the concept of lean manufacturing. It conceptualises the flow of value in a value stream. VSM adopts a supply chain approach to map the demand back from customers to raw materials. Their main goal is to help managers shift their attention from individual processes to a larger perspective. It is an attempt to shift the focus from individual process to the system of interconnected processes required to deliver the product to the customer (Rother and Shook, 2003).

**Resource Event Agent (REA):** REA is a domain specific (accounting domain) modelling ontology, which focuses on conceptualising economic resources, economic events, economic agents, and the relationships among them. These are conceptualised from the perspective of a single organisation (McCarthy, 1982). It is rooted in information science and management science. It aims to design flexible accounting systems that are better integrated with other enterprise systems and decision support systems (McCarthy, 1982).

**e-Business Modelling Schematics (EBMS):** The EBMS adopts a business network approach to business models, aiming at e-business initiatives. It adopts a focal organisation perspective to describe business models that span multiple organisations. It is rooted in management science and information science. EBMS was conceived with the aim of helping business executives to conceptualise and analyse new e-business initiatives (Weill and Vitale, 2002).

## 4.3 Assessment

Each of the BMOs is assessed against the criteria. The assessment is carried out such that if the BMOs fully support the criteria a ✓sign is assigned, and if it does not or partially support the criteria the criteria a ✗ sign is assigned. We adopt this method of evaluating the BMOs, because even if the BMOs partially support the criteria it will not lead to an accurate conceptualisation and analysis of viability. Table 10 shows how the six BMOs perform on the viability criteria derived from literature. It is clear that not all the BMOs conceptualise business models in the same way. Furthermore, it is evident that certain important viability criteria are ignored. None of the BMOs conceptualise value capture and evaluation of business models in terms of use value. Similarly, none of them conceptualise and evaluate the underlying ICT services. The business model architectures are only represented to a certain extent, but not satisfactorily. Therefore, we have rated them as not supporting the criteria "represent the business architecture".

Based on Table 10, we observe that none of the BMOs perform satisfactorily on all criteria. However, e3-value satisfies most of the criteria except for four criteria, namely, model captured value in terms of use value, model underlying ICT services, visualise ICT services for the purpose of evaluation, and business model architecture criteria. The reason why some of the BMOs perform well against the criteria and some do not could be attributed to the reason that not all of them were exclusively conceived to represent busi-

Table 10: Assessment of BMOs.

| No | Criteria | e3-value | VNA | BMC | VSM | REA | EBMS |
|---|---|---|---|---|---|---|---|
| **1.** | **Value creation** | | | | | | |
| 1.1. | Model value creation by each stakeholder | ✓ | ✗ | ✗ | ✓ | ✗ | ✗ |
| 1.2. | Model sources of value creation | | | | | | |
| 1.2.1. | Value creation activities | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ |
| 1.2.2. | Resources | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ |
| **2.** | **Value capture** | | | | | | |
| 2.1. | Model value captured by each stakeholder | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ |
| 2.2. | Model captured value in terms of use value | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ |
| 2.3. | Model captured value in terms of exchange value | ✓ | ✗ | ✓ | ✗ | ✓ | ✗ |
| **3.** | **Value exchange** | | | | | | |
| 3.1. | Model value exchanged at organisational level | | | | | | |
| 3.1.1. | Use value at organisational level | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ |
| 3.1.2. | Exchange value at organisational level | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ |
| 3.2. | Model value exchanged at business network level | | | | | | |
| 3.2.1. | Use value at business network level | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ |
| 3.2.2. | Exchange value at business network level | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ |
| **4.** | **Represent the business architecture** | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ |
| **5.** | **Design business models** | | | | | | |
| 5.1. | Ability to manipulate business models | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 5.2. | Model underlying ICT services | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ |
| 5.3. | Model multiple commodities | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 5.4. | Model multiple stakeholders/roles | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ |
| 5.5. | Ability to design business models at organisational level | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ |
| 5.6. | Ability to design business models at business network level | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ |
| **6.** | **Evaluation of business models for viability** | | | | | | |
| 6.1. | Evaluate use value captured by the stakeholders | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ |
| 6.2. | Evaluate exchange value captured by the stakeholders | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ |
| 6.3. | Visualise the ICT services | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ |
| **7.** | **Embodies business rules** | ✓ | ✗ | ✗ | ✓ | ✓ | ✗ |
| **8.** | **Model BMOs at low level of granularity** | ✓ | ✗ | ✗ | ✓ | ✓ | ✗ |

ness models. Furthermore, even the ones that were conceived to represent business models were not designed from the perspective of designing and evaluating viable business models, except for e3-value. This shows that the viability perspective has been largely ignored in context of BMOs.

# 5 CONCLUSION

Due to the increased business complexity and the distributed nature of modern day EISs, the viability of the business models becomes very hard to assess. A business model is viable if all participating organisations and stakeholders are able to capture value and if it is technologically viable.

In the past, different frameworks have been proposed to compare BMOs. However, none of these frameworks compare BMOs from the perspective of design and evaluation of viable business models. We have addressed this gap by assessing BMOs on their capabilities to support the design and evaluation of viable business models. First, a list of criteria is derived from literature for evaluating BMOs from a viability perspective. We have subsequently applied these criteria to evaluate six well-established BMOs, and identified the best suiting BMO for evaluating the viability business models.

Our analysis reveals that none of the BMOs satisfy all the criteria. Furthermore, each of the BMOs conceptualises business models differently. Our findings suggest that e3-value is the most appropriate BMO for designing and evaluating business models from a viability perspective. However, it fails on four criteria: model captured value in terms of use value, model underlying ICT services, visualise ICT services for the purpose of evaluation, and business model architecture criteria.

Our analysis confirms that it is hard to assess viability of business models, as current BMOs have a number of deficits that are particularly important for complex, distributed business settings. Consequently, these identified deficits provide clear areas for improvement of each assessed BMO. However, the derived criteria are relying on our conceptualisation of the term viability and influenced by the assumption that business models rely on ICT for execution.

Our findings concur with (Roelens and Poels, 2013) analysis that the gap between BMOs and strategic management and business model literature is large. Accordingly, future research should work towards enhancing BMOs to fully support viability as an explicit design focus of business models for dynamic and complex settings. In addition, future research can involve direct applications of enhanced BMOs, in order to assess the highly complex business models in distributed settings and their alignment with supporting distributed EISs.

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# REFERENCES

Adhikari, R. S., Aste, N., and Manfren, M. (2012). Multi-commodity network flow models for dynamic energy management–smart grid applications. *Energy Procedia*, 14:1374–1379.

Al-Debei, M. M. and Avison, D. (2010). Developing a unified framework of the business model concept. *European Journal of Information Systems*, 19(3):359–376.

Allee, V. (2002). A value network approach for modeling and measuring intangibles. *Transparent Enterprise, Madrid*.

Amit, R. and Zott, C. (2001). Value creation in e-business. *Strategic management journal*, 22(6-7):493–520.

Belton, V. and Stewart, T. (2002). *Multiple criteria decision analysis: an integrated approach*. Springer.

Bowman, C. and Ambrosini, V. (2000). Value creation versus value capture: towards a coherent definition of value in strategy. *British Journal of Management*, 11(1):1–15.

Chesbrough, H., Vanhaverbeke, W., and West, J. (2006). *Open innovation: Researching a new paradigm*. Oxford university press.

De Reuver, M. and Haaker, T. (2009). Designing viable business models for context-aware mobile services. *Telematics and Informatics*, 26(3):240–248.

Engelsman, W. and Wieringa, R. (2012). Goal-oriented requirements engineering and enterprise architecture: Two case studies and some lessons learned. In *Requirements Engineering: Foundation for Software Quality*, pages 306–320. Springer.

Eriksson, H. E. and Penker, M. (2000). *Business modeling with UML*. Wiley Chichester.

Gordijn, J. and Akkermans, J. M. (2003). Value-based requirements engineering: exploring innovative e-commerce ideas. *Requirements engineering*, 8(2):114–134.

Gordijn, J., Osterwalder, A., and Pigneur, Y. (2005). Comparing two business model ontologies for designing e-business models and value constellations. *Proceedings of the 18th Bled eConference, Bled, Slovenia*, pages 6–8.

Henderson, J. C. and Venkatraman, N. (1993). Strategic alignment: Leveraging information technology for transforming organizations. *IBM systems journal*, 32(1):4–16.

Keen, P. and Qureshi, S. (2006). Organizational transformation through business models: a framework for business model design. In *System Sciences, 2006. HICSS'06. Proceedings of the 39th Annual Hawaii International Conference on*, volume 8, pages 206b–206b. IEEE.

Kraussl-Derzsi, Z. (2011). *OPerationalized ALignment: Assessing feasibility of value constellations exploiting innovative services*. Amsterdam: Vrije Universiteit.

Lambert, S. (2003). *A Review of the Electronic Commerce Literature to Determine the Meaning of the Term 'Business Model'*. School of Commerce, Flinders University of South Australia.

Lambert, S. (2010). *A conceptual model analysis framework: Analysing and comparing business model frameworks and ontologies*. PhD thesis, International Business Management Association (IBMA).

Lankshorst, M. (2009). Enterprise architecture at work-modelling, communication and analysis. *Enterprise Architecture at Work-Modelling, Communication and Analysis*, pages 92–93.

Lepak, D. P., Smith, K. G., and Taylor, M. S. (2007). Value creation and value capture: a multilevel perspective. *Academy of management review*, 32(1):180–194.

Mäkinen, S. and Seppänen, M. (2007). Assessing business model concepts with taxonomical research criteria: A preliminary study. *Management Research News*, 30(10):735–748.

McCarthy, W. E. (1982). The rea accounting model: A generalized framework for accounting systems in a shared data environment. *The Accounting Review*, 57(3):554–578.

Osterwalder, A. and Pigneur, Y. (2002). An e-business model ontology for modeling e-business. In *15th Bled electronic commerce conference*, pages 17–19. Bled, Slovenia.

Osterwalder, A. and Pigneur, Y. (2005). Clarifying business models: Origins, present, and future of the concept. *Communications of the association for Information Systems*, 16.

Osterwalder, A. and Pigneur, Y. (2010). *Business model generation: a handbook for visionaries, game changers, and challengers*. John Wiley & Sons.

Pateli, A. G. and Giaglis, G. M. (2004). A research framework for analysing eBusiness models. *European Journal of Information Systems*, 13(4):302–314.

Roelens, B. and Poels, G. (2013). Towards an integrative component framework for business models: identifying the common elements between the current business model views. In *Forum at the 25th International Conference on Advanced Information Systems Engineering (CAiSE-2013)*, volume 998, pages 114–121.

Ross, J. W., Weill, P., and Robertson, D. C. (2006). *Enterprise architecture as strategy: Creating a foundation for business execution*. Harvard Business Press.

Rother, M. and Shook, J. (2003). *Learning to See: Value Stream Mapping to Create Value and Eliminate Muda.-Version 1.3*. Learning Enterprise Institute.

Sharma, S. and Gutiérrez, J. A. (2010). An evaluation framework for viable business models for m-commerce in the information technology sector. *Electronic Markets*, 20(1):33–52.

Tapscott, D., Lowy, A., and Ticoll, D. (2000). *Digital capital: Harnessing the power of business webs*. Harvard Business Press.

Teece, D. J. (2010). Business models, business strategy and innovation. *Long range planning*, 43(2):172–194.

Weill, P. and Vitale, M. (2002). What it infrastructure capabilities are needed to implement e-business models. *MIS quarterly Executive*, 1(1):17–34.

Zott, C., Amit, R., and Massa, L. (2011). The business model: recent developments and future research. *Journal of management*, 37(4):1019–1042.