The MOF Perspective on Business Modelling

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Abstract: The business model field of research is a young and emerging discipline that finds itself confronted with the need for a common language, lack of conceptual consolidation, and without adequate theoretical development. This not only slows down research, but also undermines business model's usefulness for research and practice. We offer a new perspective on business modelling to address these issues. It looks at business modelling from the perspective of the Meta-Object Facility, emphasising the role of models and meta-models. From this new perspective, a commonality analysis can identify the important classes in business modelling. This new perspective on business modelling helps to create a common language, achieve conceptual consolidation and supports theory development; it addresses issues that hinder business model research.

1 INTRODUCTION: A NEED FOR BUSINESS MODEL THEORY DEVELOPMENT

In general, a business model is a simple and, usually, graphic depiction of a company, often using boxes and arrows. It mostly describes a single company, a group of companies, or part of a company. In the broadest sense, a business model is an abstract (which means simplified) representation of the company, a "model of the business". The business model field of research is strongly growing and maturing over the last decade, mostly since 2000 (Osterwalder, Pigneur & Tucci, 2005; Zott, Amit & Massa, 2011). Since to this date no unified view exists regarding its conceptual foundation, this young and emerging discipline has been described (Meertens, Iacob & Nieuwenhuis 2011) as "finding itself in a state of prescientific chaos", in the sense of Kuhn (Kuhn 1970).

Practitioners using business models have a need for a common language, especially since they come from different disciplinary backgrounds: strategic management, industrial organization, and information systems (Pateli & Giaglis, 2004). In addition, links to other research domains are necessary to establish the business model field as a distinct area of investigation (Pateli & Giaglis, 2004). However, researchers still have to build more on each other's work, and research generally advances slowly and often remains superficial (Osterwalder, Pigneur & Tucci, 2005).

Currently, researchers use different terms to describe similar things, and the same term for different things. *Business model* often means "*a model of a single company*" and, specifically, of the way a company does business, creates, and captures value. However, other things are called business model as well, for example when referring to a pattern in the phrasing "*...the freemium business model...*" In addition, ontologies or frameworks such as the Business Model Ontology (BMO), e3-value, RCOV or activity system are sometimes referred to as a business model too (Osterwalder, 2004; Gordijn, 2002; Demil & Lecoq, 2010; Zott & Amit, 2010). In our research, we refer to such frameworks (BMO, e3-value, RCOV) as *meta-business models*. We define these analogous to meta-models in software or systems engineering (Van Halteren, 2003):

> A *meta-business model* is the set of concepts that is used to create business models. A business model developed from this set of concepts is an instance of the meta-business model.

For example, a meta-business model may define that "*a business model consists of a value proposition, organization, and finances.*" Thus, the

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meta-business model lays out the rules for modelling a business model. Consequently, a business model is an instance of the meta-model, following those rules. An example of a meta-business model is the BMO (Osterwalder, 2004), which can serve to make a business model of any company. This business model would be an instance of the BMO. However, the BMO is itself also a model. It is a model for creating business models. As such, it is a "*business model*"-model or, in modelling terms, a meta-"*business model*".

Stimulating researchers to build more on each other's work can be achieved by developing instruments for comparing different meta-business models. This can also help the integration with horizontally related concepts such as strategy and processes (Gordijn, Osterwalder & Pigneur, 2005). "*...A conceptual framework will provide a basis for business model theory development by providing a structure from which researchers can debate, recognize points of agreement and disagreement, identify potential points of integration or linkage along with areas of future research*" (Lambert, 2008). Such a conceptual framework can help to analyse shared or distinctive features of different meta-business models (Lambert, 2008).

Consensus on the theoretical underpinnings of the business model concept has not yet been achieved (Al-Debei and Avison, 2010), which undermines its applicability in different contexts. *"...The business model remains a theoretically underdeveloped (and sometimes overloaded) concept, which may raise doubts concerning its usefulness for empirical research and theory building*" (Zott, Amit & Massa, 2011). For future research, more clarity on the theoretical foundation and conceptual consolidation is necessary (Zott, Amit & Massa, 2011).

The articles referenced above are all review articles, specifically aimed at providing an overview of the status and developments of business model research and the emergence of the discipline. In short, the most important issues are:

- the need for a common language,
- lack of conceptual consolidation, and
- theoretical development of the concept.

These issues relate strongly to the different meta-business models existing separately. Consequently, using different meta-models may result in different business models of the very same organization. This can have severe consequences. For example, if a business model is used in a requirements engineering process, the resulting requirements can vary greatly depending on which meta-business model is used. Unfortunately, because of the gaps in business model research, such problems are hard to address currently.

Another area of research, software and systems engineering, has more experience dealing with a great variety of meta-models, and already addressed the need for a generic framework to manage, manipulate, and exchange these models. This generic framework is the Meta-Object Facility (MOF), created by the Object Management Group (OMG) (1999). The MOF represents a layering of meta-models for describing and representing meta-data: data *about* other data (Van Halteren, 2003). Although it originates from an object-oriented software design domain, the MOF allows the definition of (meta-) models independent of the application domain.

In this paper, we introduce the MOF perspective on business modelling. Introducing a new perspective on business modelling helps identify differences and commonalities of business modelling languages and concepts. We use the MOF to create a *meta-meta-business model* that promotes further theory development. In doing so, we contribute to advancing the discipline of business modelling.

The structure of the paper is as follows. After having presented the background and motivation in this section, section 2 further explains the MOF. Section 3 provides our main contribution: it applies MOF to business modelling. In addition, it provides examples for each of the layers. This includes suggesting a meta-meta-business model and a graphical example of this new model's use. Section 4 discusses further research possibilities with the introduction of MOF in business modelling. Finally, section 5 shows how this addresses the presented issues of business model research.

2 THE META-OBJECT FACILITY (MOF)

The MOF was introduced above as a generic framework for working with a great variety of models and meta-models. This section clarifies the concept. The central idea of MOF is that every model is an instance of some meta-model in an abstract layer above it. Hence, a business model is an instance of a meta-business model. The other way round, every meta-model provides a vocabulary for

creating models; these models are instances in an abstract layer below it. Thus, a meta-business model provides a vocabulary for creating business models.

The account of the MOF given here strictly follows Van Halteren (2003). Modelling data in terms of meta-data can continue indefinitely, in theory, with an infinite number of meta-layers. The MOF is defined as four layers only, M0 to M3, as shown in Figure 1:

- Layer M0 – *instances*: an instance is the flat data, which can describe a running system's state. This data is an instance of elements in the M1 layer.
- Layer M1 – *models*: the model provides the vocabulary for the instance. For example, if the instance is a running system, the model is its source code. The model is itself an instance of the M2 layer.
- Layer M2 – *meta-model*: the meta-model consists of generic elements used for description of the model at the M1 layer. For example, having a system's source code at the M1 layer, the M2 layer is a programming or modelling language such as java or UML. While the M1 layer is an instance of the M2 layer, this layer is again an instance of the even more generic elements of the M3 layer.
- Layer M3 – *meta-meta-model*: the meta-meta-model consists of the elements providing the most generic vocabulary for the M2 layer. For example, the M3 MOF model, can be used to describe a language such as java or UML. While in theory an infinite number of meta-layers exists, for our purpose, we follow the M3 layer as standardized in the OMG MOF specification, also called the *MOF model*.

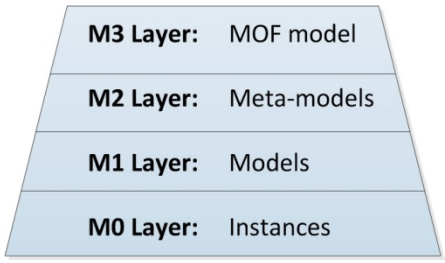

Figure 1: The MOF layers.

The MOF vocabulary comes from the context of object-oriented formalism in software engineering The MOF model itself consists of the following four concepts:

- *Classes*: classes are the primary modelling constructs. These are the central objects that interact with one another. Classes can be organized hierarchically in specializations or generalizations.
- *Associations*: associations are the relations between any two classes. Such a relationship may have a name, cardinality, and type.
- *Data types*: data types are the types used for non-class objects. For example, commonly used data types in the world of programming are integer and string.
- *Packages*: packages are groups of classes and are used to organize models and meta-models. Packages can introduce complex interactions between classes, such as nesting, inheritance, and importing.

The MOF model is a generic meta-meta-model that allows working with a diversity of meta-business models. In using the MOF, ultimately every (meta-) model is defined in terms of classes, associations, data types, and packages. In our attempt to relate business modelling to the MOF, we identify classes only.

3 THE MOF AND BUSINESS MODELLING

This section provides our main contribution: it applies the MOF to business modelling, to create a generic framework for business modelling that provides conceptual consolidation, and helps with a common language and further theory development. The most important reason for using the MOF is the perspective it provides on the practice of modelling.

First, subsection 3.1 shows how the MOF layers encompass the business modelling concepts. Second, subsection 3.2 provides general examples for each of these layers. Third, subsection 3.3 treats the M2 layer. It addresses the issue of which classes should be on this layer. Finally, subsection 3.4 shows several components at the M1 layer.

3.1 Viewing Business Modelling from the MOF Perspective

Applying the MOF layers to business modelling leads to Figure 2. It shows how the MOF layers encompass the concepts of business modelling. It is analogous to Figure 1. Every (business) model is an instance of a meta-model from the above layer. Applying this notion in terms of the MOF layers, as shown in Figure 2, leads to the following layers for business modelling:

- Layer M0 – *business model instance*: the central construct of this research area is a business

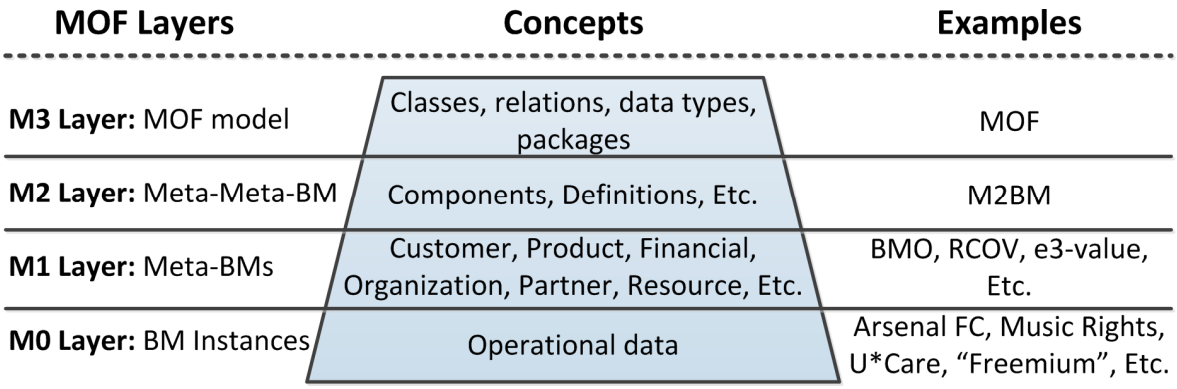

Figure 2: The MOF layers applied to business modelling.

- model instance, which can describe an organization, situation, or pattern. This business model instance is an instance of elements in the M1 layer.
- Layer M1 – *meta-business model*: the meta-business model provides the vocabulary for the business model instance. The meta-business model is itself an instance of the M2-layer. Since the instance data is a model already, the terms change compared to the MOF model. In this case, the *model* from MOF is a meta-business model.
- Layer M2 – *meta-meta-business model*: the meta-meta-business model consists of generic elements used for description of the meta-business model at the M1 layer. While the M1 layer is an instance of the M2 layer, this layer is again an instance of the even more generic elements of the M3 layer.
- Layer M3 – *MOF model*: the MOF model consists of the elements providing the most generic vocabulary for the M2 layer. This is the same model as the top layer of MOF (Figure 1). The MOF model defines every instance in terms of classes, associations, data types, and packages.

The above description shows that the concepts of business modelling and meta-business models fit effortlessly in the MOF layers. This indicates that the MOF is indeed a generic framework, which works for any form of models and meta-models.

3.2 Simple Examples for Each Layer

Starting from the bottom up, many possible examples exist at the M0 layer for business modelling. Business model instances belong in this layer, therefore, any business model that describes an organization, situation, or pattern would fit here. An example of a real life case is U*Care, a service platform for elderly care (Meertens, Iacob & Nieuwenhuis, 2011). Other examples of a business case as business model instances are two models of the clearing of music rights for internet radio stations (Gordijn, Osterwalder & Pigneur, 2005), and modelling of the development of Arsenal FC over a period of eleven years (Demil & Lecoq, 2010). A pattern, such as "freemium", also belongs on the M0 layer (Osterwalder, 2010).

At a higher level of abstraction, the M1 layer contains the meta-business models. They provide the vocabulary for the business model instances. Previously often called frameworks or even ontologies, examples of meta-business models are plentiful. For example, the music rights case is modelled in two different meta-business models, e3-value and the BMO (Gordijn, Osterwalder & Pigneur, 2005). The Arsenal FC case is modelled using the meta-business model RCOV (Demil & Lecoq, 2010). Figure 3 in subsection 3.4 provides more examples, while focussing on their components.

Since this is the first time the M2 layer is recognized in business modelling, nobody has presented examples as such at this layer yet. Following the MOF perspective, the M2 layer contains a meta-meta-business model that provides a vocabulary for meta-business models at the M1 layer. This means that such a meta-meta-business model must consist of generic elements that capture meta-business models, such as the BMO, e3-value, and RCOV. Literature that presents a review of business modelling research, such as Zott, Amit and Massa (2011), suggest those generic elements. In subsection 3.3, we propose classes for a meta-meta-business model (M2BM) that belongs on the M2 layer.

At the top of the pyramid, the M3 layer has only one example in our case. It is the MOF model itself, which we have explained in Section 2 already. It

includes classes, associations, data types, and packages.

3.3 Specifying Classes at the M2 Layer

While an interpretation of business modelling in MOF terminology provides conceptual consolidation, a meta-meta-business model at the M2 layer would provide a common language for business modelling. The meta-meta-business model would be *overarching* the meta-business models. This subsection researches what is necessary to create such an overarching meta-meta-business model.

First, 3.3.1 presents what type of elements should be in the meta-meta-business model. Second, 3.3.2 explains how to obtain these elements. Third and final, 3.3.3 suggests several of these elements in the form of classes.

3.3.1 What Should Be in the Meta-Meta-Business Model?

Business modelling is the act of creating a business model instance; this is an instance of a meta-business model. The instance is a M0 layer model, the meta-business model is a M1 layer concept. Many of these meta-business models exist already, some with a strong link to information systems, others closely related to strategic management or industrial organisation. For example, Vermolen (2010) identified nine such meta-business models published in the top 25 MIS journals. The Business Model Ontology from Osterwalder (2004) was also mentioned previously.

All meta-business models, as M1 models, must follow some sort of guidelines defined at the M2 layer. The generic rules for meta-business model should be defined at the M2 layer as a *meta-meta-business model*: M2BM (M2 both for MOF M2 layer and for meta-meta-). Such a meta-meta-business model does not exist yet; however, as the introduction shows, creating it is exactly what different researchers in the business model discipline are asking for.

The different meta-business models at the M1 layer give the first hint of what this meta-meta-business model looks like. Every model at the M1 layer must be an instance of more generic elements at the M2 layer. The meta-meta-business model must consist of such concepts that it allows the creation of any model that can be regarded as an M1 meta-business model.

The required coverage of M2 classes can be discovered with a commonality analysis amongst different meta-business models. For example, all M1 meta-business models propose some set of *components*, so one of the classes of the M2 meta-meta-business model should be *components*.

Several researchers have in fact performed such commonality analyses. We argue that the abstract meta-meta-business model that belongs on this layer should come from review literature on meta-business models. As a review synthesizes the concepts used in business modelling literature, the resulting concepts can be considered instances of classes from the M3 layer.

3.3.2 Review Literature on Business Modelling

An extensive literature survey identified five articles that can aid us in finding out what classes make up the M2 meta-meta-business model. The method we followed consisted of three steps. The first step was a search on Scopus and Web of Science for relevant articles published between 2000 and august 2011, using two queries:

- in title: “business model*”
- in title-keywords-abstract: “business model*” AND ontology OR ((framework OR e-commerce) AND (design OR analysis))

All results were checked for relevance by analysing the abstract. The second step was an analysis of the articles’ content for relevance, searching for presentation of meta-business models, or review of business model research or literature. The third step was selecting those articles usable for creating the M2 meta-meta-business model. Table 1 presents the resulting five articles.

Table 1: Overview of business model review literature.

Authors	Title	Year
Pateli and Giaglis	*A research framework for analysing eBusiness models*	2004
Gordijn, Osterwalder and Pigneur	*Comparing two Business Model Ontologies for Designing e-Business Models and Value Constellations*	2005
Lambert	*A Conceptual Framework for Business Model Research*	2008
Al-Debei and Avison	*Developing a unified framework of the business model concept*	2010
Zott, Amit and Massa	*The Business Model: Recent Developments and Future Research*	2011

Table 2: Classes for the M2 layer meta-meta-business model.

Pateli and Giaglis, 2004	Gordijn, Osterwalder and Pigneur, 2005	Lambert, 2008	Al-Debei and Avison, 2010	Zott, Amit and Massa, 2011
Definition	Definition	Definition		Definition
	Purpose of the ontology Focus of the ontology Actors using the ontology Other applications	Objective	BM reach BM Functions	Strategic marketing Value creation in networked markets Strategy Innovation
Components	Ontology content and components	Fundamentals (elements)	V4 BM dimensions	Components
Conceptual models	Representation Visualization	Fundamentals (characteristics of representations) Representations (display)		Representations
Change methodology	Change methodology			
Evaluation models	Evaluation methods for business model instances	Operational (measurement)		Firm performance
	Origins			Emergence
Design methods and tools Adoption factors	Supporting technologies Tool support		Modelling principles	
Taxonomies	Classification	Operational (recognition)		Typologies

These five articles present a number of concepts that the authors consider important in business modelling. Pateli and Giaglis (2004) identify eight streams of research in business modelling. Gordijn, Osterwalder and Pigneur (2005) compare the Business Model Ontology and e3-value on a number of criteria. Lambert (2008) creates a business modelling framework based on a conceptual framework from the domain of accounting. Al-Debei and Avison (2010) identify four facets of business modelling. Zott, Amit and Massa (2011) provide the most up to date overview of the state of art of business modelling research.

3.3.3 Classes of the M2BM: A Meta-Meta-Business Model

Table 2 identifies the important concepts in business modelling according to the review literature. It is a first indication of possible classes for the M2BM. A comforting result is that there is quite some overlap in the identified classes. For example, four of the five articles name *definition,* and all have *components*. This allows for mapping of the concepts on to each other to get to a compact list of classes. Already, Table 2 provides an attempt at this. While in some cases this mapping is obvious (as for definition and components), it remains interpretative. As section 4.2 discusses, two concepts were left out of Table 2 deliberately: *ontological role* and *ontology maturity & evaluation*. Both from Gordijn, Osterwalder and Pigneur (2005). The table suggests which classes are important to business modelling.

3.4 Example Use of M2BM: Components of Meta-Business Models

This section presents an example of the M2BM's use in business modelling. The core construct of business modelling is probably the very visible *components* of meta-business models. This example provides a comparison of ten different meta-business models based on their components. It shows how several meta-business models all have their own *instantiation* of the M2BM class *components*. Figure 3 is the result of the comparison (Alberts, 2011).

The first nine meta-business models are those identified by Vermolen (2010), published in the top 25 MIS journals. The tenth has also been

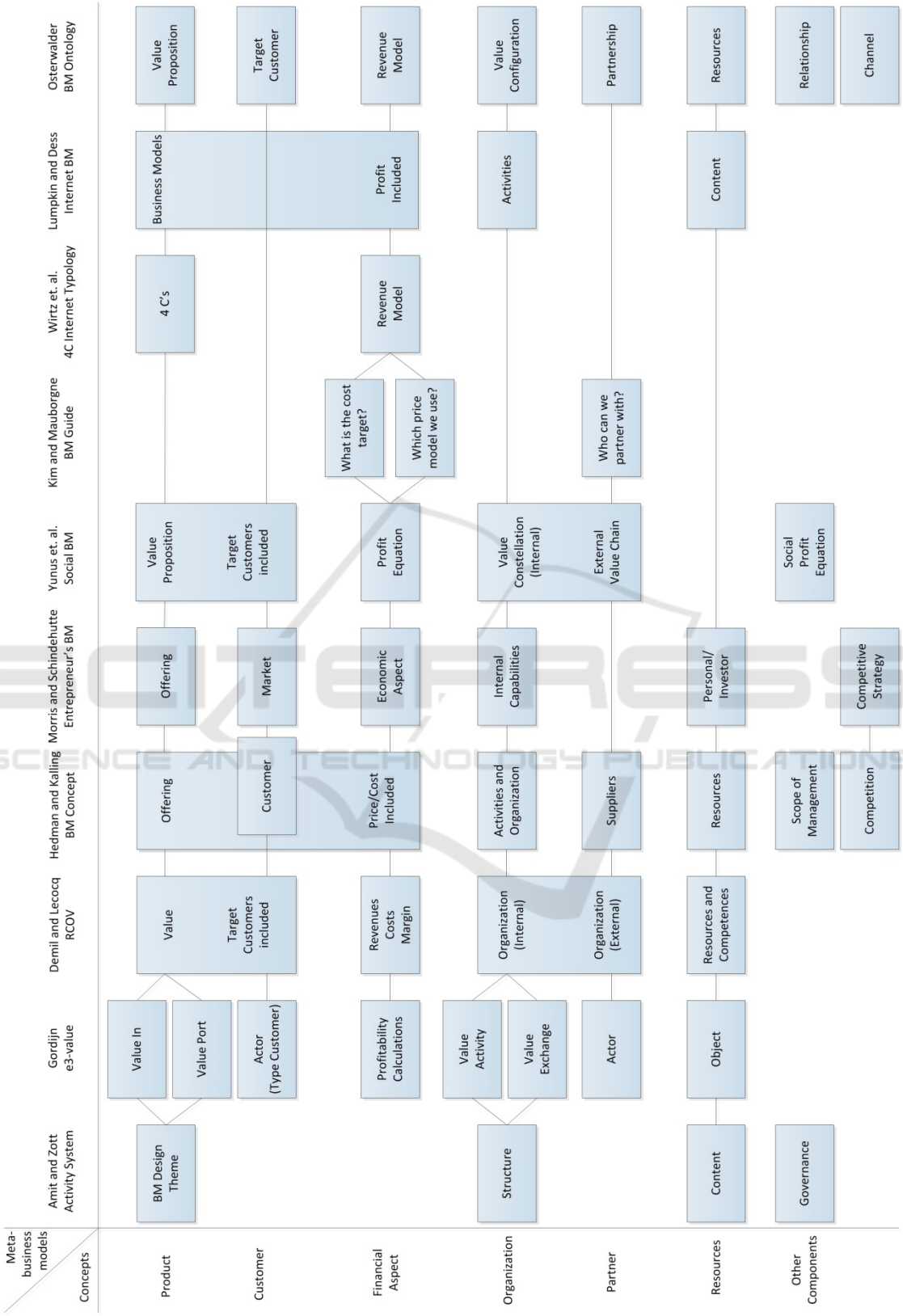

Figure 3: Comparison of M1 layer meta-business model components (adapted from Alberts (2011)).

mentioned already, Osterwalder's (2004) Business Model Ontology.

1. *Activity system* by Zott and Amit (2010).
2. *e3-value* by Gordijn (2002).
3. *RCOV* by Demil and Lecocq (2010).
4. *The BM concept* by Hedman and Kalling (2003).
5. *Entrepreneur's BM* by Morris, Schindehutte and Allen (2005).
6. *The social BM* by Yunus, Moingeon and Lehmann-Ortega (2010).
7. *The BM guide* by Kim and Mauborgne (2000).
8. *4C Wirtz*, Schilke and Ullrich (2010).
9. *Internet BM* by Lumpkin and Dess (2004).
10. *BMO* by Osterwalder (2004).

Figure 3 identifies the components used in the above articles. It is an indication of possible components for meta-business models. Quite some overlap exists in the identified components, which allows for mapping of the concepts on to each other. Already, Figure 3 provides an attempt at this. While in some cases this mapping is obvious, it remains interpretative. However, the figure still suggests which components are important to business modelling.

4 DISCUSSION

The purpose of this study is to promote theory development by viewing the concepts of business modelling in light of the Meta-Object Facility. Besides an open review of what the MOF allows, this section also comments on the classes left out of the B2BM.

4.1 Uses for the MOF Perspective on Business Modelling

Our main reason for using the MOF is the perspective it offers on the practice of modelling. As such, we have only identified classes in the M2 Layer meta-meta-business model. Still, it has become very clear that the discipline of business modelling allows for use of the MOF, and that the concept of meta-models can be of great assistance. We believe this introduction of MOF in business modelling has only scratched the surface of what is possible. Take for example an association between two classes: the scope of what is being modelled will strongly influence which components are important.

Defining the M2BM in terms of the MOF model concepts allows formalization of business modelling that promotes its use in requirements engineering and software development. In the same line of reasoning, the MOF perspective may provide a new chance to match business modelling and UML. So far, literature that uses both the terms "UML" and "business modelling" focuses on process modelling, not on business modelling. Another application of UML in this domain is creating a reference ontology (Andersson et al., 2006). This reference ontology allows model transformations between Resource-Event-Agent (REA), e3-value, and BMO. Such reference ontology may provide useful methods for the M2BM.

The MOF opens a rich new view on business modelling. So far, we have only looked at one aspect: the possible classes of the M2BM. There are still many more possibilities in using the MOF to approach business modelling.

4.2 Classes Left out of the M2BM

Two potential classes were left out of Table 2. They are ontological role, and ontology maturity & evaluation. Both concepts come from Gordijn, Osterwalder and Pigneur (2005). We argue that these two concepts are not suitable as classes for a meta-meta-business model.

The ontological role does not fit, as it is very similar to the entire concept of the MOF. As such, it has no place within one of the layers. For ontological role, Gordijn, Osterwalder and Pigneur (2005) define three levels: operational data at Level L0, ontology at Level L1, and ontology representation language at Level L2. Operational data is similar to what we call a business model instance at layer M0. Ontology is similar to what we call a meta-business model at layer M1. Finally, an ontology representation language is similar to the M2BM at layer M2.

Ontology maturity & evaluation does not fit, as it is itself not meta-data describing a meta-business model. Rather, checking maturity could be a use of the M2BM. For example, the maturity of a meta-business model could be scored based on how many of the M2BM classes it implements.

5 CONCLUSIONS

This article uses MOF to provide a new perspective on business modelling. This contributes to business modelling on three important issues:

- the need for a common language,
- lack of conceptual consolidation, and
- theoretical development of the concept.

Introducing the MOF perspective provides conceptual consolidation in business modelling. The MOF is used to take a different perspective on the meta-business models, which makes it possible to find commonalities. Identification of the M2BM classes illustrates this. In addition, existing definitions of "business model" can be positioned on the layers. This provides better options to compare definitions.

The M2BM on the M2 layer provides a common language for business modelling. In business modelling literature, many authors have their own vocabulary. In creating the M2BM, we show that different terms often refer to a single concept. Approaching the different meta-business models from a higher MOF layer addresses this issue. Doing so allows building on the strengths of the meta-business model original domains: strategic management, industrial organization, and information systems. Using the MOF, and especially the M2BM as a common language, helps overcome the differences of these domains and focus on commonalities.

Finally, theoretical development of the business model concept is promoted, as the MOF opens up a wide range of research possibilities for business modelling. Placing the concept of business model in the frame of the MOF allows for further theory development, both within the discipline and in relation to other domains. It serves as a navigational landmark for business model research when relating it to existing material. Additionally, it helps to create bridges to other research areas, especially when relating to other modelling domains.

Future research must specify a M2BM with classes, and possibly relations, data-types, and packages. This common language will define business modelling. The M2BM presented in this article is a first draft; as such, it requires more work. However, even in this rough form it shows that the MOF is a rich addition to the business modelling discipline.

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