An e-Business Model Ontology for the Creation of New Management Software Tools and IS Requirement Engineering

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Abstract. The goal of this paper is to give an overview of a thesis that focuses on the domain of e-business models and its application in Management Information Systems (MIS) and Requirements Engineering. The heart of the thesis is the development of an e-Business Model Ontology based on an extensive review of enterprise ontologies and business model literature. By merging the advantages of these two domains, one creates an appropriate basis for the development of a set of software prototypes that help managers understand, communicate and share, design and change e-business models. Further, such models that explain the e-business logic of a company would help IS designers better understand and implement e-business systems without reinventing strategy.

1 INTRODUCTION

We live in a competitive, rapidly changing and increasingly uncertain economic environment that makes business decisions complex and difficult. Companies are confronted with new information and communication technologies (ICT), such as the Internet or mobile communication systems, but also shorter product life cycles, global markets and tougher competition. In this hostile business environment, firms should be able to manage multiple distribution channels, complicated supply chains, expensive Information System[1] (IS) implementations, strategic partnerships and still stay flexible enough to react to market changes. Astonishingly, software tools that help managers facilitate strategic business decisions in this difficult environment are still scarce. Where are the tools that help managers easily explain what their business is and how exactly they execute it, except maybe for simple text editors or charting tools? Where are the really useful Management Information Systems (MIS) that allow them to assess, understand, measure, change, communicate or even simulate their business models? Of course, every manager and entrepreneur has an intuitive understanding of how his business works and the logic of how it creates value, in other words, the company's business model. But even though this business model influences all important decisions, in many cases she or he is rarely able to communicate it in a clear and simple way (Linder et al., 2001). And how can one

[1] I define IS as a term that encompasses all systems used to create, store, exchange, manage and use information in its various forms inside a firm and across its borders.

decide on something or change it, if it is not clearly understood by the other parties involved? Therefore, it would be interesting to think of a set of software tools that would allow business people to understand what their business model is, including its essential elements. In other words, - tools that would let them easily communicate this model to others (such as to the IT responsible) and allow them to introduce changes and experiment with it in order to learn about business opportunities.

2 RESEARCH QUESTIONS

The thesis outlined in this paper will endeavor to show how the fusion of the ideas in business model literature and the ideas of enterprise ontologies create an appropriate basis for the development of a range of new management tools or IS requirement engineering tools in the e-business domain. By merging the conceptually rich business model approach with the more rigorous ontological approach and by adopting it to e-business, we achieve an appropriate foundation for tools that would allow the understanding, sharing and communication, change, measuring and simulation of e-business models. On the one hand, these tools consist of new methodologies and, on the other, new management software for executives and academics.

So what really is a business model? As explained by Petrovic et al. (2001), a business model is not a description of a complex social system itself with all its actors, relations and processes. Instead, it describes the logic of a "business system" for creating value that lies behind the actual processes. A business model is the conceptual and architectural implementation of a business strategy and the foundation for the implementation of business processes and Information Systems (see figure 1).

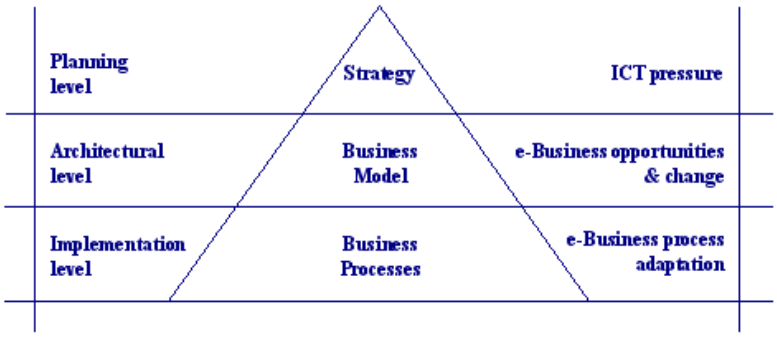

Figure 1: Business Logic Triangle

Business models have two essential functions. First, they allow managers to talk about possible implementations of strategic objectives and understand the relevant issues. Secondly, an appropriately formulated business model can help managers easily express what they expect from people on the business process level or from technically oriented people that are in charge of IS implementation. Therefore, the following research questions will be addressed throughout the thesis:

1. How does the process of modeling a social system, such as an e-business model ontology, help in ***identifying*** and ***understanding*** the relevant e-business

elements in a company and the relationships between them (Ushold et al., 1995; Morecroft, 1994)?

2. What prototypes of software-tools based on formalized e-business models (i.e. e-business model ontologies) help managers easily ***communicate and share*** their understanding of an e-business among other stakeholders (Fensel, 2001) and, how can these tools improve implementation from strategic planning down to business process execution and IS Requirements Engineering?
3. Are the mentioned prototypes a means to facilitate ***change*** and ***innovation*** because they allow business model designers to experiment with models? Would it be possible to measure and simulate these models based on system dynamics?

3 KNOWLEDGE OF THE PROBLEM DOMAIN

The research questions of the problem domain embrace three distinct areas that are separately analyzed and subsequently merged providing some interesting answers and solutions. These areas are 1) enterprise ontologies, 2) business model frameworks, 3) decision support systems and 4) IS requirements engineering.

3.1 Enterprise ontologies

An ontology is a representation of a shared conceptualization of a particular domain. Such a common conceptualization is necessary for every communication process and allows us to reason about similarities and differences between concepts (Bertolazzi et al., 2001). This thesis has found some inspiration in the different research projects on enterprise ontologies, their methodologies and the resulting software tools. These ontologies mainly concentrate on processes and organizational representation, whereas the focus of this work is on the logic and concepts of value creation. In other words, this thesis focuses on a higher level of abstraction, which is the business model. The goal of using ontologies for the purpose of this work is the creation of a shared understanding and communication of e-business models, their reuse and modification without having to re-invent the wheel each and every time (Ushold et al., 1996). The following ontologies have served as source of inspiration:

Business Engineering Model (BEM). This model represents a set of formalisms to specify the core metadata found in the operational and data warehousing environment of enterprises in order to support interoperability among them. These concepts are described in UML.

The Edinburgh Enterprise Ontology. The work of the Edinburgh Group is aimed at proposing an enterprise ontology, i.e., a set of carefully defined concepts that are widely used for describing enterprises in general and that can serve as a stable basis for specifying software requirements. The group has developed tools for modeling, communicating and representing enterprises and processes in a unique way. The EO is represented in an informal way (text version) and in a semi-formal way (Ontolingua).

The Toronto Virtual Enterprise (TOVE). This project has formally defined a set of concepts that are general enough to allow for their use in different applications.

The concepts, similarly to the EO, are grouped into thematic sections. For each concept, properties and relations are defined.

3.2 Business Model Frameworks

There exists a growing literature on (e-) business models by academics and consultants. Some speak of "Internet business models" and others of "business models for the web", but they all mean certain aspects of the business logic of a firm that have a strong IT-component. The early authors have mainly written about the classification of models in different categories (Timmers, 1998; Rappa 2001; Tapscott et al., 2000). In contrast, the latest literature has started decomposing business models into their "atomic" elements (Afuah et al., 2001; Hamel, 2000; Petrovic et al., 2001; Weill et al., 2001; Rayport et al., 2001). This section gives an overview of the existing literature taking into account three aspects, being revenue- and product-specific, business actor- and network-specific and marketing-specific. This review is necessary in order to provide a sound ontology of the e-business model domain and to understand what the composition of a business model should be.

Revenue/Product Aspects. Rappa (2001) and Tapscott et al. (2000), provide a taxonomy of e-business models rather than an explanation of what elements such a model contains. Both authors concentrate on revenue- or product-specific aspects.

Business Actor and Network Aspects. Timmers (1998) provides a taxonomy in which he classifies e-business models according to their degree of innovation and their functional integration. Gordijn and Akkermans (2001) provide a more rich and rigorous business model framework, which is based on a generic value-oriented ontology specifying what is in an e-business model. This framework even allows the graphical representation and understanding of value flows between the various actors of a model. Afuah et al. (2001) and, quite similarly, Amit et al. (2001) outline a value- and actor-centric framework that provides a list of business model components.

Marketing Specific Aspects. Hamel (2000) identifies four main business model components that are related to each other and are decomposed into different sub-elements. The main contribution of this methodology, as well as that of Rayport et al. (2001), is a view of the overall picture of a firm. Petrovic et al. (2001) divide a business model into sub-models, which describe the logic of a business system for creating value that lies behind the actual processes. Weill et al. (2001) also suggest a subdivision into so-called atomic e-business models, which are analyzed according to a number of basic components.

3.3 Decision support systems

Business Modeling. Confusingly, business modeling is currently often understood as the modeling of business processes (not the "real" business logic). A range of tool types is available to support the large spectrum of business modeling requirements (Marvin, 2001). At one end of the spectrum are drawing tools that provide the basic functionality required to portray a process as a picture. Mapping tools extend the functionality by including a spreadsheet-like function that may

allow for data entry and basic calculation. Such tools typically include methods to validate the structure of the diagrams being produced and have the ability to search and report on the data stored. Some tools provide the ability of dynamic calculations and run with data that reflect changes over time. These simulation tools represent the most complex form of modeling.

MIT Process Handbook. A team of MIT researchers has created an electronic "process repository" with thousands of activities that shall enable managers to easily explore different options for performing common tasks, help people learn about organizations, invent new kinds of organizations and improve existing processes. The resulting MIT Process Handbook was developed for viewing and manipulating process descriptions and information content about business processes.

3.4 IS Requirements Engineering

Based on discussions with executives and consultants, I conclude that there exists a gap between the top of the business logic triangle, which is strategy (see figure 1), and the implementation level, which are processes, IS and IT. When managers cannot clearly communicate their vision of a business, process and IS designers will not know what exactly to do. As a result, they often reinvent strategy and implement their own vision of a business. Few tools cover the full range of the business logic triangle.

4 State of the Existing Solutions

This thesis addresses two major shortcomings of the domains outlined above. First, the existing enterprise ontologies and decision support systems explained above mainly concentrate on business processes. They do not treat the actual business logic of a firm, which represents a higher level of abstraction than the business processes model (see figure 1). Because managers and strategy makers are mainly preoccupied with the logic of their “business system” and how it creates value that lies behind the actual processes, the existing tools do not serve their purpose. Enterprise ontologies can be very useful when it comes to IS Requirements Engineering from an engineer’s point of view, but to understand and manipulate them one has to have quite a good technical understanding. In the business logic triangle (see figure 1), enterprise ontologies would be placed at the lowest level, where they certainly serve their purpose. However, they hardly help managers translate their strategic objectives into a business model and then into processes and ISs.

Secondly, the existing business model frameworks are a starting point for managers to understand the implementation of their strategic e-business objectives. Whereas the early literature in this domain was a simple classification of business models, the latest literature enumerates what main elements are found in a business model. Some, but still few, authors cover all the relevant business domains, as explained in the literature review above. But the problem with the business model frameworks is that they are hardly rigorous or deep enough to give a clear picture of how a business model really works. They rarely decompose their models far enough to achieve a crystal-clear understanding and often the

relationships between the elements are missing. Without wanting to criticize these frameworks - because they are clearly an interesting starting point - this thesis would like to complete them with a more rigorous ontological approach. Only a rigorous approach can be the basis for the development of the business model software tools that will be explained in the next section.

5 IDEAS – APPROACH – RESULTS

The research for this thesis is divided into three consecutive levels which are (1) the ontology level, (2) the measures level and (3) the dynamic equation level (figure 2). Every one of these levels has a management function and IS applications. This thesis essentially concentrates on the first level and the development of some corresponding software prototypes.

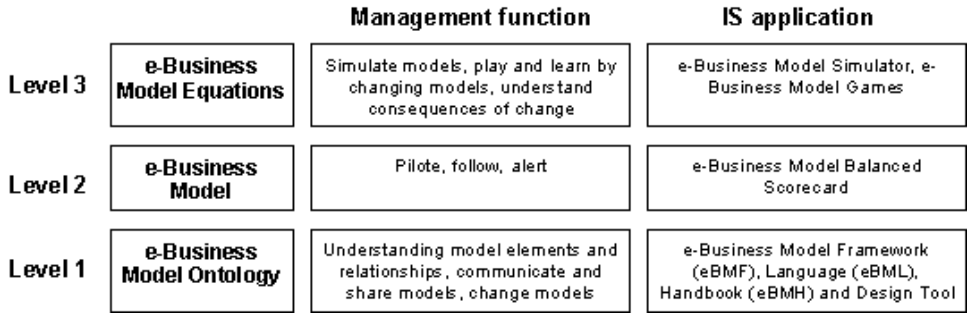

Figure 2: Research Levels

5.1 The e-Business Model Ontology (e-BMO)

The core of this thesis is the e-Business Model Ontology (e-BMO), which is the conceptualization and formalization into elements, relationships, vocabulary and semantics of the essential subjects in the e-business model domain. By providing a rigorous and formal building-block-like methodology, e-business model literature could make one step forward. This means being rigorous and enumerating the generic bricks of an e-business model in order to create the foundation to develop new software tools in e-business management and IS Requirements Engineering.

e-BMO is structured into several levels of decomposition with increasing complexity. The first level of decomposition of our ontology contains the four main pillars of a business model. These are the products and services a firm offers, the relationship it maintains with its customers, the infrastructure necessary in order to provide this and finally, the financials, which are the expression of business success or failure (see figure 3). Details can be found in Osterwalder et al. (2002).

Name of e-BMO Element	**e-BUSINESS MODEL ONTOLOGY (root element)**
Composed of	• PRODCUT INNOVATION • CUSTOMER RELATIONSHIP • INFRASTRUCTURE MANAGEMENT • FINANCIALS
Level of decomposition	0

Cardinality	1 obligatory element
Description: An e-BUSINESS MODEL ONTOLOGY is *composed of* the PRODUCT INNOVATION element, the CUSTOMER RELATIONSHIP, the INFRASTRUCTURE MANAGEMENT and its FINANCIALS. These main elements are then further decomposed.	

Name of e-BMO Element	**PRODUCT INNOVATION**
Child of	Root Element: Business Model
Composed of	• TARGET CUSTOMER SEGMENT • VALUE PROPOSITION • CAPABILITIES
Level of decomposition	1
Related to	• *Marketed through* CUSTOMER RELATIONSHIP: PRODUCT INNOVATION only represents a value for the firm when offered to their customers. • *Based on* INFRASTRUCTURE MANAGEMENT: In order to provide the element PRODUCT INNOVATION, the firm has to maintain an INFRASTRUCTURE MANAGEMENT
Cardinality	1 obligatory element
Description: The PRODUCT INNOVATION element covers all aspects related to the offering of the firm. This comprises not only its products and services, but also the manner in which it differentiates itself from its competitors. In other words, this means not only the firm's market scope (Hamel, 2000; Afuah et al., 2001) - which customers, which geographical areas and what product segments – but also the explanations of why customers would buy from this firm rather than a competitor. Moreover, the ability to offer value to a customer demands a range of specific capabilities.	
The element PRODUCT INNOVATION is *composed of* the VALUE PROPOSITIONs the firm offers to specific TARGET CUSTOMER SEGMENTs and the CAPABILITIES a firm has to be able to assure in order to deliver this value. The outcomes of the PRODUCT INNOVATION element are *marketed through* the CUSTOMER RELATIONSHIP ELEMENT, which at the same time provides a source of *feedback for* product amelioration. PRODUCT INNOVATION is based on the INFRASTRUCTURE MANAGEMENT, which provides a *resource for* it.	

Name of e-BMO Element	**INFRASTRUCTURE MANAGEMENT**
Child of	Root Element: Business Model
Composed of	• RESOURCES • ACTIVITY CONFIGURATION (or VALUE CONFIGURATION) • PARTNER NETWORK
Level of decomposition	1
Related to	• *Resource for* PRODUCT INNOVATION • *Resource for* CUSTOMER RELATIONSHIP • *Cost for* FINANCIALS
Cardinality	1 obligatory element

Description: ICT, and particularly the Internet, have had a fundamental impact on the way companies organize their activities inside and at the boundaries of the firm. Not only have company boundaries have become more fuzzy, but increasingly the decomposition and re-composition of the industry value chain has redistributed the activities among existing and new industry actors.
INFRASTRUCTURE MANAGEMENT describes the value system configuration (Gordijn et al., 2000) that is necessary in order to deliver the firm's offering and to establish and maintain a customer relationship. It is *composed of* the ACTIVITY CONFIGURATION, in-house RESSOURCES AND ASSETS and the firm's PARTNER NETWORK to fulfill these activities. The INFRASTRUCTURE MANAGEMENT element is a *resource for* PRODUCT INNOVATION and CUSTOMER RELATIONSHIP.

Name of e-BMO Element	**CUSTOMER RELATIONSHIP**
Child of	Root Element: Business Model
Composed of	• INFORMATION STRATEGY • FEEL & SERVE • TRUST & LOYALTY
Level of decomposition	1
Related to	• *Feedback for* PRODUCT INNOVATION: By analyzing the CUSTOMER RELATIONSHIP, a firm can gain important insights on the use and appreciation of its products/services. • *Based on* INFRASTRUCTURE MANAGEMENT: In order to provide the element CUSTOMER RELATIONSHIP, the firm has to maintain an INFRASTRUCTURE MANAGEMENT
Cardinality	1 obligatory element
Description: Through the use of ICT, firms can redefine and ameliorate the notion of CUSTOMER RELATIONSHIP. ICT supports and, in some cases, substitutes direct physical contact with the customer. The CUSTOMER RELATIONSHIP element describes the way a firm goes to market and gets in touch with its customers. Additionally, it contains the strategies of the company to collect and use customer information in order to improve relationships and adapt the firms offering to customer needs. Finally, the company must define and outline its plans to gain the customer's trust and loyalty.	
The element CUSTOMER RELATIONSHIP is composed of the FEEL & SERVE element, which defines the customer "touch points" (e.g. distribution channels), the INFORMATION STRATEGY for the collection and application of customer information and the TRUST & LOYALTY element, which is essential in an increasingly "virtual" business world. The CUTOMER RELATIONSHIP element *provides feedback for* PRODCUT INNOVATION and is *based on* INFRASTRUCTURE MANAGEMENT.	

Name of e-BMO Element	**FINANCIALS**
Child of	Root Element: Business Model
Composed of	• REVENUE MODEL

	• COST STRUCTURE • PROFIT/LOSS
Level of decomposition	1
Related to	• *Resource for* INFRASTRUCTURE MANAGEMENT
Cardinality	1 obligatory element
Description: The element FINANCIALS is the culmination of an e-business model. The best products and services and the finest customer relationship are only valuable to a firm if it guarantees long-term financial success.	
The FINANCIALS element is *composed of* the companies REVENUE MODEL and its COST STRUCTURE, which finally define the PROFIT/LOSS of a firm. This element is a resource for INFRASTRUCTURE MANAGEMENT and is funded through the sales in the CUSTOMER RELATIONSHIP.	

Case studies that are analyzed with the e-Business Model Ontology are assessed and described through an Extensible Markup Language (XML)-based description language that constitutes a sort of e-business model grammar (Ben Lagha et al., 2001).

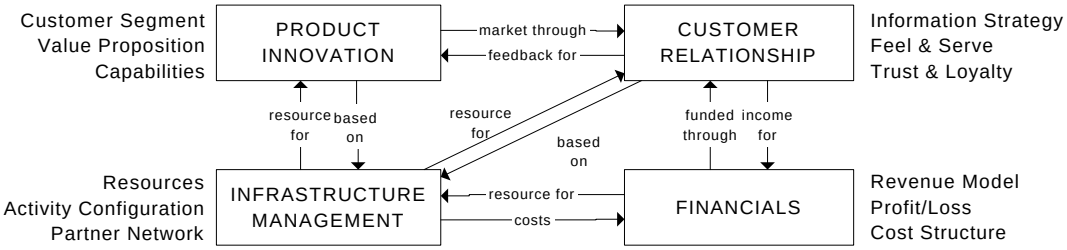

Figure 3: e-Business Model Ontology e-BMO

5.2 The e-Business Model Visualization Tool

Once the ontology has been defined with about four levels of decomposition, the development of some software prototypes for IS application can begin. It could be interesting to build a software that would allow managers to capture their business model and then visualize it through a graphical presentation (figure 4). This would help executives communicate and share their vision and understanding of what their business system looks like. Such a tool would not only enhance communication and discussion, but would facilitate decision making for business model problems.

On the one hand, the visualization tool would allow executives to graphically represent the actual business model of a firm and, on the other hand, equally allow the representation of virtually possible business models. This would facilitate change, allow the achievement of buy-in from involved decision-makers and foster innovation. Such a graphical information system could also help managers understand the business models of competitors.

But the opportunities for such software extend beyond the executive level. A visualization tool could also help in bridging the gap between the executive and the operational “world”. Often, managers have difficulty in communicating their

strategic vision into an executable form (such as a business model). As a consequence, process and IT/IS people frequently reinvent strategy and implement systems that do not correspond to the initially communicated message of executives. A visualizing business model tool would be the first step to better communication. At a later stage of the research, one could imagine more sophisticated systems that automatically design processes or IS requirements corresponding to the firm's business model.

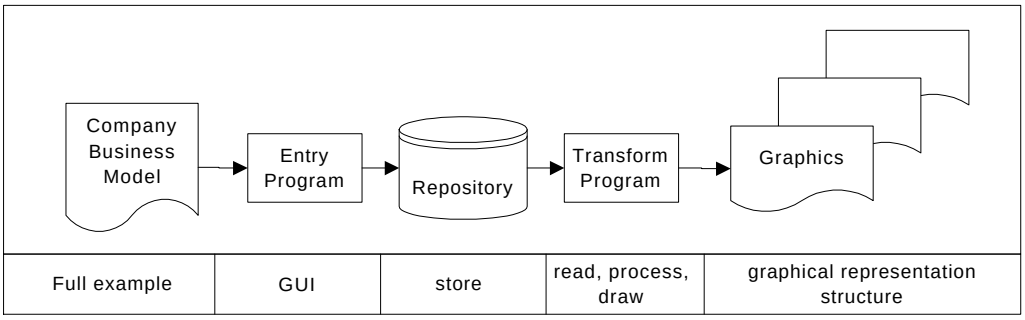

Figure 4: Visualization tool

5.3 e-Business Model Simulation – a Mission

The long-term vision and the follow-up work of this thesis could be an e-Business Model Simulation Tool based on system dynamics (Sternman, 2000). However, without the e-BMO foundation, such software would not be feasible. Based on the e-BMO, and with the help of equations that calculate the influences of the several elements of an e-business model on each other, a model could be simulated and better understood. By using simulation for learning, managers can do risk free experiments without endangering their organization (Morecroft, 1994). The concept of management and strategic simulation focuses on learning rather than wanting to predict the future. Such a tool would resemble a sort of e-business model flight simulator. Managers would gain important insights on their actions and would learn about their e-business models by experimenting with them. Further, the use of system dynamics could help companies prepare scenario planning (Van der Heijden, 1996) in order to prepare managers for an uncertain e-business future. However, this seems to be out of the range of a single thesis.

6 RESEARCH METHODOLOGY

The thesis and its research methodology are twofold. The definition of the e-Business Model Ontology is based on conceptual research. The rigorous framework is based on an extensive literature review of the existing business model frameworks and the literature on enterprise ontologies. The second part of the thesis, with its software prototypes for business model visualization, is based on design science (Au, 2001). This could be a source of inspiration not only for software firms that develop tools for management and IS Requirements Engineering, but also for executives that are interested in the idea of graphical business model representation.

7 CONTRIBUTIONS

The main contribution of this work shall be to bring business model theory one step further and to apply it to software design for management and IS Requirement tools. The practical result will be a rigorous e-Business Model Ontology based on an extensive literature review on business models and enterprise ontologies. The practical part of the thesis provides academics and executives with a possible application of e-business model theory in companies through software prototypes, such as the e-business model visualization tool.

Further, this thesis constitutes the basis for a whole new range of other applications. For example, a formalized e-business model language based on XML to assess real-world cases (Ben Lagha et al., 2001)(not to be confused with the existing XML-based e-business languages on the process level that are more EDI-like, such as ebXML, cXML or xCBL). This formal representation and the multitude of existing tools to manipulate XML documents have a number of advantages. It would be easy to compare models to one another or to generate different views (such as specific documents) in function of different needs (such as descriptions, graphical representations, business plans, reports for financing, reports for eventual partners, acquisitions or mergers, etc.). Finally, the contributions of this thesis can be the foundation for e-business model simulation and scenario planning.

The thesis outlined in this paper shall cover about three years of work. The first year, which has been completed, has covered the development of a formal e-business model ontology and some aspects of an e-business model description language based on XML. Further, some conceptual work for a building block like e-business model design tool has been fulfilled. The coming two years will be devoted to the development of the e-business model visualization prototype. Throughout this second phase, academics, executives and business consultants will evaluate the ontology and the prototype.

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