An Ontology for Open Government Data Business Model

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ABSTRACT
Despite the existence of number of well-known conceptualization in e-Business and e-Commerce, there have been no efforts so far to develop a detailed, comprehensive conceptualization for business model. Current business literature is replete with fragmented conceptualizations, which only partially describe aspects of a business model. In addition, the existing conceptualizations do not explicitly support the emerging phenomenon of open government data – an increasingly valuable economic and strategic resource. Consequently, no comprehensive, formal, executable open government data business model ontology exists, that could be directly leveraged to facilitate the design, development of an operational open data business model. This paper bridges this gap by providing a parsimonious yet sufficiently detailed, conceptualization and formal ontology of open government data business model for open data-driven organizations. Following the design science approach, we developed the ontology as a 'design artefact' and validate the ontology by using it to describe an open data business model of an open data-driven organization.

CCS Concepts
• Applied computing~E-government

Keywords
Open government data; open data business model; open data-driven organization; formal conceptualization; e-Business ontology; e-Commerce ontology; and business model ontology

1. INTRODUCTION
Companies are confronted with new information and communication technologies, 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 IT implementations, strategic partnerships, and still stay flexible enough to react to market changes [1]. To address the need of a whole range of organizations, reference model or a conceptual model is introduced. Reference models promise higher quality of a system at less cost. This is done via providing the system with a reference model that provides appropriate descriptions of an application domain and acts as a blueprint for a distinctively good design of the system and related organizational settings [2] [3]. While, management literature is famous for producing concepts and models, surprisingly, the concepts and software tools that help managers facilitate strategic business decisions [4] are still very scarce and in most of the times, little of these concepts have been translated into software-based tools such as formal conceptualization or ontology [1].

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In the practice community, business model has become a popular tool for analyzing organizational choice, challenge and development [5] and according to [4], the business model acts as a "powerful strategic tool" that help expose how businesses can tap into new markets and opportunities and displace competitors [6]. Open data business model (ODBM) concept has become popular because of a business environment shaped by open data, open government data, and big data [7], coordination of a large number of stakeholders working with data [8], optimizing and reinforcing many parts of the business [9] due to adopting new data resources and processes, today's fierce global competition, profitability, and survivability, and an increasing complexity and uncertainty that leaves managers with difficult decisions to make [10]. Organizations relying on open data, open government data, and big data need to understand, adopt, and communicate with a business model [10] that can on the one hand facilitate the use/reuse of open data, open government data, and big data and on the other hand increase competitiveness and ensure survivability of the organization [11].

Whereas scientific work performed in the area of ODBM is very limited to [12] [11] [7] and most of the business model research works stay at a non-conceptual, broad and sometimes even vague level [11], this work tries to dig into the details and define a model to describe and present OGDBM formal conceptualization in detail. To simplify the life of the managers and business analysts, by following the design science research method, this paper presents and describes an open government data business model ontology (OGDBMO) as it stands for the definition of semantics and syntax in a domain and according to [13] a "formal explicit specification of a shared conceptualization". As we want the ontology to define the concepts and their relationships in the domain [14] [15], we therefore refer to our modeling approach as a domain ontology.

Despite existence of ontologies such as Business Model Ontology [16], the e3-Value Ontology [17], and the Resource-Event-Agent (REA) Ontology [18], we developed the OGDBMO based on the ODBM conceptualization presented in [12] and [11] because it is the recently developed ODBM conceptualization addressing important elements and relationships such as internal resources, assets, processes, managerial skills, and capabilities for business model design and development in open data-driven organizations. The OGDBMO developed in this study helps governments to be more accountable and productive as it acts as a knowledge base for governments and government agencies to gain insight in the open data ecosystem. This will result in reinventing government regulations and policies that can foster economic benefit of open government data by unleashing real value of open government data for both public and private organizations and start-ups. It also helps

government agencies to identify underlying problems and challenges new businesses and start-ups may be facing in regard to using open government data for product and service innovation.
The OGDBMO developed in this paper provides a reusable conceptualization useful in 1) describing a particular OGDBM in a precise and structured way, 2) describing the essential concepts or elements and relations that needs to be considered when designing and developing an OGDBM, and 3) showing OGDBM stakeholders what kind of decisions should be made and factors to be considered during OGDBM design and development inside the open data-driven organization. We consider the developed ontology as a 'lightweight' ontology – consisting of backbone taxonomies only [19] [14].

The outcome of this research is an OGDBMO that shall ideally represent the foundation for new management tools in open data strategy. The goal of this research is to bring business model research in general and ODBM in specific a step further by tackling the concept of ODBM with an ontological approach. Therefore, we contribute to the domain by:

- introducing – as the first scholarly effort – the concept of OGDBMO
- updating the knowledge in the business model domain specifically ODBM area,
- consolidating the research in the domain of business models [11] into a specification of a conceptualization resulting in the proposition of an OGDBMO defining the semantics and relationships of eight main elements.

According to [21], a design science research publication should include introduction, related work or literature review, methodology, artifact description, evaluation, and conclusion. In this paper, we present the introduction in section 1. In section 2, we elaborate more on the related work. In Section 3, we present our approach and methodology to constructing an ODBMO. In Section 4, we discuss the ODBM conceptualization based on the 6-Values business model conceptual framework. In Section 5, we present and elaborate on the whole design of the ontology. In Section 6, we demonstrate the developed ontology. In section 7, we validate the ontology. We present final conclusions in Section 8.

2. RELATED ONTOLOGIES

In this section, we examine in more detail the well-known works on existing (e) business-oriented ontology to determine the research gaps to be tackled by our model. In this research, despite existence of number of (e) business-oriented ontology such as AIAI enterprise ontology [22] and TOronto Virtual Enterprise Ontology [23], we focus on Business model Ontology [16], e3-Value Ontology [17] and Resource-Event-Agent (REA) Ontology [18] as the focus of this research is on the most prominent and elaborated ontology that focus on the notion of value and the way objects of value are created, exchanged and consumed in a stakeholder network, while the AIAI enterprise ontology and TOronto Virtual Enterprise Ontology concentrate on the enterprise itself rather than external value perspective [24]. Also, we focus on most prominent and elaborated frameworks to ensure that selected frameworks are largely representative of the state-of-the art of business model. These ontologies and frameworks are discussed in turn below.

2.1 Business Model Ontology (BMO) [16]

In 2002, Osterwalder provides a building-block-like methodology that defines the essential concepts in e-business models and shows the relationships between them [25]. In 2004, based on the methodology defined in 2002, Osterwalder proposed a new generic conceptual model of business models which is subsequently call business model ontology (BMO) (Figure 1). The ontology aims to address the question of "*How can business models be described and represented in order to build the foundation for subsequent concepts and tools, possibly computer based?*" [16]. BMO is a managerial tool focuses on the categorization of the important aspects to create value [26] and it sees business model as a conceptual tool representing inside company logic and the way a specific company does business and earns revenue [16]. Therefore, BMO highlights the relevant elements firms have to think of, in order to operate successfully [25].

BMO consists of four main components [26] [25]: *Products and services*: This represents the 'value proposition' an organization offers to its 'customer segments' representing a substantial value to the customer, and for which he is willing to pay, *Infrastructure and the network of partner*: This represents the organization's activities or processes, its internal resources and network of partners or inter-organizational ties in order to create value and to maintain a good customer relationship, *Relationship capital*: This represents the strategies with which the organization uses to create and maintain strong relationship with the customer, in order to satisfy the customer and to generate sustainable revenues. The important elements are the a) Information strategy with which it gathers: maintains and exploits customer information, b) Distribution Strategy: the multiple channels though which it reaches the customer c) Customer Loyalty: methods to establish customer' trust in the organization and to achieve customer satisfaction and *Financial aspects*: This includes all the financial components of the business such as the 'cost model', 'revenue model', and 'profit model' generated from the value offered to its customers.

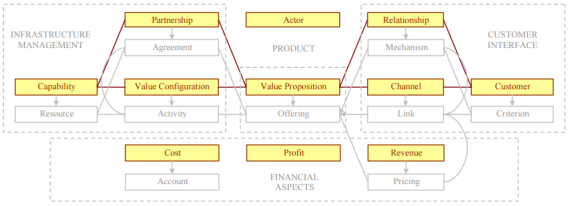

Figure 1. Business model ontology

2.2 The e3 -VALUE Ontology [17]

The main goal of a business model addressed by [17] is to answer the question: *"who is offering what to whom and expects what in return"*. The e3-value is an ontology for modeling and designing business models for business networks [27]. In e3-value, business model is seen as a network of enterprises and final customers that jointly create, distribute and consume things of economic value [16]. E3-value targets business models in an inter-organizational environment and offers constructs for modeling e-Business cases from an economical perspective [28].

The e3-value ontology contains concepts, relations, and constraints, to describe actors, alliances between them, the exchange of objects of value, the value-adding activities, and the value interfaces between them which is illustrated in Figure 2 [8]. For describing the business model, e3-value ontology looks at three different views: *The global actor view* which shows which parties are involved in a business model and which objects of value they exchange. Its main purpose is to explain the overall business model to a wide range of stakeholders. *The detailed actor view* takes a further look at the decomposition aspects. The ontology also shows, for actors identified in the global actor view, alliances between

parties, for instance virtual enterprises. Finally, *the value activity view* shows the assignment of value-adding activities to actors [24].

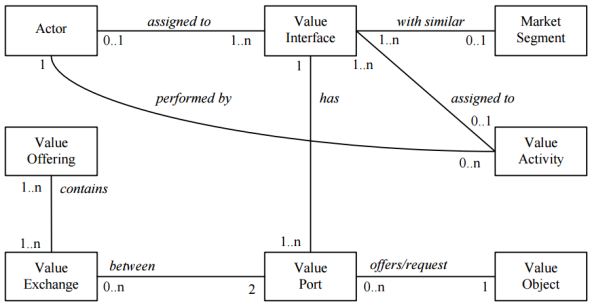

Figure 2. E3-value ontology for business modeling

E3-Value ontology presents actors that produce, distribute or consume objects of value by performing value activities. The objects of value are exchanged via value interfaces of actors or activities. Value interfaces have value ports offering or requesting objects of value. The trade of value objects is represented by value exchanges, which interconnect value ports of actors or value interfaces [16] [29].

2.3 The REA ontology [18]

[18] proposed the REA ontology designed to be used in a shared data environment. Its conceptual origins can be traced back to traditional business accounting [8]. The main purpose of the REA was to provide an environment where accountants and non-accountants would use for recording and maintaining everyday's business transaction that takes place within the organization and also with external business entities as a double entry [18][8]. The REA ontology evolved from a generalized framework for modeling accounting information systems in 1982 [18] to an ontology for enterprise information systems in 2006 [27]. REA's main components are essentially equivalent to the corresponding e3-value concepts [18].

The core concepts in the REA ontology are Resource (Economic value), Event (Economic transaction), and Actor/agent (Economic unit) and all concepts are well grounded in the economic theories [8] [26]. To get a resource an agent has to give up some other resource [8] (Figure 3). The intuition behind the ontology assumed that all business entities follow a similar pattern where things of economic values are given out to other business entities in a series of exchange or consumption process to gain things of greater economic value and thus, generate profit [26] [8].

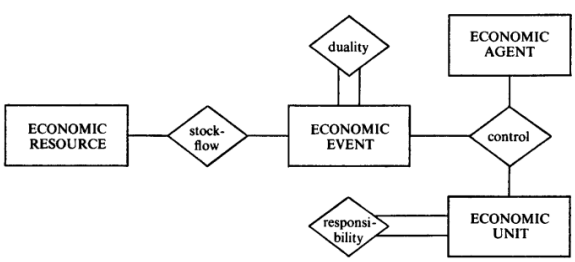

Figure 3. The REA ontology model

2.4 Summary of the three ontologies

E3-value, REA [30], and BMO [31] are the three major business model techniques. Whereas, the e3-value approach provides constructs to represent a networked business model, consisting of actors (enterprises and end-consumers) [28] and is designed for modeling value exchanges within an e-business network of multiple business partners [30], the REA ontology specifies the economic rationale behind business collaborations and "captures the declarative semantics of the collaborative space between enterprises from an economic and accounting viewpoint" [30]. However, the BMO focuses on the position of one specific company in the e-Business network and how he can make profit by conceptualizing a variety of internal resources, assets and capabilities [27].

3. APPROACH

This section presents the approach we employed for design of OGDBMO. To capture and coding the ontology, we identified the key concepts and relationships in the domain of interest and produce unambiguous text definitions of them. The conceptual foundation is presented in section 3.1 followed by a description of the methodology in section 3.2.

3.1 Conceptual Foundation

In [12] [11], building on existing conceptual and theoretical roots, we developed a detailed framework for characterizing a business model. After a careful analysis of consolidated elements of the different business model frameworks in literature [11], we identified six core concepts and the various concepts associated with each main concept that could be used to characterize the OGDBMO. We referred to the resulting model as the 6-Values Business Model Framework (Figure 4).

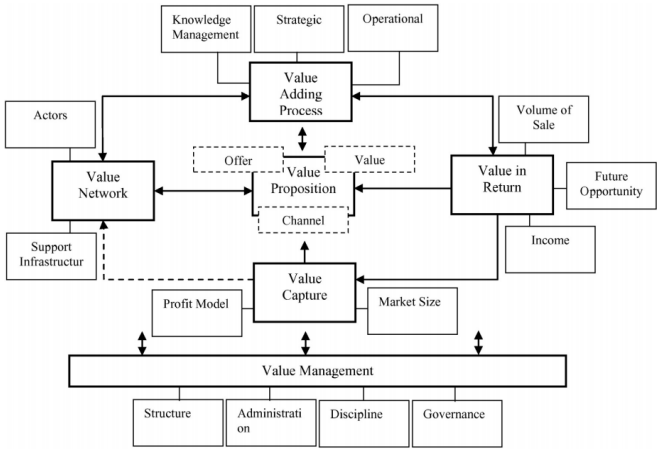

Figure 4. The 6-Values Business Model conceptual model

The six core concepts of the Business Model Framework are described in Table 1 [12] [11]:

Table 1. The 6-Values business model core concepts and definitions

Core Concepts	Definition
Value proposition	Specifies the value that business is offering. Value proposition included product, services, distribution channel, information and price.
Value adding process	Delivering value requires value-adding process including key activities and resources such as physical resources, human resources, supply chain management, partnerships, and technology. Value adding process is classified into three: 1. Operational includes activities, organizational structure, technologies and logistics systems, revenue model, resources and assets and financial model; 2. Strategic planning includes market or the target customer, competencies, capabilities,

	pricing and the control of costs, branding, differentiation, legal issues, mission and trust; 3. Knowledge management includes innovation and documents.
Value in return	what is received from the value adding process either monetary or non-monetary value including revenue, advertising space, future contracts and opportunities and rent or commission
Value capture	Value capture is the process of retaining some percentage of the value produced in transactions. This allows the business to use the output from the value in return to rethink and redesign to support the value proposition. The degree to which an organization can capture produced value depends on its competitiveness and negotiation capability with partners and customers
Value network	All the business activities are done within the value network. This includes customers, suppliers, information flow, product flow, service flow and partner businesses
Value management	Top managers play a significant role to the whole process. Therefore, this includes mind-set, organization, governance, stakeholders and shareholders

3.2 Methodology

In our methodology, we follow the design science research framework presented in [32] and [33] as the core approach and we complement it by the three-staged construction workflow (relevance stage, modeling stage, realization stage) presented in [34] serving as a best practice for model design and implementation process. We adopt the design science research framework (Figure 5) to the specific needs of the context of OGDBMO creation.

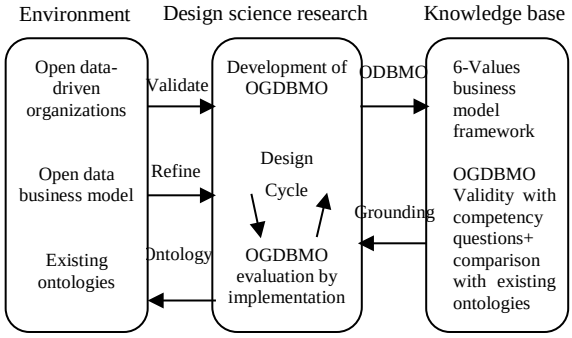

Figure 5. Research framework [33]

In our context, the research outputs include: 1) the ODBM constructs elicited, 2) the model generated and 3) instantiation by application of the executable ontology in describing one example ODBM. These output artefacts are obtained through the Thalheim's construction workflow-guided process encompassing the Relevance Stage for defining the concepts, Modeling Stage for formalizing the ontology and Realization Stage for leveraging and demonstrating the ontology in describing an ODBM of one organization. We align explicitly our research activities and research outputs in Table 2.

Table 2. Design science research framework of the study

Research activities	**Description**
Build	We elicit core business model concepts from the 6-Values business model conceptual framework constructed from the related works in the domain (we represent the detailed specifications in [11]) and based on what we want the ontology to answer (competency questions) we elicit the relations between the core concepts. We further defined the model properties according to the 6-Values conceptual model and competency questions.
Demonstration	We demonstrate one ODBM of an organization in Protégé using the developed OGDBMO
Evaluate	We claim the validity by design, the concepts leveraged for constructing the model are derived from a comprehensive study of the domain and design of the model, relationships and properties are directly from the competency questions (see competency questions below).
Internal validity	Internal validity is ensured by automatic validation capability of the data model construction and data population tool — Protégé
External validity	The 6-Values business model conceptual framework has been based on rich state-of-the art review and extends the up-to-date business model aspects. Therefore the model represents rich source of information on application domain essential for the relevance stage of the construction workflow. The reliability of the mapping has been ensured through "inter-observer" reliability tests [35]

Flexibility is permitted in competency questions formulation [36] but, given the motivating development and the main components of the 6-Values conceptual model, a set of queries will arise which place demands on an underlying ontology. We consider these queries to be functional requirements [36] that are in the form of questions that ontology must be able to answer. These are the informal competency questions, since they are not yet expressed in the formal language of the ontology [37]. We propose the following set of informal competency questions that business model designers and developers expect the OGDBMO to answer [36]. **CQ1)** what elements or activities must an ODBM include?, **CQ2)** In order to meet a particular open data value discipline, what ODBM should an organization develop?, **CQ3)** Who are the major stakeholders/actors in a particular ODBM?, **CQ4)** What is the famous/mostly-in-use ODBMs in a particular sector and country?, **CQ5)** What are the sources of revenue in a particular ODBM?, **CQ6)** what are the values offered by open data products and services?, **CQ7)** What are the developed open data products and services in each country and sector (price, delivery method, value in return and value captured are useful too)? **CQ8)** What capabilities and processes are associated with developing a particular product/service?, **CQ9)** What are the success factors leading to profitability?, and **CQ10)** What are the best practices?.

4. OPEN GOVERNMENT DATA BUSINESS MODEL CONCEPTUALIZATION

The 6-Values business model conceptual framework represented in section 3.1 includes 6 core concepts (Figure 4) and seventeen sub-concepts (Figure 4). For formal conceptualization purposes, we properly refine the conceptual model (Figure 4) and elicit eight main concepts (represent our Classes) which include 19 sub-concepts (represent our attributes or data properties) and 16 relations between main concepts (represent our object properties)

that can represent our conceptualization or ontology. The concepts are combined with contextual information to relate it to other elicited concepts (Figure 6).

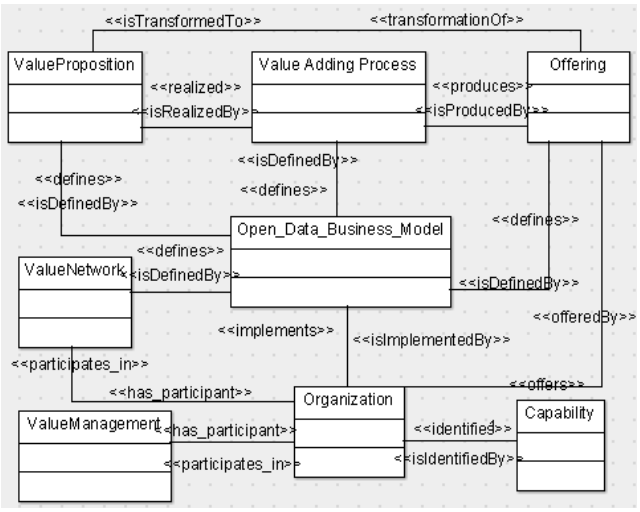

Figure 6. Classes and relations

The concepts are divided by the business model conceptual framework view and categorized in eight different groups presented in Table 3 and structured as followed: first we lists the corresponding classes names, next we list the concepts under each class, last we list the competency questions numbers (see section 3.2) corresponding each concept.

This conceptualization is very essential for modeling the three stages of Thalheim's (relevance stage, modelling stage, and realization stage) workflow-based OGDBMO design. The concepts and relations are presented in the way they can be directly mapped on the classes and properties of the end-model. The concepts presented are possibly generic to ensure clean and universal.

Table 3. Conceptualization - classes, concepts and competency questions

Classes and Concepts	Competency Questions
ValueProposition	CQ1
type	CQ6
name	CQ6
valueProposition	CQ1, CQ6
description	CQ1, CQ6
ValueAddingProcesses	CQ1
name	CQ1
description	CQ1
Offering	CQ1
type	CQ1, CQ7, CQ8
name	CQ7, CQ8
price	CQ7
availableDeliveryMethods	CQ7
valueInReturn	CQ7
valueCaptured	CQ7
description	CQ1
ValueNetwork	CQ1
actorType	CQ3
name	CQ3
description	CQ1, CQ3
OpenDataBusinessModel	CQ1
name	CQ1, CQ2, CQ3, CQ4, CQ5
description	CQ1
Capability	CQ1
capabilityType	CQ8
capability	CQ8
ValueManagement	CQ1
bestPractices	CQ10
successFactors	CQ9
Organization	CQ1
name	
year	
sector	CQ4, CQ7
country	CQ4, CQ7
revenueSource	CQ5
valueDiscipline	CQ2
organizationSize	
description	CQ1

5. OPEN GOVERNMENT DATA BUSINESS MODEL ONTOLOGY

In this section we present the OGDBMO implementation based on the concepts and relations defined in Section 4. First, we present a generic conceptual model for ODBM (Figure 5) showing the overall scope, components, sub-components and dependencies of the intended end-model.

In 6-Values view, the six major ODBM components and seventeen sub-components are represented. To generate our light-weight ontology, we include and describe concepts that can represent and answer to the competency questions and at this presentation level we omit concepts that we found un-necessary when describing our ontology at a light-weight level. It is clear from the elicited concepts that an organization is dependent on ODBM and the ODBM is linked closely to other concepts such as 'Offering', 'Value Proposition', 'Value Adding Processes', 'Value Network', 'Value Management', and 'Capability'. The semantically overlapping concepts include name, type, and description which are in common in many key concepts. This is due to the fact that, we are interested to know the names, types and description of the value proposition, value adding processes, offering, and value network of an organization and their influence on ODBM implementation.

In addition, the ontology also returns some constraints like price, value in return, and value captured which may have monetary and non-monetary values. To highlight the strong implicit dependencies it is important to mention that the eight key concepts or components are strongly dependent on each other. For example, the value adding processes influences both organization's value proposition and the offering of the organization which in return can generate higher customers/users demand on the produced products and services. Another example is when organization is dependent on its capabilities (value, dynamic, and competitive [11]) and when capabilities can strongly affect organizational decision on designing and implementing ODBM and identifying value network. In Figure 7, we further present the UML class diagram showing details of OGDBMO including concepts, data properties, and relations.

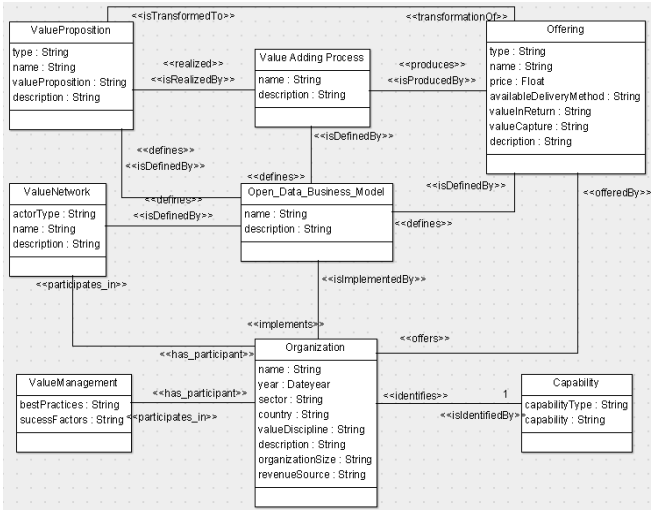

Figure 7. UML class diagram of the OGDBMO

In order to achieve maximum clarity of expression and sufficiently explicit model representation, enabling more comprehensive visualization, we represented the model using RDF – Resource Description Framework and OWL – Web ontology language. For the particular model implementation we leveraged Protégé tools for designing and implementation of OGDBMO. Protégé was selected from the existing ontology development tool because it is widely used all over the world, mature, scalable and extensible. It is a free, open-source ontology editor and framework which provides an interactive graphical interface for ontology design, display, and manipulate. Its internal structure represents ontology elements as classes, properties, constraints, and instances [38].

To design and implement the ontology and individuals, we performed number of activities. Activities include: all eight major concepts of the ODBM were conceptualized (i.e., Organization, Value proposition, and Value Network) as classes (Figure 8), then, 19 data properties were created (i.e., actorType, name, organizationSize, valueProposition, and capabilityType) and carefully mapped to the classes representing the Range and Domain of the data properties (Figure 8), afterwards, 16 object properties (relations) were created (i.e., defines, participates_in, offers, transformationOf, implements and isRealizedBy) and carefully mapped to the classes (Range and Domain) to assigning the classes with one or multiple relationships (Figure 8).

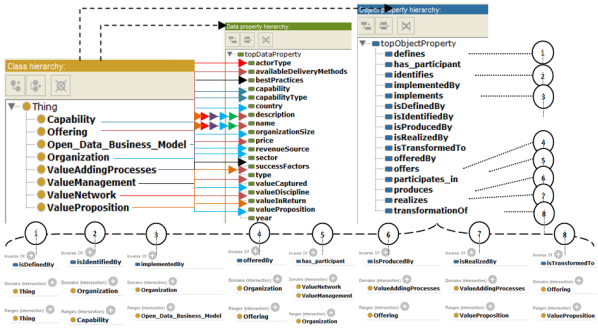

Figure 8. Open data business model ontology implementation in Protégé

As we would like our developed and implemented ontology to interact with other applications that have already committed to particular ontologies or controlled vocabularies, we imported and used existing formalism representing the knowledge we require for describing our ontology. There are many ontologies that are already available and can be imported into our OGDBMO-development environment. However, the existing ontologies did not cover all the concepts of our ontology. We reused as many existing ontologies as possible and we introduced new ontologies for those concepts which no common knowledge exists.

In Table 4, we include limited number of concepts. There are three reasons: 1) not all concepts had prior implementation or are found being implemented as ontology, 2) not all the definition of the existing ontology suits the definition of the concepts in our context and 3) not all concepts are unique to business model domain. For example: regarding reason number 1, existing ontology on 'ValueManagement' does not exist, regarding reason number 2, ontology on the concept 'business model' exist but the definition is not identical to the definition of 'open data business model' concept, regarding reason number 3, we omit concepts such as 'name', 'type', 'country', 'sector' and 'organizationSize' as they are not unique concepts of OGDBMO but general and common concepts that maybe applied in many other contexts. However, these reasons do not shrink the value of omitted concepts they are necessary for answering the competency questions.

Table 4. Reusing existing implementations

Concepts	Description	Ontology/links
Offering	An offering represents the product and service an organization offers to its customers.	http://purl.org/goodrelations/v1#Offering
Capability	Ability of an organization in performing tasks and activities.	http://purl.org/openorg/Capability
availableDeliveryMethods	The way offering is transferred to the customers	http://purl.org/goodrelations/v1#availableDeliveryMethods
valueInReturn	Important intangible benefits that are more characteristic of the broader, more diverse contours of the changing business world.	http://egov.insight-centre.org/ODBM.owl#valueInReturn
valueCaptured	Value capture is the process of retaining some percentage of the value produced in transactions.	http://egov.insight-centre.org/ODBM.owl#valueCaptured
valueProposition	Value Proposition specifies the value hidden in the products and services.	http://egov.insight-centre.org/ODBM.owl#valueProposition
actorType	Actor type is used to assign a type to an actor.	http://semanticweb.cs.vu.nl/2009/11/sem/semdoc.html#sem:actorType
bestPractices	The processes, practices, or systems that performed exceptionally well and are widely recognized	http://egov.insight-centre.org/ODBM.owl#bestPractices

successFactors	Limited number of characteristics, conditions, or variables that have a direct and serious impact on the effectiveness, efficiency, and viability of an organization, program, or project.	http://egov.insight-centre.org/ODBM.owl#successFactors
capabilityType	There are three types of capabilities: value, dymanic, and competitive capabilities.	http://egov.insight-centre.org/ODBM.owl#capabilityType
capability	Ability of an organization in performing tasks and activities.	http://purl.org/openorg/capability

6. DEMONSTRATION OF OPEN GOVERNMENT DATA BUSINESS MODEL

In this section we present and briefly discuss the example of use of the presented ontology for one open data-driven organization. The demonstration is based on one of the leading semantic web organization based in Dublin, Ireland - Derilinx. The organization is mainly relying on open data and open data platforms to generate revenue and compete with competitors in the market to survive. The core idea behind the organization has been to address high-quality Linked and open data solutions that drive decision-making and inspire change.

In this part of the document we show how we used our OGDBMO to represent the information about the organization's activities, processes, resources and etc. as means of ODBM development. In order to generate the dataset, we advanced our ontology in PROTÉGÉ tool by leveraging the provided interface to populate the ontology with relevant data accordingly to the schema defined. Considering limited space of this document we restrict ourselves to show just few representative examples of the ontology-based description creation. Nevertheless, it is possible to request a full RDF description of the initiatives presented.

Figure 9 and 10, presents PROTÉGÉ interface of the ontology along with the organization's individual — here the type (data property) and name (data property) of the Offering class expanded. An organization can have multiple offering in types of both products and services and each type can have various names. In this example as shown in Figure 9, the particular offering of the organization Derilinx is of type product and name of dataset. This shows that Derilinx offers datasets to its customers as a product of the organization. As shown in Figure 10, Derilinx also offers platform to its customers as another product of the organization.

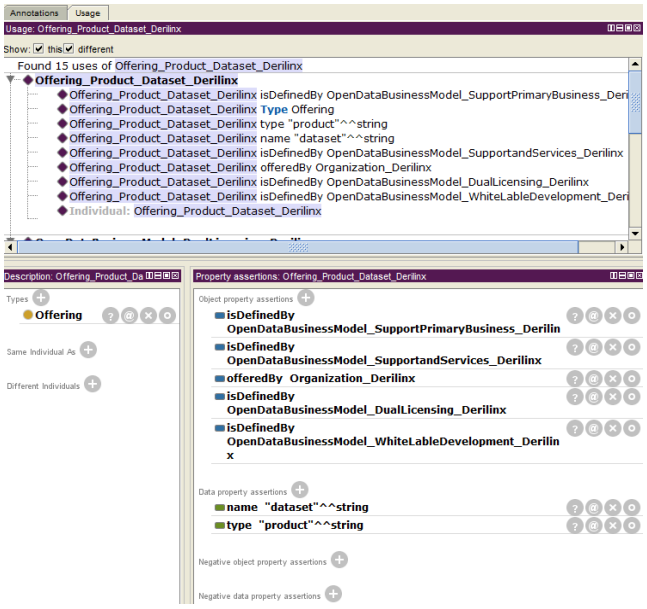

Figure 9. Offering dataset - individual

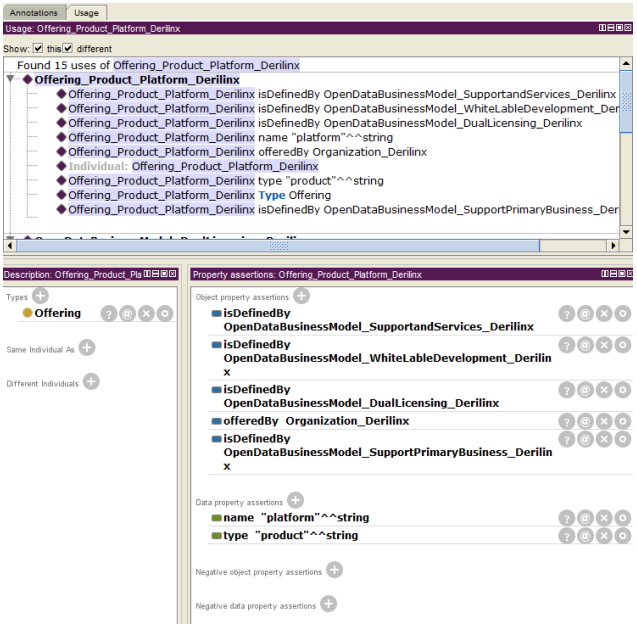

Figure 10. Offering platform - individual

7. VALIDATION

Validation relates a system and its end users implicit requirements [38]. Once knowledge is extracted from a domain and the concepts and instances are identified and organized in a manner that achieves the ontology's purpose, two important issues raised concerning the validity of the conceptual modeling process which are 1) the validity of the classification process itself; does the classification accurately represent domain knowledge? and 2) the validity of the ontology as a final product; does the ontology serve the purpose for which it was designed? [14]. The second issue cannot be determined and validated until the ontology has been used. Validity can then be assessed. The resolution of the first issue is within the scope of this paper.

Our first argument for the validity of our ontological model with respect to the competency questions follows from the rigorous design science research framework-based approach and from the

fact that the concepts and high-level relationships were carefully selected and gathered from the state-of-the-art literature (we presented the detailed process in [12]). In addition, we employed the CQs testing framework presented in [39] to test whether the ontology explicitly answer the competency questions or not (Table 5).

Table 5. CQs test

CQs	Few example answers	Correct?
CQ1	Value proposition, Offering>product/service	√
CQ2	Dual licensing, Support and services	√
CQ3	Public sector, Data customers	√
CQ4	Data/IT>Fremmium	√
CQ5	Government	√
CQ6	Improve data quality, Usefulness of data, Data transparency, Value added to data	√
CQ7	Product>Dataset>Data/IT, Healthcare	√
CQ8	Product>Portal> Access to reliable and high quality data	√
CQ9	Good quality compared to competitors, Product characteristics	√
CQ10	Increase ease of use and reuse of open data products and services	√

Therefore the question of whether the ontology answers the competency questions are trivially satisfied, i.e., the ontology is "correct by design". Secondly, regarding the internal consistency of the OGDBMO (expressed in RDF/OWL), we verified that the ontology is coherent or without contradiction by using the PROTÉGÉ Pellet Reasoner tool. Thirdly, the utility practical relevance and universal character of the ontology was established through its use in encoding the one example organization based in Ireland. Finally, the reliability of all the mappings has been ensured through "inter-observer" reliability tests.

Moreover, in Table 6, we present a comparison of the three ontologies we presented in the related work section with the developed ontology in this paper. The concepts presented in this table are not exactly identical (in terms) to the concepts used in the ontologies. To avoid overlapping concepts, we performed the comparisons based on the meaning and description of each concept. As can be seen from the table below, we have covered in our ontology, many other essential concepts critical to every open data-driven organization.

Table 6. Comparing the developed ontology with three most cited existing ontologies in the domain

Common concepts (interpreted)	**BMO**	**e3-VALUE**	**REA**	**OGDBMO**
Value Proposition	√	√		√
Value adding activities or processes	√	√	√	√
Network of partners or actors	√	√	√	√
Customer relationship	√	√		√
Financial aspects	√	√	√	√
Value discipline				√
Value management				√
Capabilities				√
Value in return				√
Value capture				√

8. CONCLUSION

ODBM concept has become very popular because of a business environment shaped by open data and big data. The fast changing and dynamic nature of open data industry makes many people in both academia and practice community to talk about ODBM. However, they do not have a clear idea and a common understanding of what is meant by an ODBM and what it consists of. (Open data) business models are interchangeably used as a process model, revenue model, pricing model, business architecture and etc. Therefore, it is very essential to study ODBM in a more structured way because it can be an adequate methodology and foundation for managerial tools assisting them to react to the increasingly dynamic industry and increase profitability and ensure survivability.

The OGDBMO developed in this paper is a significant tool to establish a common understanding of what an OGDBM is and to facilitate management under uncertainty. Furthermore, it helps them to easily design, compare business models, understand what their business model is and of what essential elements it is composed of, easily communicate their model to others in order to learn about business opportunities, and in general, make a better sense of the business model functions which can result in profitability and survivability. It also helps governments to gain insight in the open data ecosystem specifically how open government data is being used and reused by public and private organizations. Based on that, governments can develop policies and regulations that can foster economic benefit of open government data for these entities.

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