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ABSTRACT

This research proposes an ontological model for accounting information systems (AIS) based on the Bunge-Wand-Weber (BWW) modeling constructs. The proposed model is derived from the Resource-Event-Agent (REA) accounting model. REA is a well-known model for AIS and has recently been proposed as an AIS domain ontology. REA is grounded on event-based accounting theories and its sound underlying concepts make it a strong candidate as a domain ontology. However, there are several deficiencies in the current representational scheme used in REA that limit its value as a domain ontology. First the use of entity relationship modeling constructs has resulted in a lack of precision and completeness in the current model. The current model also fails to capture the dynamic aspects of the domain. Finally the current model lacks the ability to represent the different levels of abstraction required to capture the requirements of as complex a domain as accounting information systems. This research argues that the above deficiencies can be addressed through application of the BWW-based modeling constructs and presents an ontological model for the domain of AIS where the above mentioned deficiencies are addressed.

Keywords (Required)

Resource-Event-Agent (REA), Bunge-Wand-Weber (BWW), Conceptual Modeling, Accounting Information Systems (AIS).

INTRODUCTION

Theories of ontology are now commonly used as the theoretical foundations for conceptual modeling of information systems. One of the best-known ontological theories for information systems modeling is the Bunge-Wand-Weber (BWW) ontological model. This research proposes an ontological model for accounting information systems (AIS) based on the BWW modeling constructs. The proposed model is derived from the Resource-Event-Agent (REA) accounting model. REA is a well-known model for AIS and has recently been proposed as an AIS domain ontology. REA is grounded on event-based accounting theories and its sound underlying concepts make it a strong candidate as a domain ontology. However, there are several deficiencies in the current representational scheme used in REA that limit its value as a domain ontology. First the use of entity relationship modeling constructs has resulted in a lack of precision and completeness in the current model. The current model also fails to capture the dynamic aspects of the domain. Finally the current model lacks the ability to represent the different levels of abstraction required to capture the requirements of as complex a domain as accounting information systems. This research will evaluate REA using the much more rigorous modeling constructs of Bunge-Wand-Weber's (BWW) ontological model and propose an AIS domain ontological model that is based on the event-based accounting concepts in REA but without the modeling deficiencies. The contribution of this research is potentially twofold. First, the modeling inadequacies in the current REA model will be discussed in light of a more rigorous conceptual modeling grammar such as BWW. Second, an REA-based domain ontology for AIS will be proposed using BWW-based modeling constructs.

THE RESOURCE-EVENT-AGENT MODEL

REA was initially proposed by McCarthy (1982) as a general framework for accounting information systems in a shared data environment. REA has since become a well-known model for capturing economic activities in a business. Since then extensions to REA have been made at the more abstract level of enterprise value chains and at the more specific level of workflow processes (Geerts and McCarthy, 1997; Geerts and McCarthy 2000).

The conceptual core of REA is best represented in Figure 1 (McCarthy 1982). The model has three types of primitives (economic resources, economic events, and economic agents with economic units being a subset of agents) and four types of primitive relationships (stock-flow, duality, control, and responsibility). According to REA the core of an enterprise's activities over the course of its life is constituted by its history of economic exchanges or economic conversions with parties inside and outside of the firm's boundaries. These exchanges or conversions all follow a particular pattern. There is a transaction (an economic event) where an internal agent (an economic unit or agent) gives something of value (an economic resource) to an outside person (an economic agent); this decrement event should be paired with a mirror-image increment event where the internal agent receives in kind another type of economic resource which has more value to the enterprise in its pursuit of its entrepreneurial goals.

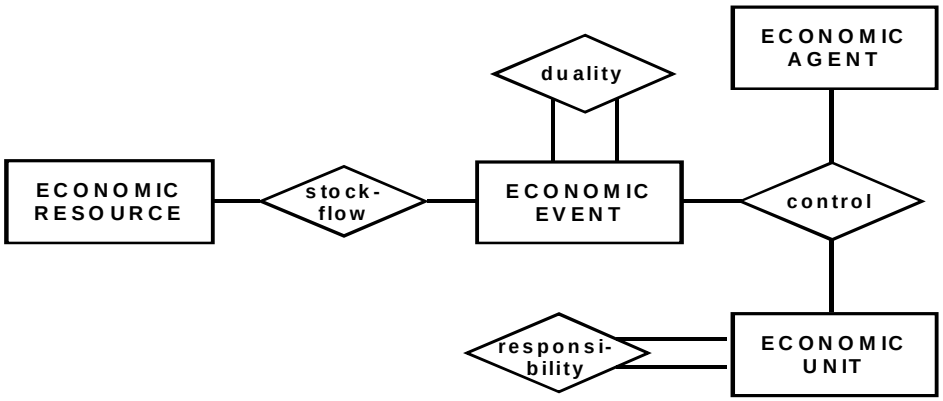

Figure 1. Conceptual Core of REA

The REA model has its root in events accounting, a term coined by Sorter (1969). Its main strength lies in the fact that its underlying concepts are firmly grounded in economic theories rather than accounting information system requirements. This focus on domain requirements rather than system requirements has been recognized as important in ensuring success in modeling information systems (Abbot, 1987; Wand and Weber, 1990; Wand and Weber, 1989). The REA model, with its recent extensions, seems to be an excellent candidate as a domain ontology for AIS. Recently, REA has been proposed as a domain ontology where REA constructs are presented in terms John Sowa's ontological categories (Geerts and McCarthy, 2002)(Sowa, 1999). While these mappings are an important first step, Geerts and McCarthy admit that much more work is needed "...to take the REA ontology to the level where a significant percentage of 'accounting conclusions' (like revenue or profit) are specified." Though the discussion of REA as a domain ontology by Geerts and McCarthy is preliminary (Geerts and McCarthy, 2002), it does open up a very interesting field of research, i.e., the modeling and creation of a domain ontology for capturing enterprise economic phenomena for AIS.

ONTOLOGICAL EVALUATION OF THE RESOURCE-EVENT-AGENT MODEL

Conceptual modeling consists of two important phases: identification of the relevant phenomena in the domain and mapping of the phenomena into modeling constructs (Wand and Weber, 2002). REA has successfully identified the core economic phenomena in its domain but has failed to adequately capture these phenomena using ontologically sound modeling constructs. REA is fundamentally a semantic model that focuses on capturing the structural aspects of the domain (McCarthy 1982). As a result the current REA model does not support the representation of the behavioral aspects of the domain (Kandelin et al, 1992; Murthy and Wiggins, 1993; Verdaasdonk, 2003). The lack of behavioral/procedural representation has been addressed through the use of modeling grammars such as data flow diagrams (DFD) (Dunn et al, 2005), and more recently, object-oriented-based approaches (Kandelin et al, 1992; Murthy and Wiggins, 1993; Verdaasdonk, 2003). The use of DFDs to capture the dynamics of the domain results in a separation of structure and behavior in the resulting model.

Though an object-oriented approach promises a better integration of structure and behavior, the current work in this respect has been rather limited and still suffers from other weaknesses described below.

Other weaknesses in the REA model include ontological incompleteness and lack ontological clarity resulting from the use of entity-relationship modeling constructs in REA (Wand and Weber, 1993; Wand and Weber, 1995; Weber, 1997; Green et al, 2005). An example of lack of ontological clarity in REA is construct overload. Several ontological constructs (REA primitives) map to one grammatical construct. For example, the construct entity is mapped to both resource and event, apparently two different types of ontological constructs. A resource is typically an enterprise asset, while an event may be a business process causing a change in the value (or state) of an asset. Ontological incompleteness exists in the current REA model because of construct deficit. For example there is no construct for representing accounting rules and constraints. In the current REA model these rules and constraints are often defined through textual descriptions.

Finally, entity relationship grammar does not support system decomposition (Wand and Weber, 1995). Accounting information systems are intended to capture a set of very complex economic phenomena and system decomposition is critical in allowing any such model to represent different levels of abstraction. There are two major benefits. First a decomposable model allows accounting procedures and rules defined at a higher level of abstraction to be propagated to lower levels of abstraction. Secondly, a decomposable model makes it easier for it to be used in guiding implementation of accounting information systems.

AN ONTOLOGICAL MODEL OF ACCOUNTING INFORMATION SYSTEMS

As shown in Figure 1, there are two basic modeling constructs in the core REA model, i.e., entity and relationship. There are three types of entities corresponding to the three primitives in REA: economic resources, economic events, and economic agents/units. An economic resource is an object of value under the direct control of an organization. An economic agent/unit is a person or party that directly participates in economic activities in an organization. Finally an economic event refers to a phenomenon/economic activity that leads to changes in economic resources in the organization.

Though all three of these primitives are represented as an entity in REA, there are obvious differences between an economic resource/economic agent and an economic event. An economic event is a more complex phenomenon. A fundamental difference between economic resource/economic agent and economic event is that an economic event can cause a state change in an economic resource. Once an economic event occurs and is captured, it should not change. For example, a cash receipt from a customer becomes a historical fact which should not be changed later. However, in REA the same modeling construct is used to model economic resource, economic agent/unit, and economic event. We argue that the difference between an economic resource/economic agent and an economic event is a very important part of the reality in accounting and should be adequately represented in any conceptual model for an accounting information system. The ontological model we are working on will address this important distinction and remove the ambiguity found in REA.

The relationship stock-flow relates the economic resource(s) with the economic event. The responsibility relationship indicates that higher level units/persons control and are held accountable for the lower level units/persons. Duality relationship represents a key concept in REA. Each economic event represents either a decrement or increment in an economic resource. A decrement event should be paired with an increment event. The control relationship comprises an internal economic unit (which is a subset of economic agents), an economic event, and an external economic agent who grants the internal unit control over the event in return for accountability for the resources involved. The relationship construct in REA describes what entities interact with what other entities but their representation in general is ambiguous and can only be explained through supplementary text.

An accounting information system is, like any information system, complex and its complexity can often be dealt with through some type of hierarchical decomposition, a feature that is also lacking in REA. The decomposition model in BWW provides an excellent tool for capturing different levels of abstraction while propagating relationships and controls at a more abstract level to lower levels, therefore ensuring proper modeling of businesses and accounting controls at different levels (Wand and Weber, 1990). Decomposition not only helps manage and understand domain complexity but it can also aid implementations of information systems based on the conceptual model. A conceptual model that is formally decomposable into subsystems allows precise description of the propagation of the dynamics in the domain being modeled.

The proposed model will be based on BWW modeling constructs and follow the approach outlined in (Evermann and Wand, 2005). The proposed model will define the domain semantics for AIS through a mapping of REA primitives to BWW-based ontological constructs. Rules and assumptions governing the primitives, their relationships, and dynamics will

be identified. The current choice of modeling grammar is UML. Recent research has demonstrated the use of UML as a visual representation of BWW modeling constructs and UML seems to be adequately equipped for presentation of the proposed AIS ontological model (Opdahl and Henderson-Sellers, 2002; Rosemann and Green, 2002). Constraints and rules will be defined for using UML to represent the proposed model through the creation of a metamodel.

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