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# Developing ontology-based EPA for representing accounting principles in a reusable knowledge component

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ABSTRACT

This study proposed an ontological EPA model (Event, Principle and Account) for describing accounting principles using a reusable knowledge component. The essential characteristics of the model include: (1) based on traditional accounting definitions for typical accounts (*A*) and business events (*E*), where the ontological properties of *A* and *E* can be identified. These characteristics can be further used to create a knowledge hierarchy for both *A* and *E*; (2) identifies the element *P* (accounting principle), which in turn can be used to measure the economic effects of events on accounts; (3) creates a relationship between *E*–*P*, which identifies how to adopt suitable principles for classifying events; and (4) the inferential (*E*–*P*)–*A* relationship, which identifies the effect of a classified event on resources (or accounts). Following typical knowledge engineering processes, hierarchical knowledge of accounting principles can be represented, stored and reused. *EPA* examples are demonstrated using OWL-based ontology. This study claims that the knowledge framework developed in *EPA* can provide a basis for full accounting knowledge creation, storage and sharing.



## 1. Introduction

Accounting is a set of general principles and rules for representing financial information related to business activities. These principles and rules are developed and accumulated by academic professionals and practitioners to provide a source of solid accounting knowledge. The "*Capitalization of expenditures*" and "*Revenue recognition*" rules are practical examples. Human accountants use these standardized principles and rules to systematically recognize diversified business transactions, measure their monetary effects, and record and summarize those effects using a predefined taxonomy system – "*chart of accounts*". Owing to accounting knowledge being a highly dependable form of expertise, modeling these principles and rules into systematic and reusable artifacts is a challenge (Stefanou, 2006). For example, in most accounting systems, accounting knowledge cannot be represented as separate logical components, but rather is hidden in thousands of lines of programs, complex algorithms and data flows. From the information system perspectives, a missing knowledge model layer can be added above a solid foundation of accounting knowledge. Consequently, this study argues that, to enhance knowledge representation capability and share core knowledge with other domains, accounting knowledge must be revisited and restructured through knowledge-intensive approaches.

To better manage accounting knowledge models, knowledge-intensive approaches such as ontology technology are suited to address knowledge reuse and sharing. The previous literatures have discussed several approaches and implementation of ontology engineering (Guarino, 1997; Uschold & Grueninger, 1996). Ontology explicitly specifies a conceptualization that expresses shared human perspectives of the real world. Ontology has long been applied to artificial intelligence and expert system to express shared human understanding of information. The advantages of using ontology in this way include permitting more disciplined design and facilitating knowledge sharing and reuse (Chi, 2007). Like most knowledge-intensive approaches, building ontology is a form of knowledge engineering that generally includes several successive processes such as knowledge acquisition, modeling, and representation (Guarino, 1995). Accordingly, the main task in building ontology is translating goal-oriented or problem-solving activities into systematic knowledge required to solve problems.

To exploit the ontology approach in building accounting knowledge, this study endeavors to identify a general process to help systematically convert accounting principles and rules into ontology. Furthermore, this study selects several important cases as a task domain to demonstrate the knowledge conversion process. Three emphases of this paper are as follows. First, this study identifies several weaknesses of traditional accounting systems in representing

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accounting knowledge, and then it develops the *EPA* model based on the ontological accounting constructs. Besides event (*E*) and account (*A*), a single add-in element *P*, which represents the accounting principles, serves as the association between events and accounts. This study uses a separate and hierarchical design of accounting principles to demonstrate that most valuable accounting knowledge can be represented, stored and reused. Secondly, to demonstrate the construct validity of *EPA* model, this study adopts Web Ontology Language-Description Logic (OWL-DL) to create a set of reusable classes, representing key accounting principles, including revenue and expense recognition, matching principle and capitalization of expenditure, and so on. Thirdly, during the validation stage, this study employs the Protégé platform to generate instances of classes to serve as competency questions, and adopts the Pellet as an inference engine for testing the knowledge validity of the *EPA*. The ontology instances empirically suggest that the *EPA* model can enhance the semantic representation capability in modeling accounting principles, and the knowledge model can be further applied to describe more complex principles and rules developed in accounting.

This study presents a feasible approach to modeling accounting knowledge, which offers an alternative to building a practical knowledge base or expert system. This study proposes that larger projects can adopt the *EPA* model to complete more comprehensive bases of accounting knowledge.

## 2. Problem domain-revisit accounting from the knowledge view

The database approach is the most popular approach in modern accounting system design. Most understandings of fundamental real-world phenomena are based on the Entity-Relationship model. It is worth re-examining whether the E-R model can represent accounting knowledge using an ontological method. In fact, adopting the perspectives of knowledge engineering, this study argues that the traditional data model cannot capture the knowledge hierarchy of fundamental accounting principles (Sutton & Arnold, 2002).

- *Problem 1*: The inability of the E-R model to represent sharable and reusable knowledge components.
  Most accounting systems use data entities to describe events and business resources (accounts), and use relationships to model transformational functions between events and resources. Problems such as "*Which resources will be impacted by a given event?*" and "*How to measure quantitative changes of the given events for each resource affected?*" are not answered using a hierarchical structure of accounting knowledge. Rather, in the E-R model, knowledge of "*Which event links with which resource (accounts)*" needs to be implemented, respectively, for each E-R pair using foreign keys in a database. The foreign key constraint offers substantial practical advantages because it can create exact key mapping between events and resources. However, the database technology has difficulty representing reusable accounting knowledge in systems. If accountants cannot identify specific transactions, the accounting system cannot help users to implement those transactions because of lacking accounting intelligence or knowledge. Ideally, while users encounter new domain problems, the intelligent system will advise them regarding how and why those problems can be resolved using existing knowledge. Apparently it is difficult to achieve the intelligent goal because using the E-R model alone it is impossible to capture event and resource properties. Furthermore, E-R model does not consider accounting principle as a separate basic construct. Rather, the database approach hides the accounting principles and rules in complex and non-reusable programming codes.
  To understand the limitations of E-R model in representing the measurement logic between events and resources, this study considers the decision process employed by a human expert when encountering the same situation. As illustrated in Fig. 1, an expert compares the properties of the unknown and cognate events existing in a single event hierarchy to allocate the unknown event to a possible type. The expert then adopts a series of acceptable accounting principles or rules $(P_1, P_2, \ldots)$ to determine the eventual classification of the unknown event in a sequential manner. Clearly, those principles or rules adopted in this process can be shared and reused in other similar (but not identical) event-recognition scenarios. This study thus argues that a knowledge based accounting system should separate reusable principles or rules from events and resources (accounts). Furthermore, the relationships among events, principles and resources should be carefully identified because they represent valuable accounting knowledge.
- *Problem 2*: The lack of a class hierarchy for basic constructs
  Resources within a database can be differentiated using a set of attributes for an object. However, most of those attributes are selected for practical purposes, and not using a knowledge-intensive approach. In accounting, accounts can be defined using a set of formal properties containing important accounting concepts and knowledge. Additionally, different resources share common properties enabling resources sharing such common properties to be generalized to more general types. The same situation exists in events (*E*). Therefore, the accounting models of resource and event types are in fact hierarchical trees. Again, this does not mean that the E-R model cannot implement the class hierarchy of resources. However, from the perspective of knowledge modeling, this study argues that an accounting ontology must develop an explicit, reusable and extensible model representing class hierarchy for basic constructs.
  Besides lacking *E* and *A* knowledge hierarchies, traditional data model are also unable to systematically capture rule associations between *E* and *A*. For example, while a capital lease event happens, traditional data model can only record both lease asset and liability increase mechanically, no deep knowledge for the transformation provided. Theoretically, the real effects of events on business resources, modeled by Bunge (1977) in the form of the transformation construct, are not observable because it might lead to some intangible changes. Measurement methods merely represent estimates of the transformation. However, in

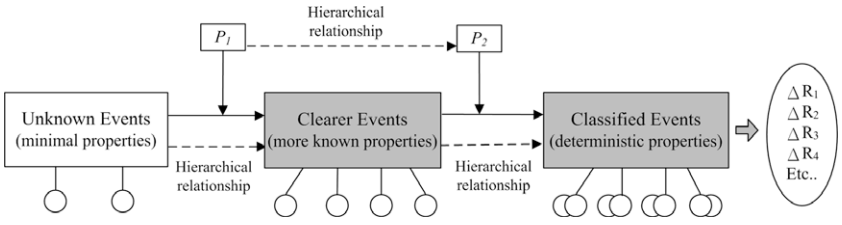


**Fig. 1.** Event-recognition process in which accounting rules are applied.