REA Business Management Ontology: Conceptual Modeling of Accounting, Finance and Management Control

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Abstract. Geerts and McCarthy [5, 6] established the REA business ontology. In its accounting and policy infrastructure the informational and procedural elements which are needed for accounting and management purposes are specified. An investigation of the requirements in the disciplines of accounting, finance and management control shows that the ontology is not complete. By including the concepts of accounting records, financial contracts and management systems the REA business ontology is extended and the resulting REA business management ontology covers the informational and procedural requirements from accounting, finance and management control. The REA business management ontology is a comprehensive ontology and it should be useful especially for business analysts who have to design accounting, enterprise and management information systems.

Keywords. REA business ontology, ALE accounting, financial contracts and derivative instruments, management control systems, accounting, enterprise and management information systems

1 Introduction

McCarthy [10] introduced the REA accounting model to conceptualize the logic of accounting in terms of economic resources (R) that are exchanged in economic events (E) between economic agents (A). With the REA accounting framework he viewed accounting theory in contrast to conventional accounting literature in a stock and flow perspective. *This framework, called the REA accounting model, is developed using data modeling techniques, and its underlying structure is found to consist of sets representing economic resources, economic events, and economic agents plus relationships among those sets.* [10, p. 554]. The economic core of the REA accounting model is the duality principle. The duality relationship expresses the economic rationale that scarce resources have a positive price that has to be paid in an exchange transaction from the buyer to the seller. McCarthy relates economic resources closely to tangible assets. He explicitly distinguishes economic claims from the economic resources to emphasize the temporal imbalance between the flows of the economic resources in economic transactions like e.g. credit-card sales and sales on account.

In: S. España, M. Ivanović, M. Savić (eds.): Proceedings of the CAiSE'16 Forum at the 28th International Conference on Advanced Information Systems Engineering, Ljubljana, Slovenia, 13-17.6.2016, published at http://ceur-ws.org

Geerts and McCarthy [5, 6] extended the REA accounting model to the REA business ontology which also contains economic contracts and a policy infrastructure. They defined economic contracts as economic bundles of economic commitments which fulfill the reciprocity principle. The reciprocity principle is the conceptual analogue of the duality principle. The policy infrastructure relates to the planning and control level (policy level) where semantic abstractions in form of typification and grouping were introduced. For demonstration purposes they give the following policy definition examples: *We distinguish between among the following three types of policy definitions: knowledge-intensive description, validation rules, and target descriptions. A knowledge-intensive description defines characteristics of a concept that apply to a group of objects. … A validation rule represents permissible values, and a common application of validation rules in enterprise systems is preventive controls. … Target descriptions provide benchmarks regarding economic phenomena, and they can take at least two different forms: standards and budgets.* [5, p. 39f].

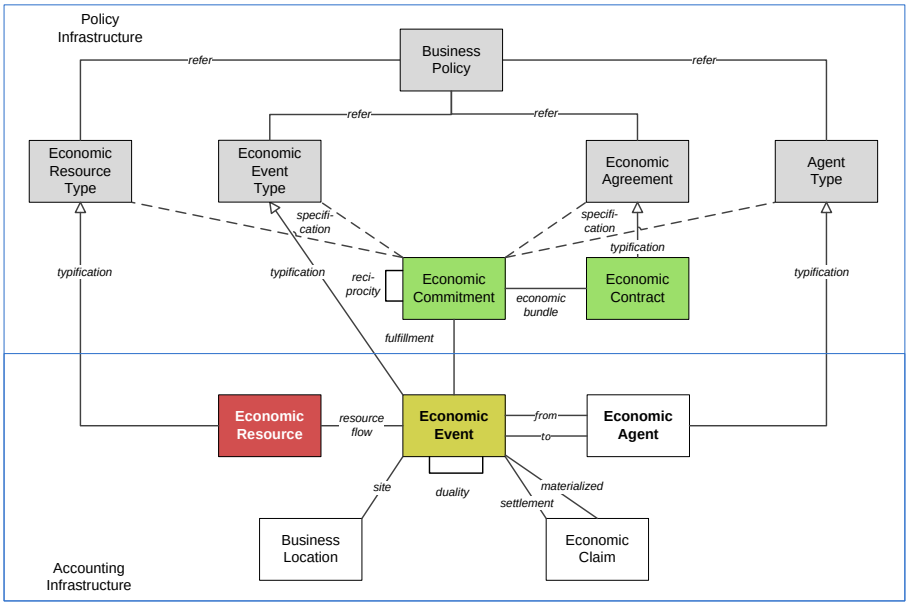

Fig. 1. REA Business Ontology – Accounting and Policy Infrastructure

Figure 1 shows the REA business ontology in form of class diagram which is used in the ISO/IEC 15944-4:2006 standard [8, p. 33] *Accounting and Economic Ontology* (AEO) to model business transactions. The REA accounting model is the lower part of the figure which specifies the accounting infrastructure of the REA business ontology. The upper part is the policy infrastructure which contains the economic commitments and the economic contracts as well as the REA types and the economic agreement on which the business policy refers to.

The REA business ontology is a powerful and convenient model for understanding business processes in economic as well as in business policy terms. The narrow focus

on tangible resources and claims makes the ontology quite easily understandable. Tangible resources like materials, goods and cash are incremented and decremented in economic events. But the narrow focus causes problems as well, as accrual accounting requirements and financial contract specific requirements are not covered. Furthermore there are deficiencies with respect to the planning and control of business processes which are not sufficiently covered in the REA business ontology.

The primary research objective of this article is the specification of the relevant concepts underlying the disciplines of accounting, finance and management control as well as their consistent integration into the REA business ontology. For this purpose the *REA business management ontology* is developed which covers the relevant requirements. The name of the ontology is taken to distinguish it from the *REA management ontology*. This term was introduced by Weigand et al. [14] for the general framework of services when they modeled management as services. The REA business management ontology covers and integrates the conceptual models that are applied in the accounting, finance and management control domains.

The structure of this article is as follows. In the next section *REA Business Ontology meets Accounting, Finance and Management Control* the missing concepts in the REA business ontology for accounting, finance and management control purposes are identified. In the subsequent section the *REA Business Management Ontology* is developed by integrating the accounting transaction model, the extended contract model and the management system model into the REA business ontology. In the final section the paper is concluded.

2 REA Business Ontology meets Accounting, Finance and Management Control

Although the REA business ontology conceptually originated from the accounting domain it does not cover fundamental accounting requirements. In Schwaiger [12] deficiencies of the REA business ontology with respect to the traditional Asset Liability Equity-/ALE-accounting logic [7] are detected in form of insufficient accounting transaction recordings of debited and credited changes in asset, liability and equity resource types. On the other side it is shown that the commitments in the REA business ontology are beneficial for integrating the peculiarities of financial instruments. With respect to management control considerations Church and Smith [3] identify shortcomings as the REA business ontology does not support Balanced Score Card-/BSC based performance management systems.

2.1 REA Business Ontology meets Accounting and Finance

In order to promote the understanding of the REA business ontology within the accounting community the inclusion of the double-entry bookkeeping elements in form of the debit and credit notation is unavoidable. The debit and credit linguistic terms are needed to give the increment and decrement events of assets, liabilities and equity a consistent interpretation within the ALE-based accounting equation. This is the

main conclusion derived by Schwaiger [12, p. 572] when analyzing the essential deficiencies of the REA business ontology with respect to its applicability in the accounting domain. In order to correct this shortcoming he developed the accounting transaction model and introduced the ALE resource typification.

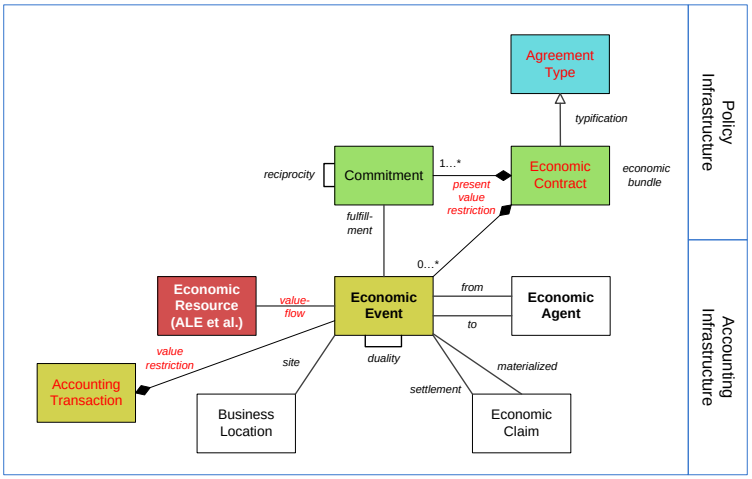

Fig. 2. REA-based ALE Accounting Ontology [12, p. 571]

Figure 2 shows the REA-based ALE accounting ontology which contains the accounting transaction model with the associated value restriction and the ALE resource categories. To make the REA business ontology compatible with the future oriented perspective in finance the economic model of the REA business ontology is defined as a composition of commitments and economic events which obey the present value restriction. This economic contract specification requires that at least one future commitment is involved. The advantage of this specification is that it allows the representation and recording of all different types of derivative, non-derivative and structured financial instruments.

2.2 REA Business Ontology meets Management Control

Church and Smith [3, p. 8] have BSC-based performance management system in mind when they make the following observation. *The REA framework reflects enterprise economic activity but does not directly address the management activity related to control processes. The REA framework offers type images as the vehicle for modeling organizational policy, such as budgets, bill of material, or pricing policy (Geerts and McCarthy 2001b, 2003). The REA type image structure does not, however, describe the managerial processes and control structure necessary to plan, link, communicate, or learn from type-level information. For example, REA policy type images can apply internal controls, such as segregation of duties, to operational level economic activity (Geerts and McCarthy 2003), but the REA policy infrastructure does*

not address how the internal control is established or who is responsible for monitoring its effectiveness.

Church and Smith address the problem of missing managerial processes and missing control structures by putting a managerial planning and measurement process [3, p. 17] on top of the REA business ontology. Figure 3 shows the class diagram version for this process. It includes *managerial events* for the two planning activities *strategic initiative* and *set target* and for the two control activities *evaluate* and *measure*. With the managerial events it is answered how the plans and controls are established. The *informational resources* added are *resources committed* and *strategic objective* related to the planning activities as well as *performance measure* related to the control activities. Furthermore *agents* are assigned to the planning and control activities. This answers who is responsible for these activities.

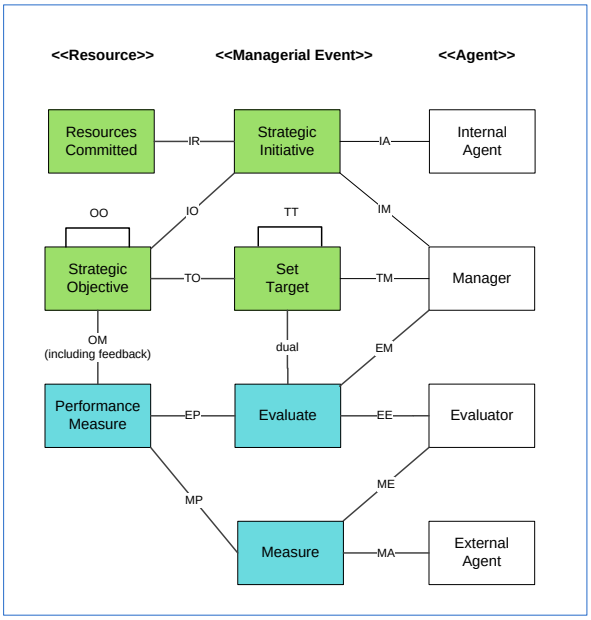

Fig. 3. BSC-based Management System – Managerial Planning and Measurement Process

This modeling of the managerial planning and measurement process in the BSC-based management system provides a solid foundation for considering the informational and procedural requirements for planning and control processes. There is just one minor question left open: What is the sense of the performance measurement and evaluation, if there are no evaluation results and thereupon defined adjusting consequences?

This point can be clarified by having a closer look into the *management control* discipline which was established by Anthony [1]. The issue relates to the closing of the loop aspect of planning and control systems. Closing the loop generates *closed loop* performance management systems, which include the fundamental characteristics of cybernetics that was introduced by Wiener [15] in form of the *feedback prin-*

ciple and the *control and communication principle*. This feedback information and the corresponding control inputs can be interpreted as being part of the *OM* relationship which links the informational resources *strategic objective* and *performance measure*.

Otley and Berry [11] apply the feedback and communication principle of control in an organizational context to specify different closed loop control structures and to design corresponding accounting information and control systems. The different control structures are distinguished by the different ways the control input can adjust the planning and control system. In single loop structures the control input adjusts the input of the operational process which is the *first order control* in Otley and Berry [11, p. 236]. In double loop structures – as originated by Argyris [2] – the control input can relate to different things. In the *second order control* it adjusts the objective/target, in *internal learning* it adjusts the prediction model used in the evaluate activity and in *systemic learning* it adjusts the business process itself by adjusting the business policy.

3 REA Business Management Ontology

After having identified in the previous section the deficiencies of the REA business ontology with respect to the accounting, finance and management control disciplines, the ontology can be extended to eliminate these shortcomings. The resulting ontology is the *REA business management ontology* which is shown in figure 4. It extends the REA business ontology by including the accounting transaction model and the modified contract model from the REA-based ALE accounting ontology and the closed loop performance management model that underlies the BSC-based management system.

The accounting transaction model is integrated as a composition of economic events. This model assures that the reporting requirements of the financial reporting standards are fulfilled. The extended contract model is a composition of economic events and commitments so that all derivative and non-derivative financial contracts are covered in the ontology.

The management system model is integrated by adding the three type images to the policy layer, i.e. *managerial event*, *managerial resource* and *(managerial) agent*. The parenthesis connected to (managerial) agent indicates that in this type image also non-managerial agents are included.

In the planning activity *strategic initiative* within the managerial events the business policy (including the resources committed which have to be performed by internal agents) is set and adjusted over time. The intention of the business policy is to achieve the *strategic objective* (*managerial resource*) which is also set in the *strategic initiative* activity by the responsible manager. For the strategic objective specific targets are set in the planning activity *set target*. In the control activity *evaluate* the performance measured in the activity *measure* is compared with the set objectives and targets to derive the feedback which induces control inputs into the business process defined in the *economic events* for single loop learning and/or control inputs into the planning activities *strategic initiative* as well as *set target* as for double loop learning.

The interplay between the objectives and targets in the policy layer and the measured results in the business layer produces the feedback information which is used in the terminology of McCarthy [10] to materialize conclusions with respect to the single/double loop learning.

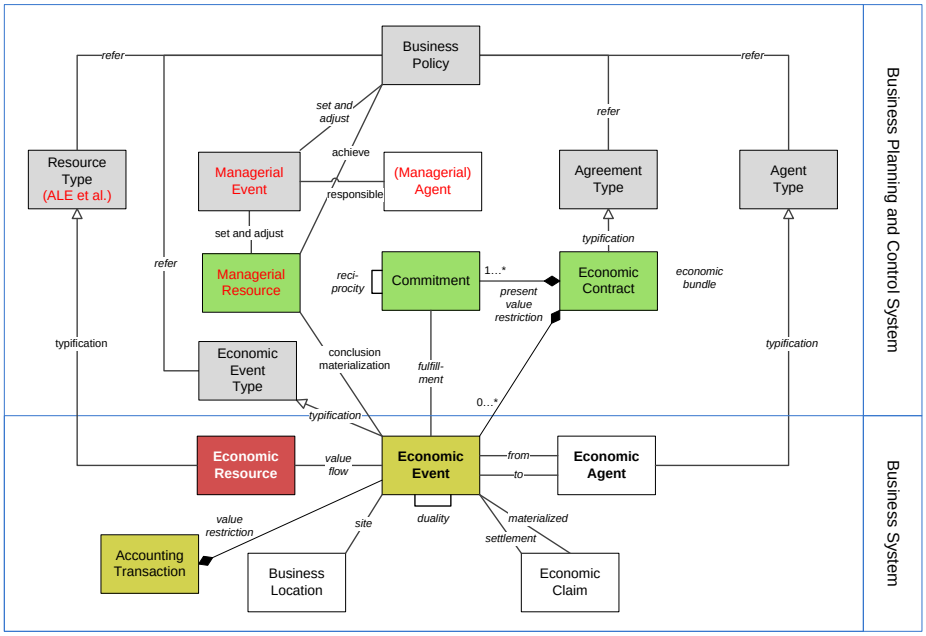

Fig. 4. REA business management ontology

4 Conclusions

The primary research objective of this article was the extension of the REA business ontology developed by Geerts and McCarthy so that it adequately covers the relevant concepts underlying the disciplines of accounting, finance and management control. For this purpose the REA-based ALE accounting ontology from Schwaiger [12] and the BSC-based management system from Church/Smith [3] were used to identify the shortcomings of the REA business ontology in form of missing accounting transactions, missing financial instruments representations and missing performance management systems. These shortcomings were solved by including adequate models into the REA business ontology and extending it to the REA business management ontology.

The REA business management ontology should be beneficial especially for business analysts who are engaged in the design of accounting, enterprise and management information systems. The big advantage of this ontology is its comprehensiveness. This should allow overcoming the currently often used silo modeling approaches into the direction of a mutually consistent modeling approach. In this sense the

accounting information systems research (e.g. Steinbart and Romney [13]), the enterprise information systems research (Dunn, Cherrington and Hollander [4]) and the management information systems research (e.g. Laudon and Laudon [9]) could be aligned and unified in order to establish information systems which cover the informational and procedural requirements needed in accounting, finance and management control.

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