ACC001 Formalising the Definitions of the Elements of the Statement of Financial Position

Gerber, MC[a]., Gerber, AJ[a]., van der Merwe, AJ[a] & Stegmann, N[b]
University of Pretoria[a] & University of Johannesburg[b]

Abstract

In this paper, we take the position that the Conceptual Framework for Financial Reporting (CFfFR) serves as a representation of accounting principles regarding financial reporting currently shared within a large contingent of the accounting community. In philosophy, the aim of Ontology is to seek truth (Mäki 2011) and obtain knowledge. Computing (Computer Sciences and Information Systems) inherited the concept of ontology from philosophy and uses ontologies to formalise complex conceptualisations of a specified domain using a formalised language based on logic (Gruber 2002). Ontologies are successfully used in computing to build computer readable artefacts that are inherently consistent and unambiguous (IHTSDO 2011; Noy and McGuinness 2000). In this paper we investigate whether the definitions of the elements of the Statement of Financial Position (SFP) as provided in the CFfFR (IASB 2010) and the Discussion Paper on the CF (DP/2013/1) (IASB 2013), could be formalised using ontology technologies. It is investigated whether such an artefact would benefit the accounting community by providing definitions that are inherently consistent and unambiguous. Based on an ontological analysis of the current definitions for the elements of the SFP provided in the CFfFR and DP/2013/1, we propose definitions for "asset", "liability" and "equity" in a formalised language, which are computer readable artefacts that are inherently consistent and unambiguous.

The general contribution of the paper is that it uses established ontology technologies from Computing and applies it to a natural language text from a specified domain i.e. financial reporting. The contribution towards the accounting community is that the methodology and ontology technologies used in this paper provides a tool, based on formal logics, to identify inconsistencies and ambiguities in a text, written in natural language such as the CFfFR. During the process of building the formal ontology certain inconsistencies and ambiguities in the current definitions of the elements of the SFP were identified. By building the formal domain ontology, the authors demonstrate that it is possible to successfully represent the elements of the SFP in a formalised language that is a computer readable artefact and is inherently consistent and unambiguous. The accounting community can now decide if the inherently consistent and unambiguous definitions of the elements of the SFP proposed in this paper, correctly describe the instances of the concepts, asset, liability and equity.

Keywords: Accounting Ontology, Conceptual Framework, Formal ontology, Financial Accounting Standards, Knowledge Representation.

1 INTRODUCTION

In this paper, the position is taken that the Conceptual Framework for Financial Reporting (CFfFR) as published by the IASB (IASB 2010) should define the most basic financial reporting concepts currently shared within a large contingent of the accounting community. In this study some of these concepts are evaluated from an ontological perspective. One of the uses of ontologies within computing is to provide a formal shared representation of a specific domain (Smith 2003).

Computing[1] adopted the concept Ontology as a formal representation from philosophy and ontologies are therefore used to formalise complex conceptualisations of a specified domain using a formalised logic-based language (Gruber 2002). Several applications of such computing ontologies exist where the goal of these computer readable artefacts include being inherently consistent and unambiguous (IHTSDO 2011; Noy and McGuinness 2000). In this paper we report on an investigation to determine whether the definitions of the elements of the Statement of Financial Position (SFP) as provided in the CFfFR (IASB 2010) and DP/2013/1 (IASB 2013), could be formalised using computing ontology technologies, and whether such an ontology artefact would benefit the accounting community by providing definitions that are inherently consistent and unambiguous.

In order to indicate the applicability of computing ontology technologies for the accounting domain, we provide a brief background discussion on ontologies (section 0): firstly discussing the historical development of the concept of Ontology in philosophy (section 0) and secondly, discussing the adoption of ontologies in computing (section 0). Lastly, in section 0 we indicate the applicability of formal ontologies to the accounting domain.

In Section 3 a design science research (DSR) approach (Hevner et al. 2004; Hevner and Chatterjee 2010; Kuechler and Vaishnavi 2008; Vaishnavi and Kuechler 2004) is used to build an artefact of the definitions of the elements in the form of a formal domain ontology. In the process of building the artefact, assumptions made to build the formal ontology are indicated in section 0. The design of the formal ontology includes a short discussion on the modelling of time (section 0) and the identification of the basic concepts and relations of the elements of the SFP in section 0. Based on the ontological analysis of the current definitions for the elements of the SFP provided in the CFfFR and DP/2013/01, definitions for "*asset*", "*liability*" and "*equity*" are proposed in section 0.3.3. We report on our findings of the modelling process in sections 0 and 0 and conclude on the benefits of a formal ontology of the definitions of the elements of the SFP for the accounting community in section 0.

[1] *Computing* is used to refer to both Computer Sciences and Information Systems.

2 ONTOLOGY BACKGROUND

2.1 Ontology in Philosophy

Computing adopted the concept of ontology from philosophy (Guarino et al. 2009), but ontologies within computing differs substantially from the original philosophical notion. Ontology defined from a philosophical perspective is "a branch of metaphysics concerned with the nature and relations of being, or a particular theory about the nature of being or the kinds of things that have existence" (Mirriam-Webster Dictionary 2014). According to Heidegger (1999) "*Ontology* means doctrine of being" and "Ontology" is used as a formal theory of objects and coincides with the ancient ontology or "metaphysics". Wolterstroff (1970) describes ontology from a philosophical perspective as "a description of the most general structure of what there is."

The concept of ontology originated with Aristotle who made the distinction between physics and metaphysics (Corazzon 2013; Heidegger 1999). Physics deals with material entities and metaphysics with immaterial entities, which are behind the physical world (Smith 1995). Through a cognitive process, Aristotle searched for the general properties of things that constitute their invariant form, namely the universal structures of patterns (universals) to be defined and axiomatized through first-order logic (Corazzon 2013). Ontology in the tradition of Husserl, Twardowski, Meinong Hartmann, and Heidegger forms the background of its adoption and use in computing (Corazzon 2013; Heidegger 1999). The importance of ontology for this study is that ontology is not isolated but connected to other disciplines, i.e. the *"field of being"* like ontology of nature, ontology of culture, and material ontologies (Heidegger 1999).

In philosophy, logic and ontology are diverse fields, but they overlap in the field of formal languages (Hofweber 2013). Hofweber (2013) identifies four notions of logic in philosophy:

- "(L1) the study of artificial formal languages;
- (L2) the study of formally valid inferences and logical consequence;
- (L3) the study of logical truths;
- (L4) the study of the general features, or form, of judgements."

Hofweber (2013) furthermore divides the discipline of ontology in philosophy into the following four parts:

- "(O1) the study of ontological commitment, i.e. what we or others are committed to,
- (O2) the study of what there is,
- (O3) the study of the most general features of what there is, and how the things there are relate to each other in the metaphysically most general ways,
- (O4) the study of meta-ontology, i.e. saying what task it is that the discipline of ontology should aim to accomplish, if any, how the questions it aims to answer should be understood, and with what methodology they can be answered."

Based on the four notions of logic and the four parts of ontology, Hofweber (Hofweber 2013) provides six areas of overlap between logic and ontology, namely:

1. Formal languages and ontological commitment. (L1) meets (O1) and (O4).
2. Is logic neutral about what there is? (L2) meets (O2).
3. Formal ontology. (L1) meets (O2) and (O3).
4. Carnap's rejection of ontology. (L1) meets (O4) and (the end of?) (O2).
5. The fundamental language. (L1) meets (O4) and (the new beginning of?) (O2).
6. The structure of thought and the structure of reality. (L4) meets (O3).

The use of ontologies and logic in computing is related to number three above - "Formal ontology (L1) meets (O2) and (O3)." The use and application of formal ontologies in computing is related to the characteristics that formal ontologies attempt to give precise mathematical formulations of concepts (properties) and the relations of these concepts in some formal language are based on a system of formal logic. In computing the formal language or ontolingua of the ontology is computer readable (Gruber 1992).

Based on this background of the transformation from ontology in philosophy to ontology in computing, the next section presents ontology within computing.

2.2 Ontology in Computing

The term *ontology* in computing is used widely referring to anything from taxonomy, a domain vocabulary, a conceptual model, to a formal logic-based ontology (McGuinness 2003). However, for this study the definition of an ontology as a shared, formal, explicit specification of a domain, typically describing a hierarchy of concepts and associating each concept's crucial properties with it is adopted (Broekstra et al. 2001). The purpose of ontologies in computing is to *represent* what exists (Gruber 1995) (a specified system or domain). Computational ontologies formally model the structure of a system (Guarino et al. 2009). In order to formally represent the relevant entities and relations of a system or domain, the ontology engineer analyses and organises the different entities of a system into its most basic concepts (also known in philosophy as universals) and relations between those concepts (Guarino et al. 2009). A taxonomy of the basic concepts (super-concepts and their sub-concepts) of a system or domain forms the backbone of an ontology (Guarino et al. 2009). An example from the accounting domain is to identify the concepts *resource*, *fixed asset*, and *building*. Resource is a super-concept of fixed asset and building. A physical building owned by an entity (business) would be an *instance* of its corresponding concept building.

Given the discussion above it is possible to make a distinction between Ontology in philosophy and computing ontologies. Ontology in philosophy aims to seek or discover the truth (Zúñiga 2001; Heidegger 1999; Mäki 2011). An ontology in computing is a *representational vocabulary* that is used to describe the relations between the set of objects of a domain to represent the knowledge of a specified domain without claiming to discover the truth or to obtain new knowledge (Mcguinness and Patel-schneider; Gruber 1995; Zúñiga 2001). Recent discussions in ontology engineering embrace the notion of

philosophical Ontology through the use of upper ontologies such as DOLCE or BFO that adopts a specific philosophical stance during ontology construction (BFO 2011; Guarino 2015; Borgo and Masolo 2009; Gangemi et al. 2002; SUMO 2015).

2.3 Formal Ontology and Accounting

According to the philosophical overlap between logic and ontology this study forms part of the overlap where (L1) meets (O2) and (O3) i.e. a "*Formal ontology"* (Hofweber 2013). Hofweber (Hofweber 2013) identifies three kinds of formal ontologies: representational, descriptive and systematic. As this study only proposes to *represent* the definitions of the elements of the SFP in an inherently consistent and unambiguous manner, it falls within the representational formal ontology as identified by Hofweber (2013). The study does not attempt to truly describe, as a formal set theory, the entities of the financial reporting domain and is thus not a descriptive formal ontology. Accordingly, the *representational formal ontology* in this study is successful from a philosophical angle if the ontology successfully *represents* the definitions as presented in the CFfFR and DP/2013/1. The success of the proposed ontology is not dependent on whether the written definitions *truly describe* the financial reporting domain of entities, because there are several unresolved issues, and consensus within the domain is required to achieve this goal.

For the purposes of this study an *ontology* is a special kind of information object or computational artefact that captures the knowledge of a specified domain in a computer readable form. Furthermore, it is a formal ontology meaning that a computer can not only read the ontology but also reason with the knowledge and draw logical inferences from the assertions. The goal of this study is to build a representational formal domain ontology focused on the financial reporting domain using a representational vocabulary and formal language based on DL's and Web Ontology Language (OWL), with specific reference to the definitions of the elements of the SFP.

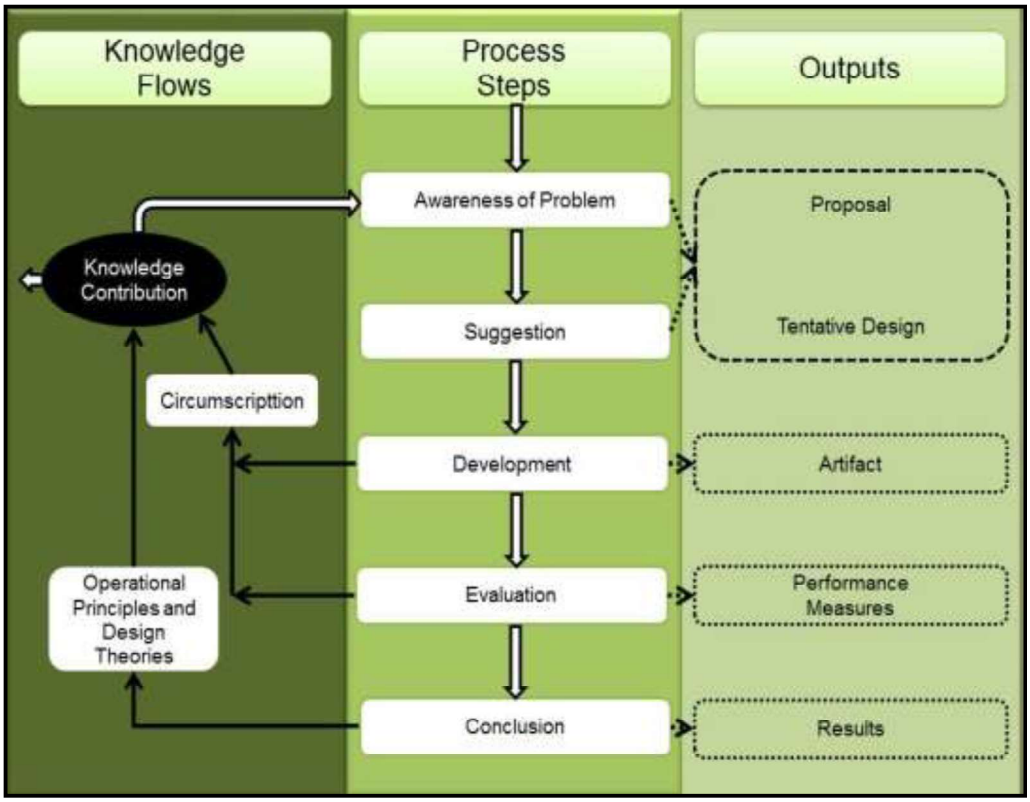
3 METHODOLOGY: DESIGN SCIENCE RESEARCH (DSR)

In this study *design science research* (DSR) [2] is adopted as research approach. DSR uses design as the research approach and the driving DSR concept is 'learning by building' (Hevner et al. 2004; Hevner and Chatterjee 2010; Kuechler and Vaishnavi 2008; Vaishnavi and Kuechler 2004). The DSR approach is relevant in cases where a study is testing previously untested interactions between existing artefact components or where new, untried principles are introduced (Kuechler and Vaishnavi 2011). The goal of a DSR project is to produce a purposeful artefact that addresses an identified pragmatic problem, especially in cases where elements of the problem will only arise during an attempted solution, or where the problem is not completely understood (Hevner et al. 2004). DSR is furthermore an iterative activity where the solution artefact is developed through various cycles of *awareness*, *suggestion*, *development* and *evaluation* (Vaishnavi and Kuechler

[2] As this paper reports on a second iteration of the first artefact, the same research methodology and development environment as in Gerber et al. (2014) is used.

2004; Kuechler and Vaishnavi 2011). Figure 3.1 below depicts a schematic presentation of a design science process model. [3]

Figure 3.1: Design Science Research Process Model



Crucial to DSR is the notion of rigour and relevance cycles, where *relevance* pertains to the interaction with the environment in which a real problem is identified and solved and rigour relates to the interaction with the scientific knowledge base where knowledge is used and contributed (Hevner and Chatterjee 2010; Hevner et al. 2004).

Within this research the *awareness* of vagueness, inconsistencies and ambiguities within the CFfFR resulted in a *suggestion* to use ontologies in computing to develop and ontology-based formal language to represent the concepts of the CFfFR. The first version artefact that was developed is an ontology that represents the definitions of *asset*, *liability* and *equity* of the CFfFR (Gerber et al. 2014). Feedback given the first iteration as well as the documentation and discussion in DP/2013/1, resulted in the development of the second iteration given the DSR approach. As before, an ontology engineering approach and development environment was used for the *development phase* as discussed in section 0.

[3] An advantage of DSR is that the researcher learns from knowledge obtained during a previous cycle and then builds on that knowledge during a following cycle. The development process continues until a satisfying answer / artefact is reached. The benefit for accounting is that DSR can be used in a cycle to investigate new untried principles in cases where elements of the problem will only arise during an attempt to a solution even when the problem is not fully understood.

3.1 Development Environment

The development of an ontology-based formal language for a domain commences with the construction of an ontology formally capturing the basic concepts and relationships of the domain. During the development cycles of the DSR project, Protégé 4.3 with bundled reasoners (e.g. FACT++ and Pellet) were used as tools to develop an OWL 2 ontology (W3C 2009). As a development approach during the DSR development cycle, an ontology engineering approach, described by Horridge (2009) and Noy and McGuinness (2000) was incorporated that consists broadly of the following steps:

- Identification of the concepts and concept hierarchy, including disjointness (section 5.2);
- Addition of all the relationships between concepts (section 5.2);
- Refinement of concepts based on relationships they participate in (sections 6.1 - 6.3);
- Identification of definitions (sections 6.1 - 6.3);
- Addition of annotations, which are used for meta-data or descriptions of anything that is represented (sections 6.1 - 6.3); and
- Refinement of the ontology through various iterations of the above steps.

The logical next step is the execution of the above steps for the ontology construction which is discussed below.

4 BASIC ASSUMPTIONS TO BUILD A FORMAL ONTOLOGY

4.1 Concepts and relations

A formal ontology consists of assertions about **concepts** and the **relations** between the concepts within a specified semantic (accounting) domain. The reasoner, which forms part of Protégé, uses the DL assertions to infer logical consequences about the domain and checks, for instance, whether these assertions are consistent. In order to build a logical consistent ontology the *semantic meaning* of the concepts and relations needs to be asserted formally. Before an ontology is constructed, assumptions are documented and whenever the modeller doubts the meaning of a specific concept or relation during the ontology construction process, it is usually an indication of an ambiguity and in this case it forces the identification of further assumptions about the meaning of concepts and relations.

Therefore, in order to build the formal ontology (or formal language), the semantic domain has to be analysed to identify the **most basic concepts and relations** within the specified domain. The CFfFR claims to represent the basic postulates or principles of the financial reporting domain and once the ontology has been built from these basic postulates, it should be possible to expand the ontology to principles (principle based standards) derived from the postulates to test if the principles are logically consistent with the most basic concepts.

4.2 Assumptions

For this research study we:

- adopt the view that the CFfFR should define the basic concepts and principles (postulates) necessary for the development of financial accounting standards;
- assume the position that the textual representation of the CFfFR, given its supposed role, is sufficient without any further explanations. It should not be necessary to explain concepts or statements from third party sources;
- use only the current textual representation of the CFfFR and DP/2013/1 to develop the ontology;
- regard situations where the published texts are unclear, ambiguous or inconsistent, as omissions and propose that this should be amended;
- accept the textual description as presented in the CFfFR and DP/2013/1, but suggest that this could be augmented with an ontology-based formal language where the semantics are captured unambiguously;
- consider the explanations provided in DP/2013/1 to clarify terminology used in the proposed definitions of DP/2013/1; and
- suggest that, if inconsistencies and ambiguities exist, they do not necessarily have to be solved as the solution may be complex, but they should at least be known.

5 FORMAL ONTOLOGY OF THE ELEMENTS NECESSARY FOR THE MEASUREMENT OF FINANCIAL POSITION

5.1 Representation of time: Past, Present and Future

Within the accounting domain, an important basic concept is **time** as *time* functions as a **deciding factor** between inclusion or exclusion of a concept (element) in terms of the relations **owned by** / **owed by** the concept entity.

Adding temporal dimensions to OWL is not straightforward as OWL's specific logic-based formalism does not support the representation of dynamically changing information (Krieger 2008). Several solutions to the representation of time in OWL have been proposed in literature, either by equipping the formal semantics (Artale et al. 2008; Lutz et al. 2008; Krieger 2008), or through modelling constructs (Hobbs and Pan 2004; Ma 2007; Connor and Das 2011). An ontology engineer would choose a solution based on the requirements that the ontology should fulfil.

In the basic definitions of the CFfFR, the concepts Past, Present and Future are pertinent.[4] Unfortunately, the CFfFR definitions do not clearly state what is meant with Past, Present and Future. It would be straightforward to assume that Past and Future are Intervals. Present is problematic, and for the first version of our ontology, the choice was made to represent Present as an Instant, with a member (individual) TimeOfConsideration. Past then has a temporalEnd, which is the TimeOfConsideration, and Future temporalBegins at

[4] In Gerber et al. (2014) the notion of time is discussed in more detail.

the TimeOfConsideration. TimeOfConsideration in this study refers to the instant whenever the inclusion or exclusion of an element is considered. This implies that it may for example, be the time when a contract is concluded, the reporting date, when an obligation is settled or an asset is derecognised.

The following is a schematic presentation of the notion of time:

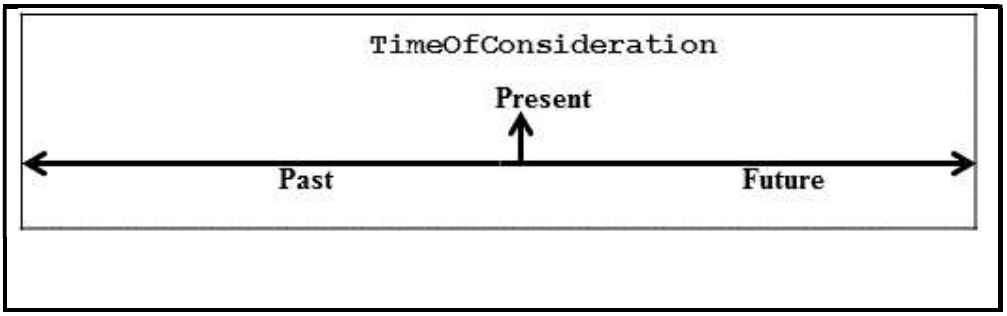


Figure 5.1: Presentation of Present as an Instant (TimeOfConsideration), with Past and Future as related Intervals (Gerber et al. 2014)

Identification of basic concepts and relations

For the purpose of this study, we endeavoured to identify the **basic concepts** represented in the elements of the SFP. According to our analysis of the current definitions of the elements of the SFP, the basic concepts contained in them are **resources**, **claims** (against those resources) and **entity** (the owner of the resources and claims). These concepts are disjointed from each other as a **resource** cannot be a **claim** or an **entity**. Within ontology engineering, the identification of the concept hierarchy / taxonomy is a departure point for ontology construction. The taxonomy is the logical relationship between **sub-concepts** (lower on the hierarchy of concepts) to its **super-concepts**. These concepts should be defined in an unambiguous way to achieve an unambiguous formal language. Once these basic concepts of the elements are identified, sub-concepts presented in the current definitions of SFP elements could be identified.

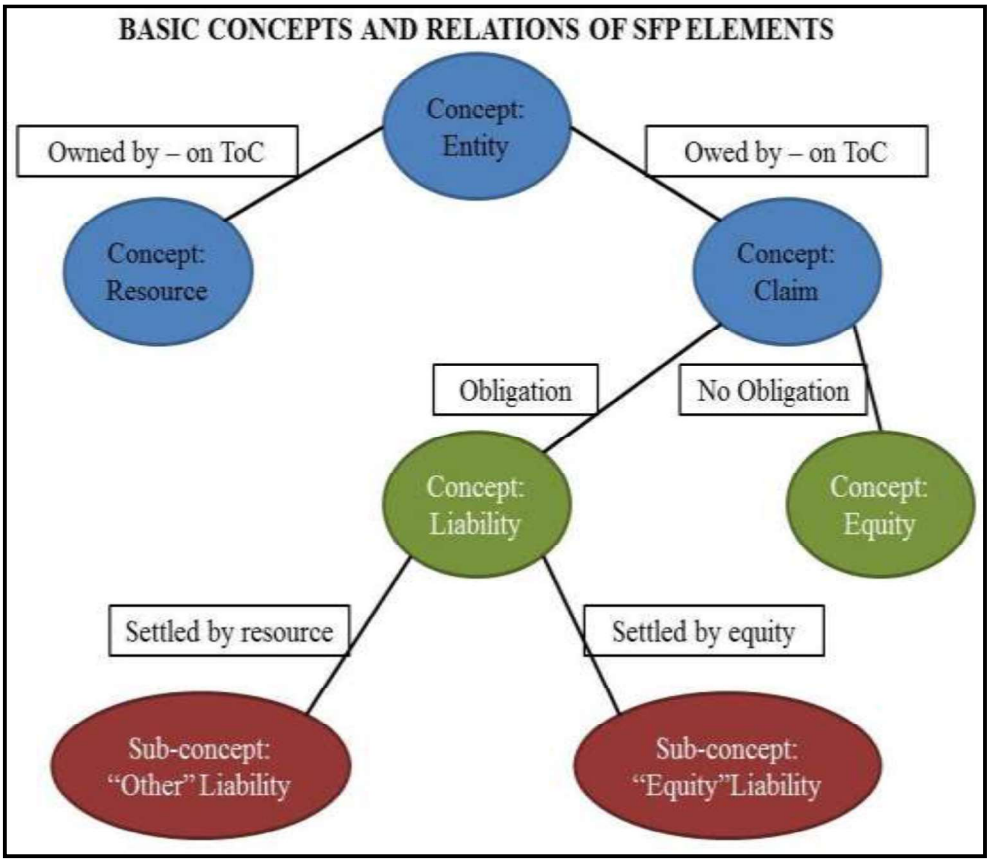
No sub-concepts were identified under the concept *resources*, whilst two sub-concepts were identified under *claims*, i.e. *equity* and *liability*. The most onerous part was to determine **the most basic distinguishing aspect** between equity and liability. According to our reading of the comments in DP/2013/1, the most distinguishing aspect is the concept **obligation** as defined and explained in the DP/2013/1 on the reporting date / TimeOfConsideration.

Equity is linked to *entity* with the relation *owed by*, but it is not an *obligation* on the TimeOfConsideration (ToC) (distinguished from liability by the concept time). Once *equity* was distinguished from *liability* by the concept *obligation,* two sub-concepts of liability were identified. The most basic distinguishing aspect according to the discussion in the DP/2013/1 is: **How will the obligation be settled**? The two most basic ways in which an obligation may be settled is either by equity or by a resource. Even when an

obligation is partially settled by equity and partially by a resource (hybrid instrument), it only represents a combination of the two most basic settlement methods.

Other concepts identified and included in the definitions and the ontology are: **control, past event** and **economic benefit**.
The following is a schematic presentation of basic concepts and relations of SFP elements.

Figure 5.2: Schematic presentation of basic SFP concepts and relations



Using the analysis of concepts and relations as presented in figure 5.2, the definitions as provided in the CFfFR and DP/2013/1 were analysed.

6 REPRESENTATION OF DEFINITIONS

6.1 Representing an Asset

6.1.1 The CFfFR

> *"An asset is a resource controlled by the entity as a result of past events and from which future economic benefits are expected to flow to the entity"* (IASB 2010, 4.4(a)).

As the first modelling cycle of an asset was reported on in Gerber et al. (2014) this paper only reports on the findings of the second modelling cycle.

6.1.2 The Discussion Paper

> An asset of an entity is: "*a present economic resource controlled by the entity as a result of past events*" (IASB 2013). Economic resource is defined as: "*a right, or other source of value, that is capable of producing economic benefits*" (IASB 2013).

The asset definition as stated in DP/2013/1 addresses the following questions raised on the definition in the CFfFR:

1. A "resource" is defined as "a right, or other source of value". This provides some clarity, but from a logical modelling perspective, the definition "*resource*" is in the first instance "*a source of value*" of which a "*right*"[5] is one type of source of value. The implication is that there are also "*sources of value*" other than rights that are resources. It is open for interpretation to determine what the "*other sources of value*" may be. We suggest that the concept "sources of value" should be elaborated upon.
2. The sub-concept EconomicBenefit is still used in the definition of economic resource. The question is whether EconomicBenefit refers to a benefit with monetary value? Some clarity on the intended meaning of the concept "*economic*" is needed to avoid ambiguous interpretations of the concept "*economic*".
3. As the words "*controlled by*", is still used in the same manner in the definition in DP/2013/1 as in the CFfFR, the comments made in Gerber et al. (2014) regarding the concept of Control are still applicable.
4. DP/2013/1 excludes the term "expected", which solves the problems experienced with the representation of the CFfFR definition. We are in agreement with the discussion and preliminary views on uncertainty in the DP/2013/1 (IASB 2013). There is however still some uncertainty built into the term "capable" as it is used in the definition, which should make provision for some uncertainty.
5. Regarding the use of the time concept "*future*": We welcome the omission of "*future*" as we are of opinion that the term is not a deciding and essential concept or relation in the definition to determine an asset.
6. Regarding the use of time "*past*": The authors view the use of the time concept PastEvent as a deciding and essential concept in the definition and it does contribute to identify an asset and must therefore be included in the definition of an asset.

[5] See the DP/2013/1 (IASB 2013) par 2.14 (a) for an example of a "*right*".

7. Regarding the use of time "*present*": As acknowledged by the IASB (IASB 2013) par. 2.16 (b) "this notion is already implicit in the existing definition" and by making it explicit does not contribute to make the definition more clear, in fact it created some problems." To include "*present*" in the definition on the basis of "emphasising the parallel with the definition of a liability " (IASB 2013, para. 2.16 (b)) is not enough motivation to include it in the definition of an asset. When attempting to represent "*present economic resource*" it was unclear what "present" means? Is it the resource that has economic value at "*present*", or is it a "*present*" resource? What does the time notion "*present*" refer to, is it for example the *reporting date* or *the time of consideration*? If "*present"* refers to the reporting date, it is assumed and not clear from the text.

Based on the comments above we propose the following definition for an asset, which can be represented in an ontology-based formal language.

6.1.3 Proposed asset definition

> An asset of an entity is: "*a resource (right or other source of value), which is under the control of an entity as a result of past events and which is capable of producing economic benefits.*"

The following is a formal representation of the proposed asset definition:

Asset

$$\text{Asset} \equiv \text{Resource} \sqcap \exists\, \text{isCapableToProduce.EconomicBenefit} \sqcap \exists\, \text{isUnderControlOf.Control}$$
$$\text{Control} \sqsubseteq \exists\, \text{isControlOf.Entity} \sqcap \exists\, \text{isResultOf.PastEvent}$$
$$\text{Resource} \equiv \text{SourceOfValue} \equiv \text{OtherSourceOfValue} \sqcup \text{Right}$$
$$\text{OtherSourceOfValue} \sqsubseteq \neg\, \text{Right}$$
$$\text{EconomicBenefit} \sqsubseteq \text{Benefit}$$
$$\text{PastEvent} \sqsubseteq \text{Event} \sqcap \exists\, \text{happenIn.Past}$$
$$\text{Past} \sqsubseteq \text{Interval} \sqcap \exists\, \text{temporalEnds.}\{\text{TimeOfConsiderationInstant}\}$$

Figure 6.1: Formal representation of the proposed asset definition

The following serves as motivation for the proposed asset definition:

1. The proposed definition includes the additional definition provided in the DP/2013/1 for economic resource. We are of opinion that the combination of the two definitions will eliminate possible ambiguities and vagueness. At this stage, we included "right or other source of value" in brackets after "resource" to clearly indicate what the intended meaning of the concept resource is.
2. The sub-concept EconomicBenefit was kept as it is a deciding concept in the process to determine an asset. The remarks regarding the clarity on the meaning of "*economic*" are maintained.
3. Based on the discussion above we omitted the notion of time "present" in the proposed definition. However, it is suggested that, should the IASB be of the opinion that "present" is a deciding notion in the definition, *present* should be

replaced with *time of consideration* as this should indicate the intended meaning of present as an instant and not a period of time. The proposed definition would then read as follows: "a resource (right or other source of value), which is *on the time of consideration* under the control of an entity as a result of past events and which is capable of producing economic benefits." This way it is stated clearly that the control of the resource happens on the date of reporting. It is also clear that the time before the date of reporting is the past and the time after the date of reporting is the future.

4. The notion of control is complex[6] and in order to represent this complexity *control* was modelled as a concept, control, and not as a relation as it is formulated in the current definitions. To represent *control* as a concept will make it possible to model different types of control as it is used in IFRS 10. The IASB proposes a definition for control on par. 3.23 with some further guidance in par 3.26 - 3.32 (IASB 2013).
5. It was decided not to dissect the proposed definition of *control* as provided in par. 3.23 at this stage, however we identified some possible issues in the proposed definition namely:
    a) The intended meaning of "present ability";
    b) The intended meaning of "that flow from it"; and
    c) The previous comments on "economic", "present" and "benefit" that are also applicable to the proposed definition of control.

6.2 REPRESENTING A LIABILITY

6.2.1 The CFfFR

> **"***A liability is a present obligation of the entity arising from past events, the settlement of which is expected to result in an outflow from the entity of resources embodying economic benefits*"(IASB 2010, 4.4(b)).

As the first modelling cycle of a liability was reported on in Gerber et al. (2014) this paper only reports on the findings of the second modelling cycle.

6.2.2 The Discussion Paper

> A liability of an entity is: "*a present obligation of the entity to transfer an economic resource as a result of past events.*" (IASB 2013).

When attempting to model *liability* as proposed in the DP/2013/1, the following was found:

[6] The complexity and different uses of control is discussed in the DP/2013/1 in detail (IASB 2013).

1. The transfer of an economic resource poses the same problem as "outflow of resource" in the definition in the CFfFR. A specific entity can only transfer economic resources defined as assets under control of that specific entity and not any economic resource.
2. As "expected" is not included in the definition proposed in the DP/2013/1 the problem identified in the CFfFR is resolved.
3. The discussion on the use of the time notion "present" in the definition of an asset is also valid in the use of the time notion "present" in the liability definition. The IASB should consider to rather use "time of consideration" instead of "present".
4. The use of the time concept TimeOfConsideration depends on the IASB's opinion if TimeOfConsideration contributes as a deciding and distinguishing factor to the definition of a liability. In the DP/2013/1 (IASB 2013, par. 2.16 (a)) it is emphasised that "present" / (TimeOfConsideration) contributes to decide whether a liability exists at the reporting date.

6.2.3 Proposed liability definition

Based on the modelling problems indicated and keeping the proposed definition of equity in mind, the following definition for a liability is proposed:

> A liability of an entity is: "*An obligation, owed on the time of consideration by the entity as a result of past events*".

The following is a formal representation of the proposed liability definition:

Liability

$\text{Liability} \equiv \text{Obligation} \sqcap \exists\ \text{isOwedBy.Entity} \sqcap \exists\ \text{isResultOf.PastEvent} \sqcap \exists\ \text{isValidInTime.TimeOfConsideration}$
$\text{Obligation} \equiv \text{PresentObligation} \equiv \sqsubseteq \exists\ \text{isValidInTime.TimeOfConsideration}$
$\text{Obligation} \sqsubseteq \text{Claim} \sqcap \exists\ \text{isResultOf.PastEvent}$
$\text{Liability} \sqsubseteq \neg\ \text{Equity}$

Figure 6.2: Formal representation of the proposed liability definition

1. The words "of the entity" in the definition in the DP/2013/1 is replaced with "*owed by the entity"*. The change is to emphasise and clearly formulates the relation between the concepts obligation and entity.
2. The word "present" could be replaced with "time of consideration" as it will indicate clearly the intended meaning of present.
3. The phrase "*transfer an economic resource*" is not included in the proposed definition as a result of the problem discussed above. This concurs with the narrow equity approach as discussed in the DP (IASB 2013). The reason we opted for this option is not to have an inconsistency with the proposed definition of equity.

4. In order to accommodate the advantages of the strict obligation approach (IASB 2013, par. 5.37-5.43) we suggest that obligations must differentiate between "obligations to transfer an asset" and "obligations to transfer equity".
5. From the perspective of a liability, the only distinguishing factor between a liability and equity will be if a claim is an obligation at the date of reporting or not.

The proposed definitions of asset and liability concur with the IASB view that "an asset is a resource and a liability is an obligation**"** (IASB 2013, 25, par. 2.13-2.15)**.**

6.3 REPRESENTING EQUITY

6.3.1 The CFfFR

> "*Equity is the residual interest in the assets of the entity after deducting all its liabilities*" (IASB 2010).

"Analysing this definition, Interest as an additional and disjoint concept to be used for equity. ResidualInterest is a type of Interest that has to be refined further as it is *interest* in assets *after deducting* liabilities. A possibility for formalising the notion of deduction in a DL ontology is through set difference or formally: $B \backslash A = \{x \in B \mid x \notin A\}$[7]. For the proposed definition it is viable to use set difference and therefore Equity was initially represented as Asset and not Liability.

However, this definition of Equity resulted in an inconsistency in Protégé. The reasoner inferred that the Equity and therefore Asset concepts are inconsistent (or sub-concepts of Nothing) as indicated in Gerber et al. (2014).

6.3.2 The Discussion Paper

The same definition for equity is proposed in the DP/2013/1. The comments made during the first modelling cycle in Gerber et al. (2014) are still valid.

6.3.3 Proposed equity definition

The following definition for equity is proposed:

> Equity is: "a *shareholder' claim against the entity, that is the result of a past event and which is not a present obligation*".

The following is a formal representation of the proposed equity definition:

[7] DL is formally based on set theory and conceptually; mathematical deduction is represented with set difference.

Equity

$\text{Equity} \equiv \text{Claim} \sqcap \neg\, \text{PresentObligation} \sqcap \exists\, \text{isClaimOf.Shareholder} \sqcap \exists\, \text{isOwedBy.Entity} \sqcap \exists\, \text{isResultOf.PastEvent}$
$\text{Equity} \sqsubseteq \neg\, \text{Obligation}$

Figure 6.3: Formal representation of the proposed equity definition

The following discussion partly results from the analysis to identify the most basic concepts and relations of the accounting domain. During the modelling process, it became clear that the concept entity is in relation to only two basic concepts, namely resources and claims. Although all the items on the equity and liability side of the statement of financial position are claims, the entity does not have an obligation on the date of reporting to settle all the claims.

An obligation implies that on the date of reporting, the entity **must**, due to an event in the past, settle a specific claim in the future. By introducing the concept obligation, claims may be subdivided into "*claims with an obligation*" and "*claims without an obligation*" on the date of reporting. Some of the claims without an obligation are the result of a specific type of agreement, a shareholders' agreement. We propose that claims, which are the result of a shareholders' agreement without an obligation to settle the claim on the time of consideration must be classified as equity and the remaining claims would be classified as liabilities. The logical implication is that equity is not an obligation. This analysis resulted in the proposed definition for equity and agrees with the narrow equity approach as described in the DP/2013/1 in par. 5.30-5.33.

When the settlement methods of claims with an obligation at the time of consideration are analysed, it is clear that those claims (liabilities) may only be settled either by transferring control of an asset (transferring control of a resource), or by delivering an equity claim. Our analysis brought us back to the two most basic concepts of an entity. An entity does not have anything else to settle an obligation, except to exchange one obligation for another obligation.
Schematically the discussion above is presented as follows:

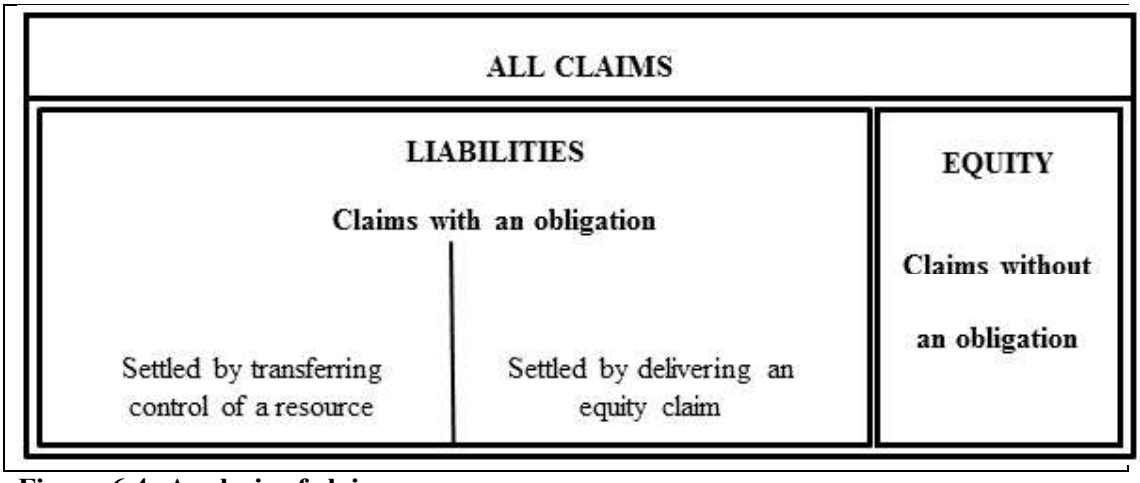


Figure 6.4: Analysis of claims

We suggest that disclosure requirements are formulated for the different classes of liabilities to accommodate the advantages provided by the strict obligation approach. This way one stays true to the modelling requirements and to the needs of the primary users of financial statements.

6.4 Summary of the representation process

The following table summarises the three definitions of *asset*, *liability*, *equity* and *economic resource* from the different sources in this study.

Table 1: Summary of definitions

Definition	CFfFR	Discussion Paper DP/2013/1	Proposed
Asset:	A resource controlled by the entity as a result of past events and from which future economic benefits are expected to flow to the entity	A present economic resource controlled by the entity as a result of past events.	A resource (right or other source of value), which is, under the control of an entity as a result of past events and which is capable of producing economic benefits.
Liability:	A present obligation of the entity arising from past events, the settlement of which is expected to result in an outflow from the entity of resources embodying economic benefits.	A present obligation of the entity to transfer an economic resource as a result of past events.	An obligation, owed on the time of consideration by the entity as a result of past events.
Equity:	Equity is the residual interest in the assets of the entity after deducting all its liabilities.	Equity is the residual interest in the assets of the entity after deducting all its liabilities.	A shareholder' claim against the entity, that is the result of past events and which is not an obligation on the time of consideration.

Economic resource	No existing definition	A right, or other source of value, that is capable of producing economic benefits.	Incorporated into the definitions.

6.5 A summary of the changes proposed to the definitions

Comments on suggested changes from DP/2013/1 asset definition:

- The definition of an economic resource was included in the asset definition to avoid confusion with two separate definitions.
- "Controlled by" was rephrased to formulate "control" as a concept, as it is implied in the definition, and not a relation.

Comments on suggested changes from the DP/2013/1 liability definition:

- *Present obligation* is changed to "*An obligation ... on the time of consideration"* because it is not clear what the meaning of *present* is. From the discussion of the concept *time*, it is possible to argue that *present* means *reporting date*. When the replacement of *present* with *reporting date* was evaluated with accounting experts, they mentioned a valid objection that the implication is that a liability has to be recognised when the transaction is concluded and not only on the reporting date. By replacing present with *time of consideration,* we address the objection as *time of consideration* refers to any time when the inclusion or exclusion of a possible liability (or any other transaction for that matter) is considered - on any reporting date.
- *"Of the entity"* is replaced with "*owed .... by the entity*". The word *owed* indicates clearly the relation between obligation and entity. See also the schematic illustration above.
- The phrase "*transfer an economic resource*" is not included in the proposed definition.
- From the perspective of a liability, as illustrated above, the only distinguishing factor between a liability and equity will be if a claim is ***an obligation on the time of consideration (reporting date)*** or not.
- To be consistent with the proposed liability and equity definitions two main classes of liabilities are proposed:
  1. Liabilities with the obligation to transfer **an economic resource**.
  2. Liabilities with the obligation to transfer **equity**.
- The proposal of two different classes of liabilities leaves room to have separate disclosure requirements for the two different classes of liabilities.
- It also provides room to disclose the different elements of hybrid liabilities according to the above mentioned disclosure requirements.

Comments on suggested changes from the DP/2013/1 equity definition:

- A new definition for *equity* is proposed. The current definition of equity does not contribute any distinguishing element between *asset* or *liability* and it was not possible to formally represent the current definition in the ontology.
- In the proposed definition, it is stated that equity is a claim against the entity, which is consistent with the schematic illustration above.
- The proposed equity definition distinguishes equity from liability by stating that although equity is a claim against the entity, it is *not an obligation at the time of consideration*.
- The proposed definition further limits equity to only business owners.

7 FINDINGS AND CONCLUSION

In this paper the position is established that using ontology is applicable both from a philosophical and computing perspective and can assist with the establishment of a rigorous, consistent and unambiguous CFfFR for accounting that represents the current knowledge of the financial reporting domain. In order to assess this position, we developed a representational formal domain ontology (artefact) from the natural text as provided in the CFfFR (IASB 2010) and DP/2013/1 (IASB 2013).

From a philosophical perspective of ontology, this study falls within the category representational formal ontology ((L1) meets (O2) and (O3)) as described by Hofweber (2013). This study does not propose to be a descriptive or systematic ontology as described by Zúñiga (Zúñiga 2001). The artefact represents the most basic concepts and relations (universals according to Aristotle) of the SFP elements of the accounting domain. The ontology of the definitions of the elements of the SFP stands in the tradition of the ontological thinking of Heidegger and the formal logic of Bolzano. In the philosophical terminology of Heidegger, this study provides a formal representation of the *being* of the concepts asset, liability and equity.

From a computing perspective, the result of this study is an artefact built by means of design science research in the form of a formal ontology. The formal ontology is formulated in a computer readable language (OWL) and tested for inconsistencies and ambiguities, using the reasoners provided by Protégé. The Protégé reasoner is based on formal logic (Description Logics). It can thus be concluded that the formal ontology of the elements of the SFP complies with Gruber's (1995) definition of an ontology as "an explicit specification of a conceptualization".

During the representation process of the formal ontology, various inconsistencies and ambiguities within the definitions of asset, liability and equity were identified. These inconsistencies and ambiguities were reported in section 0. The most important inconsistency identified was the inability to represent the CFfFR definition of *equity* due to the disjointness between the concepts *asset* and *liability*. In order to be able to represent

the definitions of the elements of the SFP a definition for *equity* is proposed that is inherently consistent and unambiguous. Another result of the attempt to build a formal ontology of the definitions is the introduction of the concept "*claim"*, implied but not explicitly mentioned in the current definitions, as the most basic concept adjacent to the concept "*resource*".

A further contribution of the paper is that it uses established ontology technologies from computing and applies it to a natural language text from a specified domain i.e. financial reporting. The contribution towards the accounting community is that the methodology and ontology technologies used in this paper provides an approach and tool, based on formal logic, to identify inconsistencies and ambiguities in a text, written in natural language such as the CFfFR. By building the formal domain ontology, the authors demonstrate that it is possible to *successfully represent* the elements of the SFP in a formalised language that is a computer readable artefact and is inherently consistent and unambiguous.

In figure 7.1 a graphical representation of the basic concepts and relations of the definitions of the elements of the SFP, represented in the ontology is provided.

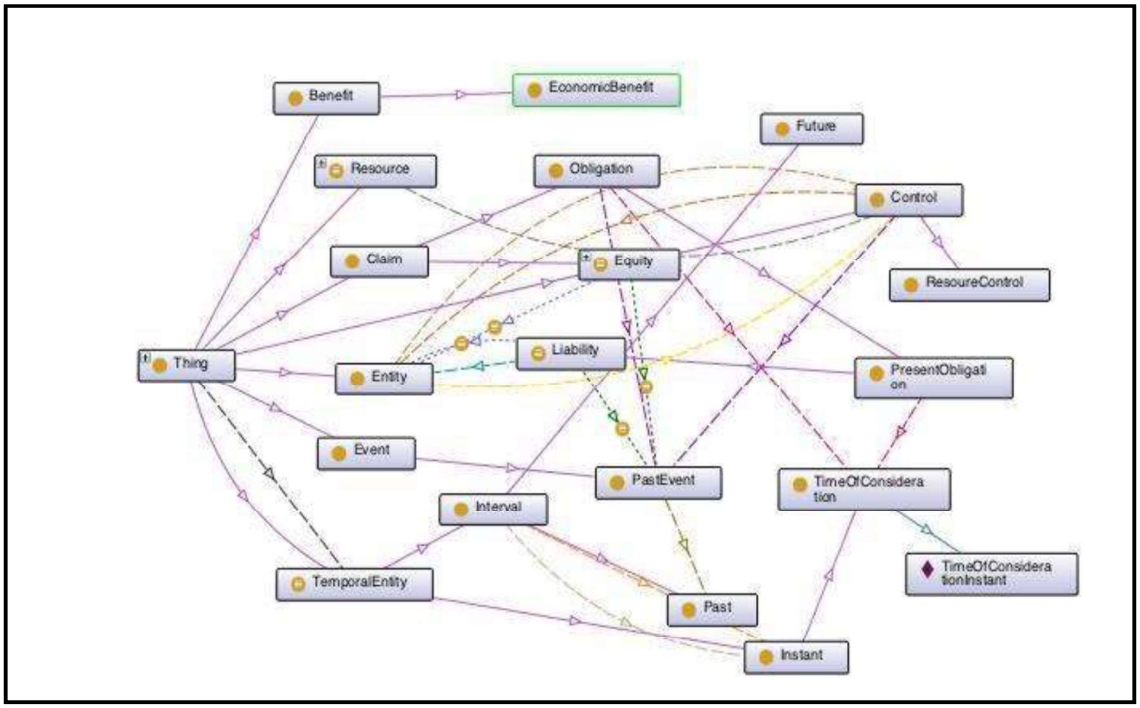


Figure 7.1: Represented ontology of the elements of the SFP

We acknowledge that our approach will not resolve all issues, but maintain the stance that a formal representation of the financial reporting domain in the form of an ontology should assist with the establishment of an unambiguous and consistent conceptual framework for financial reporting.

The accounting community could now be involved to decide whether the inherently consistent and unambiguous definitions of the elements of the SFP proposed in this paper, correctly represent the instances of the concepts, asset, liability and equity.

8 REFERENCES

Artale, A., N. Guarino, and C. M. Keet. 2008. Formalising Temporal Constraints on Part-Whole Relations. In Journal of Web Semantics, 5:46.

BFO. 2011. BFO. American Banker 168 (190): 572–577.

Borgo, S., and C. Masolo. 2009. Foundational choices in DOLCE. In Handbook on Ontologies (Second Edition), ed. S. Staab and R. Studer, 22:361–382. Springer Berlin Heidelberg.

Broekstra, J., M. Klein, S. Decker, D. Fensel, F. van Harmelen, and I. Horrocks. 2001. Enabling Knowledge Representation on the Web by Extending RDF Schema. In Accounting, Organizations and Society,, ACM 1-5811:467. Addison Wesley Professional.

Connor, M. J. O., and A. K. Das. 2011. A Method for Representing and Querying Temporal Information in OWL: 97–110.

Corazzon, R. 2013. Theory and History of Ontology. http://www.ontology.co/idx00.htm.

Gangemi, A., N. Guarino, C. Masolo, A. Oltramari, and L. Schneider. 2002. Sweetening Ontologies with DOLCE. In Knowledge engineering and knowledge management: Ontologies and the semantic Web., 166–181. Springer Berlin Heidelberg.

Gerber, M. C., A. J. Gerber, and A. J. Van der Merwe. 2014. An Analysis of Fundamental Concepts in the Conceptual Framework Using Ontology Technologies. South African Journal of Economic & Management Sciences 17 (4): 396–411.

Gruber, T. R. 1992. Ontolingua: A Mechanism to Support Portable Ontologies. Final. Stanford, CA, USA: Knowledge Systems Laboratory, Stanford University.

———. 1995. Toward principles for the design of ontologies used for knowledge sharing? International Journal of Human-Computer Studies 43 (5-6): 907–928.

———. 2002. What is an Ontology? Knowldedge Systems, AI Laboratory. Stanford University. http://www.ksl.stanford.edu/kst/what-is-an-ontology.html.

Guarino, N. 2015. DOLCE. Laboratory for Applied Ontology. http://www.loa.istc.cnr.it/old/DOLCE.html.

Guarino, N., D. Oberle, and S. Staab. 2009. What Is An Ontology? In Handbook on Ontologies, ed. S. Staab and R. Struder, 1–17. Springer-Verlag Berlin Heidelberg.

Heidegger, M. 1999. Ontology: The Hermeneutics of Facticity. Indiana, U.S.A.: Indiana University Press.

Hevner, A., and S. Chatterjee. 2010. Design Research in Information Systems: Theory and Practice. Integrated Series in Information Systems. Boston, MA: Springer US.

Hevner, A. R., S. T. March, J. Park, and S. Ram. 2004. Design science in information systems research. MIS quarterly 28 (1): 75–105.

Hobbs, J. R., and F. Pan. 2004. An Ontology of Time for the Semantic Web. ACM Transactions on Asian Language Processing (TALIP): Special issue on Temporal Information Processing 3 (1): 66–85.

Hofweber, T. 2013. Logic and Ontology. In The Stanford Encyclopedia of Philosophy, ed. E. N. Zalta. Stanford.

Horridge, M. 2009. Protege OWL Tutorial. http://130.88.198.11/tutorials/protegeowltutorial/.

IASB. 2010. The Conceptual Framework for Financial Reporting. London: IFRS Foundation.

———. 2013. A Review of the Conceptual Framework for Financial Reporting. DP/2013/1. Discussion Paper. London: United Kingdom.

IHTSDO. 2011. Snomed CT. International Journal of Disclosure and Governance. http://www.ihtsdo.org/snomed-ct/.

Krieger, H. 2008. Where Temporal Description Logics Fail : Representing Temporally-Changing. KI2008: Advances in Artificial Intelligence. Lecture Notes in Computer Science 5243: 249–257.

Kuechler, B., and V. Vaishnavi. 2008. On theory development in design science research: anatomy of a research project. European Journal of Information Systems 17: 489–504.

———. 2011. Extending Prior Research with Design Science Research : Two Patterns for DSRIS Project Generation. In DESRIST 2011,, 166–175. Springer-Verlag Berlin Heidelberg 2011.

Lutz, C., F. Wolter, and M. Zakharyaschev. 2008. Temporal Description Logics: A Survey. 2008 15th International Symposium on Temporal Representation and Reasoning: 3–14.

Ma, J. 2007. Ontological considerations of time, meta-predicates and temporal propositions. Applied Ontology 2: 37–66.

Mäki, U. 2011. Models and the locus of their truth. Synthese 5 (1): 47–63.

McGuinness, D. L. 2003. Ontologies come of age. In Spinning the semantic web: bringing the World Wide Web to its full potential, ed. D. Fensel, J. Hendler, H. Lieberman, and W. Wahlster, 1–14. First edit. MIT Press.

Mcguinness, D. L., and P. F. Patel-schneider. From Description Logic Provers to Knowledge Representation Systems: 271–288.

Mirriam-Webster Dictionary. 2014. Ontology. http://www.merriam-webster.com/dictionary/ontology.

Noy, N. F., and D. L. McGuinness. 2000. Ontology Development 101: A Guide to Creating Your First Ontology. Stanford, CA, 94305.

Smith, B. 1995. Towards an ontology of common sense. In International Journal of Human-Computer Studies, 43:641–667.

———. 2003. Ontology. In Blackwell Guide to the Philosophy of Computing and Information, ed. L. Floridi, 155–166. Oxford: Blackwell Publishing Ltd.

SUMO. 2015. SUMO. Suggested Upper Merged Ontology. http://www.ontologyportal.org/.

Vaishnavi, V., and W. Kuechler. 2004. Design Research in Information Systems. BRW. http://desrist.org/design-research-in-information-systems.

W3C. 2009. OWL 2 Web Ontology Language: Document Overview. http://www.w3.org/TR/owl2-overview/.

Wolterstorff, N. 1970. On Universals : An Essay in Ontology. Chicago, USA: The University of Chicago Press.

Zúñiga, G. L. 2001. Ontology: Its Transformation From Philosophy to Information Systems. In Proceedings of the international conference on Formal Ontology in Information Systems - FOIS '01, 2001:187–197. New York, USA: ACM Press.