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Using a Controlled Vocabulary to Support Business Process Design

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Abstract. Rapid business change demands the ability to adapt, rearrange and reinvent business processes while keeping the alignment with supporting information systems. However, such tasks require a business process to be consistently specified and modelled. To address this issue, this paper describes an organizational taxonomy that defines a controlled vocabulary to design business processes using the concepts of information entity, business process, organizational unit, actor, business schedule and business goal.

Keywords: organizational taxonomy, ontology, business process design, conceptual modelling.

1 Introduction

Business process management plays a central role at operational, organizational and technological levels [1-3]. Business process modelling produces abstract descriptions of business processes that are a central asset to the organization as they enable its specification, documentation, analysis and engineering through multiple paradigms, languages and techniques [3-7]. However, process modelling languages are criticised due to the lack of mechanisms to deal with domain changes and integrating the requirements of multiple stakeholders [8, 9].

The goal of this paper is to define a shared language that enables specifying business processes while serving as a communication, analysis and discussion platform among its stakeholders. Such goal attempts to minimize having multiple inconsistent specifications of the same business process for different stakeholder subgroups.

We argue that such inconsistent specifications stem from two main causes. The first is that the different stakeholders of the same process tend to belong to different organizational areas as a business process also tends to crosscut intra- or even inter-organizational boundaries. Hence, stakeholders have contrasting concerns over the same process and focus on different perspectives of that process such as performance, auditing, information systems, people or compliance. Such issue also arises in archi-

tectural descriptions and is commonly addressed by having multiple views over the same conceptual domain [10, 11]. The second cause is that the specification of a process is intrinsically tied to its design team, thus depending on the team's knowledge and background and not exclusively on the organizational factors that do define the process. This means that two different design teams modelling the same process tend to obtain different specifications. Moreover, several business processes representations rely on natural language, especially to specify the names of business process activities. This makes complex the task of assessing whether two process models are actually equivalent.

This paper describes a controlled vocabulary that encompasses a set of core constructs to define a business process. The constructs are: information entity, business process, organizational unit, actor, business schedule and business goal.

The remainder of this paper is structured as follows. The next section reviews related work. Section 3 introduces the concepts, ontology and taxonomy to support business design. Section 4 presents the applicability of the taxonomies. Finally, section 5 summarizes the proposal.

2 Related Work

Organizations require different perspectives for modelling business processes, such as modelling for compliance or documentation (such as legal, regulatory, training), modelling for process redesign, and modelling for execution. No matter which purpose the modelling is for, the output would be business process representations in certain format and possible comparison among them. Each problem dimension or view should be modelled by specific criteria with a specific design paradigm. Although several methodologies or approaches that conduct us to produce a business representation within a type of graphical, it is understood as part engineering part art, where experience and common sense play an important role. This means that a repeated usage of similar techniques may yield contrasting results. Actually, in this cycle of functionally breaking down a process into activities or aggregating activities into processes, the boundary between what can be specified is unclear in most of the methodologies.

This issue is partially addressed with organizational taxonomies and reference process models [12, 13] such as the Supply Chain Operations Reference (SCOR). These enable the systematic reuse of proven practices across process design projects. They do so by capturing knowledge about common activities, information artefacts and flows encountered in specific application domains. However, their do not go beyond pre-defined repositories of process models and provide little or no guidance to support analysts adapting these process models to specific needs and different contexts. Moreover, there is a lack of standard notations and methods to model reference processes and to enable the systematic reuse of reference process models in business process management projects.

Techniques such as Petri nets [14], flowcharts [15], state charts [16], EPC [17], UML Activity Diagrams [18] and BPMN [19] are valuable for specifying the control-flow associated with a business process. Entity-relationship diagrams [20] and data flow diagrams [21] are useful to capture the data handled by a process. Other ap-

proaches such as Speech Act Theory [22] and the Language/Action Perspective [23] explicitly model the interaction between actors and systems and the how they do so.

However, several of these techniques only address a single aspect of the domain – with a strong emphasis on flow modelling – and therefore require supplementary modelling mechanisms to provide a comprehensive description of the process. This also implies that these different mechanisms need to be tightly integrated so that the resulting models are consistent and traceable. Since assessing the coherence and equivalence of the different representations of the same process is complex, organizations are compelled to design and maintain various representations of the same domain. This makes analysing and communicating the processes complex and also hinders the design of the information systems that support these business processes because there is no single source of knowledge. For instance, an EPC model specifies resources and objects, which are required for handling specific activities at one process level but there are no criteria to detail or decompose those elements. BPMN does not provide an unambiguous definition of activity and event meaning that different modellers can use both concepts to represent the same thing. Moreover, activity and event naming is expressed in natural language which, without a proper glossary or vocabulary, may lead to further ambiguity.

If we examine formal business processes definitions, they are rather limited in scope, regardless of their accuracy. The most popular formal technique for flow-based business process modelling are Petri nets that specify parallelism, synchronization, non-determinism, and mutual exclusion. In this technique, the main concern is how the workflow is represented. In other specifications a process is defined mostly by its outputs [24, 25]. However, if two processes have the same output but use different human skills in different locations and in different moments, they would be consider equivalent according to the aforementioned techniques whereas there would by no means equivalent in an actual scenario.

Altogether, existing modelling languages and notations do not completely define the necessary means to consistently describe business processes and to unambiguously identify the concepts that constitute it. The primary goal of this paper is therefore to provide a contribution to this issue.

3 Core Concepts

The purpose of business process design is the construction of concise and unambiguous models of a business or a business area in terms of the activities that take place in the organization. The fundamental assumption behind this project is that a business process can be represented through the identification of the concepts that are associated to the following six dimensions: *what, where, who, when, why* and *how*, i.e. the classic 5W1H dimensions [26].

From this assumption, we define a business process as a set of connected activities (*how*) which consumes and produces tangible or intangible artefacts (*what*), is performed by people or systems (*who*), contributes to achieving goals (*why*), takes place in a specific location (*where*) and during a specific period of time (*when*). Figure 1 depicts these relationships. This definition comprises the 5W1H dimensions and the

answer to each dimension corresponds to a different concept which is independent by itself while the combination of all answers characterizes the business process concept as a whole.

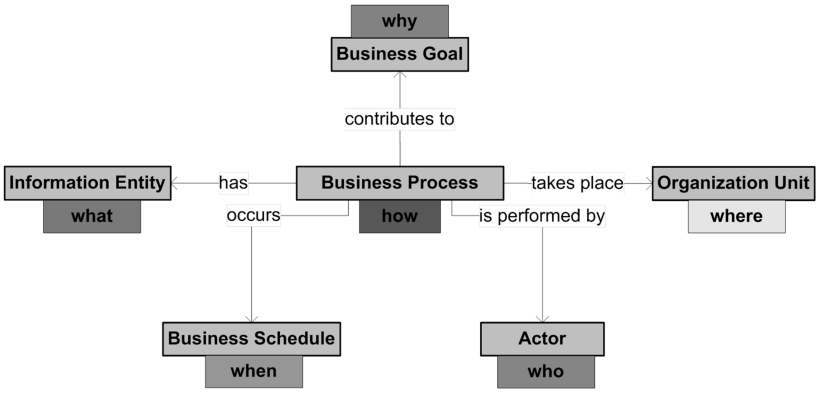

Fig. 1. The six core concepts of a business process and the corresponding six classification dimensions (why, what, where, when, who and how).

A business process can be functionally decomposed into a set of individual tasks. While we refer to a business process as a set of activities, both concepts are actually interchangeable. However, the resulting decomposition structure needs to be formalized in order to avoid unambiguity. We use Krogstie & Sølvberg's definition of hierarchy to model the functional decomposition of a process into finer grained elements [27]. This definition states that **H** is an hierarchy iff it is an ordered triple **H=<S,b,D>** where **S** is a nonempty set, **b** a distinguished element of **S** and **D** a binary relation over **S** such that:

1. **S** has a single beginner, **b**. (**H** has one and only one supreme commander)
2. **b** stands in some power of **D** to every other member of **S**. (That is, no matter how low in the hierarchy an element of S may stand, it is still under the command of the beginner)
3. For any given element **y** of **S** except **b**, there is exactly one other element **x** of **S** such that $\mathbf{D_{xy}}$. (i.e. every member has a single direct boss.)
4. **D** is transitive and anti-symmetric.

Therefore, we assume the resulting process tree is strict hierarchal graph i.e. a digraph whose underlying graph is a tree, and for which there is one specific vertex from which all other vertices can be reached.

The relationships between the concepts can take the form of classification, aggregation and generalization as depicted in Figure 3.

Classification ("is member of"). Is used for abstraction a concept as a class of objects characterized by common properties, i.e., abstracting away detailed differences between individuals, so that a class can represent the commonalities.

Aggregation ("is part of"). Defines a new class from a set of classes that represent its component parts, i.e., thinking of concepts as wholes, not just a collection of their attributes/components.

Generalization (“is a”). Defines a subset relationship between the elements of two or more classes, i.e., abstracting commonalities of several classes into a superclass.

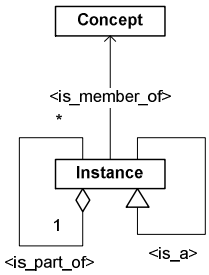

Fig. 3. The basic structural relationships.

The remainder of this section presents the taxonomy of concepts and the relationship between these concepts.

4 Taxonomy

To instantiate the concepts within the reality of the organization, we propose an ontology for each language construct and a taxonomy for each corresponding instance. These taxonomies are ontologies define a controlled vocabulary which intends to be understandable to all the process stakeholders.

A taxonomy is a collection of terms organized as an hierarchical structure. Each term in taxonomy is in one or more parent-child relationships to other terms in the taxonomy. There may be different types of parent-child relationships in a taxonomy (e.g., whole-part, genus-species, type-instance), but good practice limits all parent-child relationships to a single parent to be of the same type. The taxonomy represents the hierarchical classification of the concepts used to represent business processes. A taxonomy is a powerful approach to map and retrieve unstructured data. It also helps to structure, classify, model and represent the concepts and relationships pertaining to business process design while enabling a community to come to agreement and to commit to use the same terms in the same way.

Therefore, for each concept we need to create a taxonomy based on the categorization of each concept instantiation in the classification structure. The definition of the classification structure is directly dependent of the way how the organization conducts its business and it can be different from organization to organization. For this reason it is necessary to define the ontology that should be applied for each concept and this must be recognized for all the stakeholders. Here, we consider an ontology to be a formal explicit description of the concepts within a domain of discourse, the properties of each concept and the relationships between the concepts.

The following subsections describe the ontologies for each of the concepts depicted in Figure 1, namely BUSINESS PROCESS, INFORMATION ENTITY, ORGANIZATIONAL UNIT, ACTOR, BUSINESS SCHEDULE and BUSINESS GOAL.

4.1 Business Process

A BUSINESS PROCESS is a set of connected activities that consumes and produces tangible or intangible artefacts, is performed by people or systems, contributes to achieving goals, takes place in a specific location and during a specific period of time. A business process can be functionally decomposed as a set of individual tasks. Thus, a business process:

- Has one or more INFORMATION ENTITIES as input/output.
- Takes place in one or more ORGANIZATION UNITS.
- Is performed by one or more ACTORS.
- Occurs in a specific BUSINESS SCHEDULE.
- Contributes to one or more BUSINESS GOALS.

Moreover, a business process can be classified as:

MACRO-PROCESS. A large-scale business PROCESS that is initiated by a customer request, or by the decision of the company to enter a new line of business, and results in the delivery of a process or service to a customer, i.e., purchase, manufacturing, logistics, customer service, marketing, sales, etc.

PROCESS. At its most generic, any set of ACTIVITIES performed by a business that is initiated by an event, transforms information, materials or business commitments, and produces an output. Process can be decomposed indefinitely.

ACTIVITY. The leaves of the process tree are activities. So, an ACTIVITY is a PROCESS that cannot be further decomposed.

4.2 Information Entity

An entity is any person, place, concept, thing, or event that has meaning (information) in the context of the business, and about which data may be stored [28]. INFORMATION ENTITIES are composed by several attributes and can have relationships with other entities. An entity can be classified as:

THING. It is an information "bag" that represents the many different types of electronic or physical artefacts that are important to the business, such as documents, products, resources, etc.

DATA ENTITY. Is something that has some meaning in the context of the business, and about which data may be stored. The instances of data type represent a specialization of a THING, such as invoice, order, application form, receipt, customer, supplier, employee, etc.

PROPERTY. A relevant characteristic of a DATA ENTITY that further describes what that data entity is in the context of the business, such as order number, item price, customer address, invoice date, etc.

4.3 Organizational Unit

The organizational structure includes information about the ORGANIZATIONAL UNITS that make up an organization, the human resources that belong to those organizational units, as well as the structure and relationships that connect them all together. The three following concepts classify organizational unit:

GEOGRAPHICAL LOCATION. Place where the organization is located which may be a country, city, geographical area, etc.

PHYSICAL LOCATION. Building where the organization is installed, e.g. headquarters, delegation, office, store, etc.

UNIT. Used to create a hierarchy of organizational areas within a organization, e.g. division, department, section, etc.

4.4 Actor

Actor specifies a role played by a user or any other system that interacts with the subject. ACTORS may represent roles played by human users, information systems, or other active subjects. Note that an actor does not necessarily represent a specific physical entity but merely a particular role of some entity that is relevant to the specification of its associated use cases. Thus, a single physical instance may play the role of several different actors and, conversely, a given actor may be played by multiple different instances [29, 30]. The concept of actor is classified as:

POSITION. A function within a chain of command of an organization that has the responsibility for decisions involving the use of the organizational resources, i.e., manager, chief business officer, clerk, supervisor, project manager, etc.

4.5 Business Schedule

A BUSINESS SCHEDULE is a plan that specifies time periods for completing specific activities. In the context of this work, business schedule is the set of events that are important for the enterprise and have business process associated to them. A schedule is classified through events:

EVENT. All occurrences happening at a determinable time that the organization must be aware of. Event can be decomposed as other events.

4.6 Business Goal

BUSINESS GOALS are a set of objectives that are accomplished by one more business process. Goals are classified as:

GOAL. An end which the organization seeks to achieve through its operations.

OBJECTIVE. A decomposition of GOAL that can be achieved within a defined timeframe and a set of resources.

KPI. Key performance indicators can be associated to GOALS and OBJECTIVES to provide measures that will reflect success factors, such as time to answer a customer request or maximum lead time of a process.

4.7 Relationships between concepts

Table 1 summarizes the relationships between a business process and the other concepts.

Table 1. Relationships between the core concepts and a business process.

Concept		Macro-process	Process	Activity
Information Entity	**Thing**	X		
	Data Entity		X	X
	Property			X
Organizational Unit	**Geographical location**	X	X	
	Physical location	X	X	
	Unit		X	X
Actor	**Position**	X	X	X
Business Schedule	**Event**	X	X	X
Business Goal	**Goal**	X		
	Objective		X	X
	KPI			X

5 Ontology

Large teams of process designers collaborate and communicate mostly via process representations. A representation of an existing domain is a repository of information to be passed along multiple readers that, unlike words, encompasses some basic principles [31]:

- Use minimum set of fundamental concepts, upon which the information (or communication) can be assembled. These are the elements (or concepts) upon which information is defined;
- No concept corresponds to the same symbol, and no symbol corresponds to different concepts. This is a coherent representation/blueprint. No misunderstanding will result from multiple interpretations of the message.

The previous section introduced the core concepts required to model an through an hierarchical structure. These concepts are grounded defined according to a taxonomy. Figures 4 depicts an ontology for a business process according to the concepts of business process, macro-process, process and activity. Figure 5 depicts an ontology for an information entity.

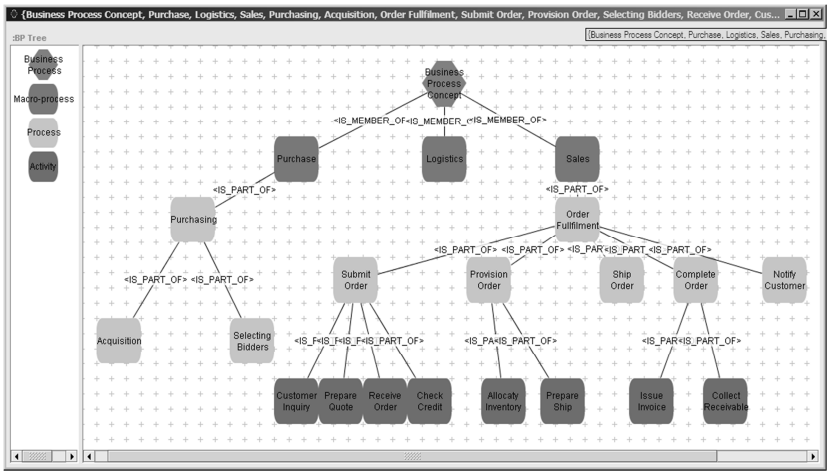

Fig. 4. Ontology of a business process.

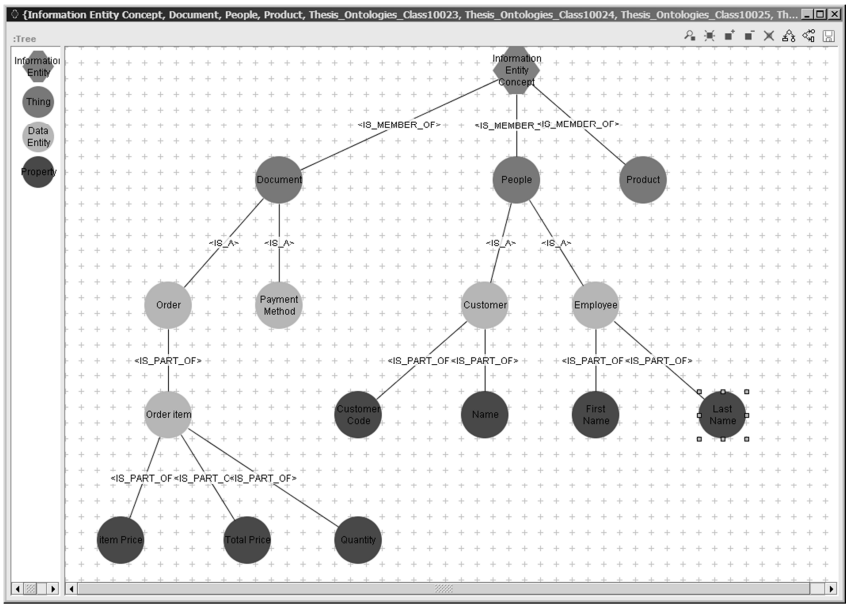

Fig. 5. Ontology of an information entity.

6 Conclusions

The lack of a common language between the stakeholders and the process designers results in a significant gap between different modelling perspectives. To reduce this gap, this paper has proposed a controlled vocabulary to support business process design. This vocabulary is grounded on six dimensions of inquiry (how, where, why,

when, what, who). The concepts pertaining to the vocabulary (information entity, business process, organizational unit, actor, business schedule and business goal) are organized as a taxonomy that allows for the hierarchical creation of an ontology that describes the specific domain of the organization. This approach has been experimented and validated in several professional projects at Link (www.link.pt).

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