Conference Paper

Tools Used in Modeling of the Economic Processes

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Abstract

The paper aims at identifying the economic process modeling languages, starting from the premise that the main beneficiaries of the resulting models are economists or decision-makers, respectively economic researchers. There are a large number of languages that have been developed with different objectives, but they have all been used to describe business processes. Languages have studied different aspects of business processes (dynamic, functional, organizational, informational) and may be more or less formal, depending on the intended use and audience. There is no easy way to classify these languages along a single dimension. However, the languages fall into four groups, clearly defined scientifically or professionally: traditional process modeling languages, object-oriented languages, dynamic process modeling languages, and the integration of languages. Economic processes are generally very complex and, therefore, different points can be formulated about their modeling.

Keywords: Formal language, model, simulation, algorithm, business processes.

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1. Introduction

Business units are complex organizational forms that involve customers, business units, resources, and even systems. They extend over many different processes that interact in a seemingly chaotic way. When trying to change business processes in an organization, change is confronted and confused with great complexity. In order to reduce the complexity and improve business processes, a systematic and controlled approach is needed.

Modeling economic processes has to match different requirements to create models that are of real use. On the one hand, it must be easily accessible and easy to understand to serve as a means of communication between the persons involved. The main model users are economists or decision-makers, respectively an economics researcher. These people are not aware of these modeling languages, but they also have to implement these models in companies. That is why these models must be easy to understand by an economist.

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These languages must be based on real concepts for the field in which they are achieved. It must have a clear architectural significance for business modeling.

On the other hand, models should be analyzed using computer tools and serve as a starting point for system design. This implies that models should have a rigorous definition and syntax. Mathematical rigor and communicability are qualities that are not found in all companies.

Business and analysis modeling imposes requirements specific to the models used, as well as languages for expressing these models. Models must be easy to understand and analyze.

The history of modeling languages has shown that the modeling process derives from business and from different traditions that can serve different purposes and represent different things [3]. The modeling of the business process is useful for three basic reasons, which may support multiple business objectives [10], [4].

The modeling methods are common, these being personalized for each opinion. Most object-oriented modeling methods include the first three groups (functional, dynamic, and informational point of view). Some methods may combine description methods both functionally and dynamically, but the important concepts of these views are properly represented. The method that describes the organization from a organizational point of view is a new element that includes a description of process participants as well as a physical description (location) and the organizational context in which this process takes place. Additionally, since the informational plan in object-oriented modeling represents only the data entities, in the information modeling model business processes can represent tangible resources that are used and produced by processes.

2. Literature Review

Modeling can be seen as a connection between two worlds, the world modeled, and the shaping of the world. A modeling technique is defined by how we look at things differently: concept or design in shaping the world, concept or design in world modeling. Different modeling techniques embody different perspectives, as these details must be abstracted, leaving only those aspects that are relevant to the tasks being pursued. Software specialists are familiar with modeling techniques and, more precisely, the object-oriented modeling technique. The modeling of the business process is different from this modeling. [4].

Isodes distinguish between two types of object-oriented modeling, which he called the real world modeling, and pseudo-real-world modeling [7]. It identifies three possible uses of object-oriented modeling: (1) to gain an understanding of how the real world works; (2) to run a real world simulation and (3) write a request to automate parts of business processes and present different types of modeling.

The following example [7] illustrates the difference between real-world modeling and pseudo- -real-world modeling.

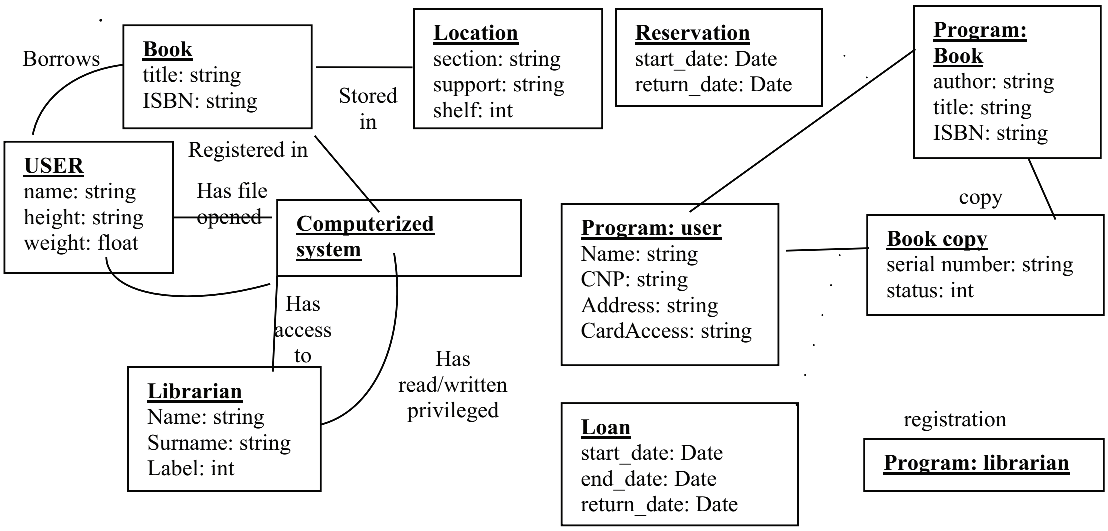

Figure 1: (a) the real-world model of the library with the computerized system; (b) the pseudo-real-world model of the computerized system.

Suppose we want to build an automation system for the library. The real world includes books, users, user files, librarians, description of subject areas and physical locations (sections, drawers, shelves). If we should use a computer system for the library, the "real automated world" would include users, books, librarians, physical locations, and would include the "system" that manages clues, user files, books and tracks. Figure 1. (a) shows the static model in the real world of operation of the library with a computerized system. Figure 1. (b) shows a pseudo-model of the real world of the computerized system itself. In modeling with the real world, we modeled the real entity in the real world (height, weight). Pseudo-real-world modeling modeled information modeling for the computerized system to manipulate data. Obviously, the user class appearing in the model in Figure 1 (a) is different from the one shown in Figure 1. (b): First, the user is represented as real, while the second figure is the user's file. The same applies to Librarian and Book classes. Isoda describes a series of modeling errors that result from the real-world modeling mix with pseudo-real-world modeling [7].

There are a number of languages that have been developed based on different objectives, but in fact all have been used to describe business processes. Languages have studied the different faces of business processes (dynamic, functional, organizational, informational) and may be more or less formal, depending on the intended use and audience. There is no easy way to classify these languages along a single dimension. However, the languages fall into four groups, clearly defined scientifically or professionally [4].

1. *Languages of traditional process modeling* come mostly from the management information system (MIS), information engineering and business process engineering. These languages are typically not formal but can be borrowed for various informal or heuristic analyzes. The languages in this category include IDEF, Petri's Networks, Chain Event Process (EPC) [8], Role of Activity Diagrams [10], Event Resource-Agent (REA) [9]; more recently Modeling Languages of Economic Processes [1];

2. *Object oriented languages* despite age, object-oriented modeling has been praised from the outset as a natural way of representing the world in a way that both industry experts and IT can report (for example, see [2] and [12] The question that was raised was: "Which world?" After the "naivety" business modeling) and domain solution (software modeling), they have become quite well defined to realize that object-oriented modeling languages are, for the most part, the domain software solution rather than the problem (business) domain due to inherent deficiencies The Object Oriented Languages are: UML 1.x, which has mechanisms to extend it, as well as various extensions that have been proposed in the literature to deal with modeling for enterprises, including EDOC. UML 2 also incorporates a number of extensions in its metamodels, and the new metamodel at construction level is introduced into UML 2;

3. Dynamic processes modeling languages. A number of standards for process modeling languages proposed by various international organizations - most industrial ones - have emerged in the last decade;

4. *The process of integration of languages.* The emergence of B2B business has boosted interest in process modeling languages in order to integrate processes between two or more business partners. Such specific languages focus on the abstract integration mechanism, independent technologies, programming interface, and data exchange formats. Languages in this category can also capture different levels of semantics of the processes underlying them. Three languages are known: RosettaNet, ebXML, and WS-CDL..

Next, I will only describe the first set of modeling languages and those languages that can be applied to economic processes.

3. Applied Method. Modeling Languages for Economic Processes

Modeling is used to construct models of economic processes with the stated purpose of predicting and estimating the impact of change due to changes. The power of a model is manifested by its ability to simplify the system of the real world it represents and to predict certain factors. Process modeling languages are a help to understand the mechanisms for both model designers and users of these models.

3.1. Group IDEF

IDEF is a group of modeling and analysis methods for enterprises sponsored by the US Air Force [6]. Launched in the mid-seventies, it sought to increase manufacturing productivity by systematically applying computerized technology. The (manufacturing) program recognized by the analysis process is an important tool and identified the need for better communication techniques to describe such processes. A family of modeling methods has been introduced collectively as IDEF (ICAM Definition). Initially, three methods were planned: IDEF0 for functional modeling, IDEF1 for informational modeling, and IDEF2 for dynamic modeling. The methods have been updated and maintained with Knowledge Based Systems Inc. with sponsorship from the US Department of Commerce. New methods have joined the family: IDEF4, which is an object-oriented modeling methodology and IDEF5, which is a developing ontology methodology.

Here are briefly presented the following models: IDEF0 (functional modeling): IDEF1X (an extension of IDEF1); IDEF3 (Dynamic Modeling), which replaces IDEF2 and IDEF4, which is an object-oriented design method.

- **IDEF0**: **functional modelling**

IDEF0 was based on Structured and Technical Analysis (SADT) [11]. It includes both a definition of graphical notation and a comprehensive methodology for the development of functional models.

The Technical Analysis and Design (SADT) is a notation diagram, specifically designed to help people describe and understand systems. It provides blocks for entity and activity representation and a variety of arrows to define the boxes. These boxes and arrows have associated an informal SADT semantics that can be used as a functional analysis tool for a particular process using successive levels of detail. The

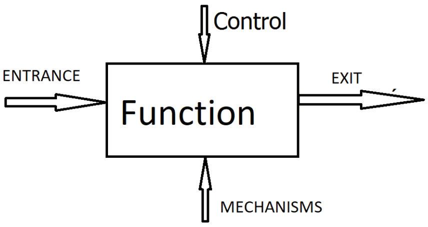

Figure 2: SADT base element.

SADT method allows to define user needs for IT development, which is widely used in industry.

The SADT provides a functional view specific to any enterprise that describes the functions and relationships in a company. These functions meet the objectives of a company such as sales, planning, product design, product manufacturing, and human resource management. SADT may represent simple functional relationships and may reflect data flow and relationships between different control functions.

- **IDEF1/IDEF1X**: **informational modelling**

IDEF1X is a technique to represent semantic enterprise data models. The initial modeling technique (IDEF1, 1981) was based on the relational and entity-relationship (E / R) model. IDEF1 was later extended (1985) to incorporate concepts of semantic data models, including much richer semantics for relationships and new concepts such as aggregation and categorization, organization of entities in specialized general hierarchies.

IDEF1 was designed as a method of analysis and communication in setting requirements. IDEF1 is generally used for:

1. identify what information is managed within the organization;

2. determine which issues identified during the needs analysis are caused by the lack of adequate information management;

3. specify what information will be handled for their implementation.

IDEF1 captures information about objects that exist within an enterprise's scope. The IDEF1 perspective of an information system includes not only automated system components, but also non-automated objects such as people, warehouse cabinets, telephones, and so on. IDEF1 was designed as a way for organizations to analyze and manage their information resources for both needs and requirements. Rather than a database, the IDEF1 design method is an analysis method used to identify:

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- Information collected, stored and managed by the enterprise;
- Rules governing information management;
- Logical relationships within the enterprise reflected in the information;
- Problems caused by lack of information for good management.

The results of information analysis can be used for strategies and tactics within the enterprise, to influence information assets and to gain competitive advantage.

- **IDEF3**: **behavioural point of view**

IDEF3 has been developed specifically to describe the dynamic aspect of business processes [6]. One of the IDEF3 motivations was to facilitate system requirements for IT systems. IDEF3 was designed to support a description of the following issues:

1) organizational activity scenarios;

2) roles of types of guides in organizational activities;

3) the cases of use;

4) user classes;

5) timing, succession and resource constraints;

6) user interface objects.

Referring to the typology of modeling approaches, attributes 1, 2, and 3 correspond to real-world business modeling with automated system, and attributes 4 and 6 correspond to software modeling (real-world modeling pseudo), and aspect 5) involves a bit of both.

The description of the IDEF3 method provides a mechanism for process collection and documentation. IDEF3 captures the priorities and causal relationships between situations and events in a natural form from industry experts, providing a structured way to express knowledge about how a system, process, or organization works.

IDEF3 captures the behavioral aspects of an existing or proposed system. Capturing the knowledge process is structured in the context of a scenario, making IDEF3 an intuitive device for acquiring knowledge in describing a system. IDEF3 captures all time information, including the priorities and causality associated with business processes. The results of the IDEF3 method descriptions provide a structured knowledge base for building analytical and design models. IDEF3 builds structured descriptions. These descriptions capture information about what a system actually does or will do, and also about organizing and expressing different views on how to use the system.

- **IDEF4 Object Oriented-Design Method**

The intuitive nature of object-oriented programming is easier to produce code. Unfortunately, the ease with which the software is produced makes it easier to create design-free design software from systems reusable, modular, and maintainable. The IDEF4 method is designed to help correctly apply this technology.

IDEF4 highlights the object-oriented design process over graphic syntax, using graphic syntax and charts as aids, focusing and communicating important design issues. IDEF4 is significantly different from other object design methods, primarily through "commitment" support, strategies and support for design impact assessment, and interaction between class inheritance, object composition, functional decomposition, and polymorphism.

IDEF4 shares the object-oriented design activity into discretely manageable pieces. Each sub-activity is supported by a graphical syntax that highlights the fact that design decisions must also be made for their impact on other design perspectives.

3.2. Business process modeling language

The Business Process Modeling Language defines a formal model to express the executable process that addresses all aspects of business processes within an enterprise, including complex complex activities, clearing operations, management of data [1]. The BPML specifications were developed by the Business Process Management Initiative, an organization founded in 2000 to develop standards for business process management, both within an organization and between organizations. BPML makes extensive use of XML in two different places:

1. XML is used to present and format the format for describing the business process;
2. XML Schema descriptions (XSD) is used to specify the type of data handled by the business process.

BPML is highly implementation-oriented and powerful analogues with programming languages. Almost speaking, a process is a set of activities executed in a context. An activity is "something to be done". BPML comes with a predefined set of activities at a rather low but appropriate level to control the programming language structures. The context of an activity is its execution context. It is characterized by a set of specific properties for this activity (local variables, exceptions, internal functions / processes, etc.). The closest thing to programming is the stack / call framework for a function.

A process is, in turn, a complex activity that defines its own execution context [5]. The closest thing in terms of programming is a function or procedure. Some processes are visible everywhere, others are local for other processes. Processes can be triggered in one of two ways: 1) by an explicit call from another process or activity, or 2) by an event. Processes have input / output parameters. Properties are local variables in a context. We can specify a type, a default value, and an expression for assigning a value. The type can be any valid XML schema, including simple types, complex types, derived types, and anonymous types defined by element statements.

A program is a series of time events. We can associate a program with a process, if the first event launches the process, and subsequent events launch different parts of the process.

Clearly, BPML is a language for describing execution processes. BPMI works with graphical notation, but judging by the above discussed constructions (context, program, exceptions, etc.), either the notation is indescribable to business analysts, or the notation will only reflect a subset of BPML. In addition, language does not deal with organizational concepts, such as resources, roles, actors or organizations.

4. Obtained Results

The multitude of modeling languages that can be used to describe the various economic processes determines us to compare these languages to see what their advantages, disadvantages and limitations are.

By comparing the IDEF modeling languages of the economic processes presented in Table 1, the following conclusions can be drawn:

Table 1: Comparison of Modeling Languages in the IDEF Class for Economic Processes.

Limbaj	**IDEF0**	**IDEF1**	**IDEF2**	**IDEF3**	**IDEF4**
Informational		exists			
Functional	exists				
Dynamic			exists	exists	exists
Organizational					

From the organizational point of view (representing the roles and actors within the organization), no language in the IDEF class does not contain this feature. For the other models, their comparison is shown in Table 2:

Another comparison is made for IDEF and Petri networks, where IDEF charts provide a mechanism for process analysis and documentation, and Petri networks are for systems where resource sharing, communication, and synchronization are important. Petri networks are designed to represent system dynamics, namely: start and end of

TABLE 2: Comparison of modeling languages for economic processes.

Limbaj	Petri Networks	RAD	EPC	REA	BPML
Informational		partially	can exist		can exist
Functional				exists	
Dynamic	exists	exists	există	exists	exists
Organizational		exists	can exist	exists	partially

activity, waiting time, availability of resources, control mechanisms, etc. Modeling with the IDEF diagrams of activities is expressed very clearly, being a very good tool to communicate between the designer and the model user.

IDEF charts and Petri networks are compared to the following criteria: simplicity, standardization, formalism and representation power (Table 3).

TABLE 3: Comparison between IDEF diagrams and Petri networks.

Used criterias	IDEF Diagrams	Petri Networks
Simplicity	Simple but not applicable for complex models	Quite simply, even for complex models
Standardization	There is and is very strong	Several versions are devoid of standardization
Formalism	There is, or very little (elaboration)	There is a strong formalism
Power of representation	It's not too big	Very big

The IDEF diagrams and the Petri nets can also be compared according to their basic elements: process, activity, resource entity, event according to table 4.

TABLE 4: Comparison between IDEF0, IDEF3 and Petri Networks.

Element	IDEF0 Diagram	IDEF3 Diagram	Petri Networks
Process	Yes	Yes	Yes
Activity	Yes	Yes	Yes
Entity	Yes	Yes	Yes
Resource	Yes	Yes	Yes
Start/Ending	No	No	No special symbol
Event	No	Yes	Yes
Dynamic	No	Limited	Yes

5. Conclusion

The conclusion of these comparisons is that IDEF3 charts contain powerful elements and elements for modeling simulation, while the IDEF0 diagram allows visualization of model mode (activities, entities, resources and control). Petri Networks are more

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powerful simulation methods, because they capture all the important elements of the process dynamics.

For the other modeling languages of the economic processes, we can see that they are models that have only some of these functions due to the fact that there is an incomplete set for that feature. In some models, there is no such feature, but it can exist if the language designers have achieved these features. For example, the EPC does not include an informational metamodel, but designers assume that process descriptions are linked to a data model expressed in a form of entity-relationship.

This comparison shows that the two methods complement each other, and can be used together to model business processes to achieve better results. Due to their simplicity, it is appropriate to develop IDEF diagrams in the preliminary stages of business process modeling projects in order to develop models. When models are developed, IDEF charts can be transformed into Petri networks that add formal semantics to models.

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