A Business Modeling Method
For Information Systems Development

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Abstract

An important premise of most of the contemporary methods for developing Software and Information Systems is that a good understanding of the application domain is essential for a comprehensive definition of its requirements. However, when these methods are applied to the enterprise context, it is very unclear what an application domain means. To solve this problem, we elaborate the notion of business system and propose a method based on such notion for modeling application domains of Enterprise Information Systems (EIS). This method helps EIS development teams to get comprehensive knowledge about EIS application domains. This knowledge is expressed in terms of the fundamental concepts of a business system: goals, technologies, business rules, business processes, business objects, actors, job structure, and events. The method is described in terms of three methodological components: a product model, a process model, and a team model. This structure facilitates the explanation, understanding and application of the method.

Keywords: Information Systems, Information Systems Development, Enterprise Information Systems, Business Modeling, Requirements Engineering

Resumen

En la mayoría de los métodos modernos que existen para desarrollar Software y Sistemas de Información, se emplea una premisa que establece que una buena comprensión del dominio de la aplicación es fundamental para lograr una mejor definición de sus requerimientos. Cuando estos métodos se aplican en el contexto empresarial, no queda, sin embargo, muy claro que es el dominio de aplicación. En este artículo, se elabora la noción de sistema de negocios para referirnos al dominio de los sistemas de información empresarial (SIE) y se propone un método de modelado de negocios basado en dicha noción. Este método está dirigido al desarrollo de SIE y puede ser utilizado por grupos de desarrollo para adquirir y representar conocimientos sobre el dominio de aplicación de los SIE. Estos conocimientos se expresan en términos de los conceptos fundamentales de un sistema de negocios: fines, tecnologías, reglas de negocio, procesos de negocio, objetos de negocio, actores, estructura organizacional y eventos. El método se describe sobre la base de tres componentes metodológicos: el modelo del producto, el modelo del proceso y el modelo del grupo de desarrollo. Esta manera de diseñar y presentar el método está fundamentada en principios de la Ingeniería de Métodos y tiene la ventaja de que facilita la explicación, comprensión y aplicación del método.

Palabras claves: Sistemas de Información, Desarrollo de Sistemas de Información, Sistemas de Información Empresarial, Modelado Empresarial, Ingeniería de Requerimientos
1. Introduction

Developing an Enterprise Information System (EIS) is a very complex process that involves solving not only the technological problems associated with the EIS architecture and its components, but also the organizational and social problems related to the EIS application domain. In the enterprise context, the application domain of an EIS can be seen as the business system supported by the EIS.

A good understanding of the EIS application domain is a critical factor for ensuring the success of the requirements elicitation activity – the first stage of the requirements engineering process. One of the sources to elicit requirements is the domain knowledge that EIS developers are supposed to have. However, how this knowledge about the EIS application domain can be obtained is not directly addressed by the requirements elicitation stage.

Authors, such as Avison, Fitzgerald [1] and Flynn [2], emphasize the importance of modeling the application domain before eliciting requirements. A business model – a model of the EIS application domain - can help EIS developers to gain a more comprehensive understanding of the business, its information problems, and the functional requirements that the EIS must satisfy.

Business modeling is a central activity to many different areas, including Business Process Reengineering, Organizational Development, Enterprise Modeling & Integration, Business Process Management, Enterprise Application Integration, ERP System Configuration, E-Commerce, Software Development and Information System Planning and Development. Different methods can be found in the literature to support business modeling in these areas (see, for example, [2] – [16]).

In the realms of Information Systems and Software Development (IS/SD), even when business modeling is recognized as an essential activity, few methods address explicitly the critically important organizational dimension of the IS/SD process models [1]. Some of the methods found in the literature that include explicitly the business modeling as an activity of their IS/SD process models are the following: Business Engineering [8], RUP [9], Watch [10], MERISE [11], EKD [12], Mainstream Objects [13], Information Engineering [14], Business Modeling with UML [15], and Enterprise Modeling with UML [16]. These methods describe, in one way or another, the activities, artifacts and workflows that are needed to model a business. Typical business concepts that are modeled, by these methods, are the following: goals, business processes, actors, business rules, job structure, business objects, and events. The way these concepts are modeled differs from one method to the other. We also found that these methods fail to meet some important business modeling requirements, for instance:

• None of them considers and models explicitly the technologies used by the enterprise to support its business process. Modeling the supporting technologies of an enterprise is important, since business processes are highly dependent on these technologies.
• Few of them allow the developers to model all the business concepts mentioned above and all their relationships.
• Very few of them provide a clear and precise definition of the enterprise as a system. A system view of the enterprise helps developers to get a wider and complete picture of the enterprise, its components, and their relationships.

In this paper, we introduce a business modeling method, call BMM for brevity. This method captures and represents the main concepts of a business system and their relationships, including the technologies that are applied by the business system. The method can be used as a previous stage of the requirements engineering process to help EIS development teams to get deeper understanding of EIS application domains.

The paper is organized as follows. In Section 2, we present the working definition of business systems used by the BMM method and the relationships between the notions of enterprise, business systems, and enterprise information system. The scope and structure of the BMM method are described in Section 3. The three components of the method – the product model, the team model, and the process model – are described in Sections 4-6, respectively. How our method differs from those mentioned above is summarized in Section 7. Finally, the significance of the method, its advantages and limitations are discussed in section 8.

2. The notion of Business System

An enterprise is a business organization that may be seen as a human activity system whose main activities, called business processes, are designed and executed to reach a set of pre-defined goals [17]. The execution of the enterprise’s business processes is normally supported by a kind of software applications called Enterprise Information Systems (EISs). Some common types of EISs are the following: enterprise resource planning (ERP), legacy applications, OLTP applications, EAI applications, e-business systems, e-commerce applications, management information systems, and executive information systems.
EISs are open systems. They are part of wider systems called application domains in the IS/SD terminology. The
main objective of an EIS is to provide information services to its application domain (e.g., supplying information to
decision making, process execution, and process control).

But what exactly is the application domain of an EIS? Many authors consider the EIS application domain as the
business process that the EIS supports (e.g., the finance process of an insurance company). The problem of this
approach is that it does not directly consider other important elements of an enterprise, such as enterprise goals,
business rules, technology, and events. A more holistic approach is needed to define the application domain of an
EIS.

We define the domain of an EIS as a business system. A business system is part of a major system: the enterprise.
A production enterprise, for example, is structured into several business systems, such as the engineering system, the
production system, the marketing system, the personnel system, the finance system, and the accounting system. An
enterprise is, therefore, seen as a set of business systems. Each business system has associated one or more EISs, as
shown in Figure 1.

A business system is comprised by an organized set of activities called business processes that are designed and
performed by a group of actors with the purpose of achieving a set of pre-defined goals. Actors are organized into a
job structure composed by business units (e.g. departments, divisions, sections). Actors have associated roles that
define the responsibilities for performing processes. Each processes requires, uses or involves a set of business
objects (e.g., personnel, clients, raw materials, products and clients) and one or more technologies (e.g., information
systems, production methods, techniques or instruments). A business process is triggered by an event (e.g., the
arrival of raw material or a service order) which may modify the state of the objects involved in the process. A
process is regulated by business rules (e.g. laws, policies, norms and procedures).

The relationships between a business system and its EISs are also illustrated in Figure 1. The EIS objective is to
produce the information needed by actors in a business system.

![Fig. 1. Relationships between an enterprise, its business systems and its EISs](image)

Actors request information from an EIS to perform business processes. The EIS supply the requested information
by processing the data stored in its database. An EIS database is a model of the business objects associated with the
business system. Each relevant object of the business system is represented in the database by a data object, which
captures the state and behavior that the business object has in the business system at a given time. The business
processes and the events that occur in the business system, or in its environment, generate data that are used by the
EIS to update the database.

The tight relationships that exist between a business system and its EISs suggest the need for modeling the
business system as a previous phase or stage in the process of developing an EIS.
3. The Business Modeling Method (BMM): scope and components

We introduce now the BMM method for business modeling. This method uses the notion of business system developed in Section 2, in order to create business models that can be used in the development of EISs.

BMM can be used in most existing IS/SD methods. Figure 2 exemplifies the placement of the BMM method in the context of the WATCH method, - an EIS method for developing web applications [18]. In that method, business modeling is performed between the project planning step, which is one of the initial activities of the management process, and the requirements definition and specification phase.

![Fig. 2. Placement of the BMM method in a IS/SD process model](image)

The Business Modeling Method (BMM) was designed based on principles, processes and concepts borrowed from Method Engineering [19, 20], Enterprise Modeling [15, 16, 21], and Object Oriented Software Engineering [22]. A method engineering common practice is to structure a method into three components: a product model that describes the generic structure and characteristics of the product to be elaborated using the method; a process model that describes the structure and dynamics of the activities needed to produce the product; and a team model that describes the roles of the team’s members to be played during the application of the method [18].

Based on this principle, we structured the BMM into the following components:

1. **The BMM product model.** This is a model that describes the generic concepts that characterize any business system and the relationships between these concepts. It defines the structure of the business model and indicates what must be captured and represented during the business modeling process.

2. **The BMM process model.** It describes the activities that the modeling team must follow to build a business model.

3. **The BMM team model.** It describes an appropriated way of organizing the business modeling team and describes the roles that the members of this team must play during the business modeling process. Each of these components is described in detail in the next sections.

4. The BMM product model

Based on the notion of business system elaborated in Section 2, we built a product model that identifies and represents the set of generic concepts that may be found in any business system. This model is shown in Figure 3. The importance of this model is that it identifies the set of business concepts that must be represented during the process of modeling the application domain of an EIS: the business system.
The BMM product model is composed by two methodological elements:

- **A set of meta-models.** The meta-models describe, in more detail, the generic business concepts identified in Figure 3. Each meta-model represents a generic business concept and its relationships. The meta-models are used during the business modeling process to determine what types of specific business concepts must be represented in the business model.

- **A business model structure.** This structure defines the content of a business model produced using the BMM method. It indicates how to organize a business model and the types of diagrams that must be used to represent the specific business concepts that characterize a particular business system. The structure is shown in Table 1. According to this structure, a business model is composed by a set of seven models. Each model is an instantiation of its corresponding meta-model.

An important decision to be made during the business modeling process is the notations and languages that the modeling team must use to represent the structure and behavior of the business concepts described by the meta-models. We chose UML [23] as the main modeling language. UML is the de facto standard for modeling software and is used by many well-known methods involving business modeling (see, for example, [9], [15] and [16]). Additional notations used in BMM are also indicated in Table 1.

### Table 1. Structure and content of a business model

| Business Model Component    | Diagram               | Modeling Language                        |
|-----------------------------|-----------------------|------------------------------------------|
| Goals Model                 | Goals hierarchy       | Goal notation [24]                       |
|                            | Goal description      | Goal notation [24]                       |
| Technologies Model          | Technology Diagram    | Engineering Schematics                   |
| Business Rules Model        | BR Hierarchy          | UML Class Diagram                        |
|                            | BR Description        | Pseudo-language                          |
| Business Processes Model    | Value Chain           | Porter’s notation [25]                   |
|                            | BP Hierarchy          | Eriksson & Penker UML extension [15]     |
|                            | BP Diagram            | Eriksson & Penker UML extension [15]     |
|                            | Activity Diagram      | UML Activity Diagram with Swinlanes      |
| Business Objects Model      | BO Class Diagram      | UML Class Diagram                        |
| Events Model                | Event Diagram         | Petri nets [26]                          |
|                            |                      | UML Statechart Diagram                   |
| Actors/Units Model          | Business Structure Diag. | Organizational Charts [4]          |

In the next sub-sections, we explain the set of meta-models of the BMM product model. A more detailed description of this model is given in [21] and [27].

### 2.1 Business Goals

Goals are the reason of being of a business system. They are established by actors (e.g., top managers and stakeholders) to comply with business interests and needs demanded by the environment. Goals may be classified according to their scope into: vision, mission, and objectives. A vision is a purposive statement on how the stakeholders envisage the enterprise or business system in the coming future. A mission is a broad purposive statement that establishes the reason of being of the enterprise. An objective is a state or condition that contributes to
the fulfillment of the mission. Objectives can be classified into several categories: general or specific, quantitative or qualitative. Figure 4 captures the goal concepts and the relationships that must be present in a business model.

Fig. 4. The Business Goal Meta-model

2.2 Business processes

To reach its goals a business system must design, organize, and perform a set of activities called business processes. A business process is a set of structured and hierarchical activities designed for reaching business goals. Figure 5 shows the definition of the process concept and its relationships. Process may be organized into several categories. Figure 5 illustrates two of the most common categorizations of business processes. Primary and support processes, for instance, are categories associated with the value chain of an enterprise [25].

Fig. 5. The Business Process Meta-model

The business processes of a business system must be modeled as a hierarchy of processes and activities at several levels of abstractions. Figure 6 illustrates the way of structuring a business process using the UML extension for business modeling proposed by Eriksson and Penker [15]. The depth of the hierarchy depends on the complexity of the business system being modeled.
2.3 Actors, business units and business structure

Business processes are carried out by actors. An actor may be either a person or a machine capable of performing defined actions or tasks. Actors may be external or internal to the scope of the business system. External actors are part of the business system environment. They interact with the business system to fulfill their needs or provide resources. Clients, suppliers, shareholders, and actors belonging to other business systems are examples of external actors. Internal actors, on the other hand, are part of the business system.

Instead of modeling actors as persons, we are more interested in representing the roles they play in a business system. Each role is responsible for performing a set of tasks which are part of one or more business processes. Actors are assigned, according to their roles, to business units (see Figure 7). Business units are organized into a hierarchical business structure, which is commonly represented in the organization chart of the enterprise. This chart defines the enterprise structure expressed in terms of authority lines that govern the relationships among business units.

2.4 Technologies

Business processes use technologies to perform their activities more efficiently and effectively. For instance, information and communication (IC) technologies, such as computer networks, EISs, and databases, are commonly used to support the efficient execution of business processes in many enterprises.

Depending on the purpose of the enterprise, different technologies are applied to support business processes. In an oil industry, for example, many complex technologies are used to explore, produce, deliver, and transform oil into finished products. In addition to IC technologies, an oil industry uses geological, petrochemical, mechanical, transportation, automation and control technologies.

Most business processes are highly tied to the technologies they apply. The influence of the technologies in the business processes becomes more apparent in the middle and low levels of the business process hierarchy. Many low level processes, activities are determined by the technologies they use.
2.5 Business rules

Business processes are delimited not only by the technologies they use, but also by the business rules they must comply. A business system must adhere, for instance, to the government regulations and laws imposed by its operating environment. Similarly, a business system must satisfy the policies, plans and standards established internally by the enterprise managers.

Processes are therefore regulated or controlled by a set of business rules. These rules may be of different types, as shown in Figure 8. Modeling a business process involves the previous identification and modeling of the business rules that control its execution.

A business rule may be composed by other rules forming a hierarchy whose leaves are made of low level rules that are expressed in terms of conditions and actions as indicated in Figure 8. Low level rules are important for the design of EISs. They can be either embedded into the EIS code or stored separated in a rule base, in order to be processed by a rule engine during the execution of programs.

2.6 Business objects

The execution of a business process involves a set of entities called business objects. A business object is a concrete or abstract thing that is relevant to the business system. For instance, resources such as people, money, raw
materials, equipment, and data are types of business objects that are required to carry out processes. Clients and suppliers are also types of business objects that participate in many processes. The most common types of business objects are identified in Figure 9.

Fig. 9. The Business Object Meta-model

Each business object has associated a type that describes its structure and behavior. The structure is defined by a set of attributes. Each attribute represents a known property of the object. At a given time, each object is in some state. This state is determined by the set of all the values assigned to the attributes of the object.

2.7 Events

Processes are activated by the occurrence of events. An event is an action of very short duration that takes place inside or outside the business system. It signals the starting or ending point of a process. Events may be programmed or non-programmed (casual). For instance, the occurrence of the starting time of an activity that is established in a plan or schedule is a programmed event; whereas the occurrence of an accident or an equipment fault is a non-programmed event.

Events are also classified into external and internal. External events occur in the environment of the business system. The arrival of a service order is an example of external events caused by an external actor or another business system. Internal events happen into the business system. Reaching a production quote and the occurrence of a programmed time for starting (or stopping) a production process are examples of internal events.

An event may change the state of one or more business objects of the business system (see Figure 10). A change of state implies changes in some of the attribute values of a business object.

5. The BMM Team Model

An important element of any method is the organization of the team that will develop the product. Defining the roles of the team members is crucial to the application of the process model, because it helps the team leader to select the right people and assign the appropriate activities to them. In this section, we describe the structure of a business modeling team and the roles of its members.

A business modeling team can be organized in many different ways depending on the size and complexity of the business system. For small and medium size EIS projects, the business modeling team can be organized as follows:

- A team leader who is responsible for planning, organizing, directing, and controlling the effort and resources needed to model the business system. The BM team leader is normally the EIS development project leader.
- One or more adviser users that bring to the modeling process their knowledge about the business system.
• One or more *business analysts* who interpret the user’s knowledge and represent this knowledge using the modeling languages indicated in the product model. Business analysts are responsible for building the components of a business model that are shown in Table 1.
• One or more *business system managers* who are responsible for validating the business model.

![Diagram of Event Meta-model](image)

*Fig. 10. The Event Meta-model*

### 6. The BMM Process Model

This model describes the workflow that is needed to produce a business model during the development of an EIS. The workflow is presented in Figure 11 using an UML activity diagram. This diagram shows only the flow of control between the activities (steps) needed to build a business model.

As illustrated in Figure 11, the business modeling process starts after the EIS project has been planned. The main inputs to the process model are the business system documentation and the knowledge that the actors have about their business system. The output of the process model is a business model, that is, a document that describes the business system that will be supported by the EIS being developed. The business model will be used as a framework for defining and specifying the user's requirements during the Requirement Analysis & Specification phase of the EIS development process (see Figure 2).

The BMM process model is composed by nine steps. As indicated in Figure 11, the execution of these steps is cyclic and iterative.

- **The cyclic execution of the modeling process.** The modeling process evolves through a series of cycles. A cycle is a complete execution of the steps 1-8 (see Fig. 11). In each cycle, the BMM team produces a version of the business model. Each version is validated at the end of a cycle. If the business system managers agree on the version, the modeling process is finished and the business model is delivered to the development team, in order to proceed with the EIS Requirements Definition & Specification Phase (as exemplified in Fig. 2). Otherwise, a new modeling cycle is initiated to enhance, correct or improve the most recent version of the business model.

- **The iterative execution of the modeling process.** In each step, the BMM team produces a deliverable, that is, a sub-model or component of the business model version to be delivered at the end of the cycle. The deliverables produced in each of the intermediate steps 1-7 are verified (reviewed) by the BMM team before advancing to the next step. The Step 0 determines when the modeling process moves from one step to the next, or when the process must return to any previous step to add, modify or correct elements of the sub-models being produced. In Step 8, the business model version is assembled and must be validated by the business system managers before initiating a new cycle or concluding the modeling process.
In Table 2, we describe in more detail the activities that the BMM team must perform in each step and each cycle. For small and medium size EIS projects, two and three cycles of the process model are required to produce an acceptable business model. Table 2 illustrates a three cycle process that was applied in a medium size organization to produce a business model for an EIS that manage the imports and exports of scientific, cultural, and technological products in a Venezuelan custom office [28].

In the first cycle, the process model focuses on identifying the business concepts that are present in a business system, according to the BMM product model (see Figures 3-5, 7-10). The second cycle creates the models (diagrams) for each type of business concept using the modeling languages indicated in Table 1. The third cycle concentrates on the relationships that are present between the business concept models.

### Table 2. Cycles, steps and activities of the BMM Process Model

| Steps                  | 1st Cycle                                                                 | 2nd Cycle                                                                 | 3rd Cycle                                                                 |
|------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------|
| Business System (BS)   | - Plan the BS project  
- Organize the BS team  
- Collect BS documents  
- Define the BS scope  
- Describe the BS          | - Refine the BS informal description  
- Describe EIS objectives | - Refine the BS informal description  
- Describe EIS general characteristics |
| Goals Modeling         | - Define the BS vision, mission and general objectives  
- Model high level goals  
- Review the goals model | - Define specific objectives  
- Model specific goals  
- Review the goals model | - Refine goals model  
- Describe each goal formally  
- Review the goals model |
| Technologies and Business Rules (BR) Modeling | - Identify technologies  
- Identify and model high level BR  
- Review the BR model | - Identify technologies  
- Identify and model intermediate level BR  
- Review the BR model | For each low-level BP:  
- Identify low-level BR  
- Describe each low-level BR formally  
- Review the BR model |
| Business Processes (BP) Modeling | - Model the BS value chain  
- Decompose the high level primary and support BPs into a process hierarchy  
- Review the BP model | - Decompose hierarchically each primary and support BP  
- For each low-level process, create a BP diagram  
- Review the BP model | For each low-level BP:  
- Identify activities and tasks  
- Draw activity diagram  
- Relate activities and units using swimlanes  
- Review the activity model |
7. Comparing the method

The BMM method integrates the main concepts included in the most known methods for business modeling: RUP’s business modeling [9], EKD [12], Business Modeling with UML [15], and Marshall’s Enterprise Modeling [16]. The differences among BMM and these methods are summarized in Table 3. These differences are self-explanatory.

Table 3. Comparing BMM and other business modeling methods

| Feature | BMM | EKD [12] | RUP [9] | Eriksson & Pender [15] | Marshall [16] |
|---------|-----|----------|---------|------------------------|---------------|
| Focus   | EIS Development | Business Modeling | Software Development | Business Modeling | Business Engineering |
| Application Domain Definition | Business System | Enterprise | Organization | Business | Enterprise |
| Product Model or equivalent | √ | √ | Artifacts | Models/Patterns | Meta-models |
| Team Model or equivalent | √ | Workers |
| Process Model or equivalent | √ | Activity/Workflow | (Not explicit) | (Not explicit) |
| Concept: Goal | √ | √ | √ | √ | √ |
| Concept: Business Process | √ | √ | √ | √ | √ |
| Concept: Activity/Workflow | √ | √ | √ | √ | √ |
| Concept: Business Object | √ | √ | √ | √ | √ |
| Concept: Event | √ | √ | √ | √ | √ |
| Concept: Business Rule | √ | √ | √ | √ | √ |
| Concept: Actor/Role | √ | √ | √ | √ | √ |
| Concept: Business Structure | √ | √ | √ | √ | √ |
| Concept: Technology | √ | √ | √ | √ | √ |

8. Conclusions

We have presented in this paper a business modeling method, called BMM, which helps EIS development teams to plan, organize, and control the process of modeling EIS application domains. BMM guides a business modeling team to get comprehensive knowledge of a business system before initiating the requirements engineering processes. This knowledge is expressed in terms of the main concepts of a business: goals, technologies, business rules, business processes, business objects, actors, job structure, and events.
A good separation of concerns was achieved by structuring the method in three methodological components: the product model, the process model, and the team model. This way of designing and presenting the method facilitates its explanation, understanding and application.

The significance and contribution of our method to the development of EISs are summarized as follows:

- **A better understanding of the EIS application domain.** We believe that by modeling the concepts present in the business system, developers can get a more comprehensive knowledge of the business and the nature of problems that the EIS must solve.

- **Better elicitation and analysis of EIS requirements.** The business models produced by the BMM can be used effectively in the process of identifying and defining requirements in EIS projects. The Business Processes Model, in particular, can be used to elicit and analyze the functional requirements based on the business processes described in that model.

- **A better separation between manual and automated process.** The business model documents the workflow of a business system and establishes the separation between processes that must be automated and processes that must be performed manually. This separation facilitates the elicitation, analysis and validation of requirements.

- **An initial definition of business objects, rules, events, and automated processes.** The BMM helps the EIS developers to identify and model aspects of the EIS system that are normally identified in later phases of the conventional EIS development methods. The business object model, for instance, can be used as the initial version of the database conceptual design. The rules, events and processes model, on the other hand, can be used as input to the process of designing the EIS architecture and its components.

The BMM was used in the development of a business model for a Venezuelan custom office. This case study provided a real environment that was complete and complex enough for the purpose of evaluating and improving the method. This experience is reported in [27] and [28]. BMM has also been included as a business modeling phase in METAS, a method for planning the integrated automation of industrial plants [29]. The method is been extensively used as a teaching instrument for developing small projects in several courses on information systems and software engineering conducted at the University of Los Andes in Mérida, Venezuela.

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