Business Process Modeling: Evolution of the Concept in a University Context

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Abstract. Business Process Management (BPM) covers concepts, methods, techniques and software tools that support the business process lifecycle. Implementation of BPM solutions represents a complex task, which has led different authors and tool vendors to define their own cycle to address these initiatives, where the modeling phase is an invariant element. It includes a process analysis with the purpose of identifying problems and opportunities for business improvement, and then creating an electronic design, which can be implemented and continuously enhanced. The objective of this research is to analyze the understanding evolution of the Business Process Modeling concept at the Integrated Technology Research Complex from 2009 to 2012. The results obtained provide evidence of the factors that have influenced in the assimilation and incorporation of BPM paradigm at the institution.

Keywords: Business process modeling, business process management.

Modelado de procesos de negocio: evolución del concepto en el contexto universitario

Resumen. La Gestión de Procesos de Negocios (BPM, siglas en inglés) abarca conceptos, métodos, técnicas y herramientas de software que brindan soporte al ciclo de vida de los procesos de negocio. La implantación de soluciones BPM representa una tarea compleja, que ha provocado que diferentes autores y fabricantes de tecnologías definan su propio ciclo para afrontar iniciativas de este tipo, donde el modelado representa un elemento invariante. Dicha fase comprende el análisis de procesos con el propósito de detectar problemas y oportunidades, para luego realizar un diseño electrónico que pueda ser ejecutado y mejorado continuamente. El objetivo de la presente investigación consiste en analizar cómo ha evolucionado la comprensión del concepto de Modelado de Procesos de Negocio en el Complejo de Investigaciones Tecnológicas Integradas en el período 2009-2012. Los resultados ofrecen evidencias de los factores que han influido en la asimilación e incorporación del paradigma BPM en la institución.

Palabras Claves: Modelado de procesos de negocio, gestión de procesos de negocio.

1 Introduction

Nowadays, Business Process Management (BPM) is one of the topics most frequently pronounced when speaking of Information Technology (IT) applied to business environment. This paradigm covers a set of concepts, methods, techniques and software tools that support the business process lifecycle of an organization, BPM cycle, with the objective of achieving an integrated and horizontal management that ensures increased agility and business efficiency as well as the generation of competitive advantages (M. Weske, 2007 [50]), (Van der Aalst *et al.* 2006 [48]), (Houy *et al.* 2010 [19]).

To successfully introduce and maintain BPM discipline in an institution represents a complex task, which involves an alignment between strategic initiatives and business processes, whose life cycle is supported by BPM technologies or systems (BPMS). These tools enable collaboration and joint responsibility in business process analysis, design, automation and optimization to IT and business staff (Weske, 2007 [50]).

To address implementation of this type of solution, dissimilar authors and BPMS vendors have defined their own cycle, but when they execute each of its phases, they often do not take into account several factors that influence the assimilation and incorporation of the paradigm. This leads to project delay or failure. The process orientation and the employment of guidelines to drive the work represent some of the factors emerging from studies (Mendling *et al.* 2010 [31]), (Reijers, 2006 [41]).

Independently, the differentiation of the number and phase's nomenclature among defined cycles and the purpose of these do not change essentially. The modeling phase represents a crucial and invariant element among the diverse definitions. This phase includes a process analysis in order to identify problems and opportunities for business improvement, and then creation of an electronic design that can be implemented and continuously enhanced through a BPMS. Therefore, it represents the implantation base of a BPM solution (Reijers *et al.* 2009 [42]).

The objective of this research is to analyze the understanding evolution of the Business Process Modeling concept, from the perspective of BPM paradigm in a specific organizational context. For this purpose, we have fulfilled a study of projects conducted at the Integrated Technology Research Complex (CITI, Spanish acronym) from 2009 to 2012. The CITI is a research center resulting from cooperation among teachers and students of the Superior Polytechnic Institute José Antonio Echeverría (CUJAE) and specialists. The obtained results provide evidence of the factors that have influenced the progress of the project as well as the maturity of the institution regarding the Business Process Modeling, as part of the assimilation and incorporation of the BPM paradigm. These findings afford a guide to improve future work at CITI and other institutions which intend to tackle a project of this type.

2 Materials and Methods

2.1 Business Process Modeling Concept

The Business Process Modeling concept, as part of the BPM paradigm, constitutes the base of this investigation. In order to understand this concept, it is necessary to understand another two key ideas firstly: Business Processes and Business Process Models.

A Business Process consists in a set of interrelated consecutive activities or tasks, which take an entrance and add value to produce an expected exit for a customer. They constitute the central axis of any corporation to achieve objectives and strategies, to obtain a product or service efficiently and with high quality, as well as to improve it continually (Weske, 2007 [19]) (Houy *et al.* 2010 [19]). Meanwhile, Business Process Models contain a structured description of information required for a process analysis and interpretation, both for people and systems: activity flow, participants, data, business rules, etc. These models represent a fundamental artifact for process implementation (Weske,

Table 1. Different BPM cycle definitions: theoretical and technological approaches

Author	Proposals of Phases
(Van der Aalst *et al.* 2006 [48]) (Ko *et al.* 2009 [21]) (López, 2011 [26])	Process design. System configuration. Process enactment. Diagnosis.
(Weske, 2007 [50])	Design and Analysis. Configuration. Enactment. Evaluation.
(Houy *et al.* 2010 [19])	Strategy development. Definition and modeling. Implementation. Execution. Monitoring and Controlling. Optimization and improvement.
(Reijers *et al.* 2010 [43])	Analysis. Design. Implementation. Enactment. Monitoring. Evaluation.
(Wilkins, 2010 [51])	Analysis. Design. Implementation. Monitoring.
(BizAgi, 2009) [5]	Modeling. Automation. Execution. Improvement.

2007 [50]) (Bridgeland and Zahavis, 2009 [6]), (Martínez and Warboys, 2001 [28]).

The discipline of creating these Business Process Models is called Business Process Modeling. To define this concept, we analyzed different BPM phases defined by several authors and technology vendors. The results are shown in Table 1, starting with a theoretic (Van der Aalst *et al.*, 2006 [48]) (Ko *et al.* 2009 [21]) (López, 2011 [26]) (Weske, 2007 [50]) (Houy *et al.* 2010 [19]) (Reijers *et al.* 2010 [43]) and technological perspective (Wilkins, 2010 [51]) (BizAgi, 2009 [5]). The latter refers to how BPMS vendors have established phases for business process automation depending on the components and functionality provided by the solution offered.

As it can be seen, the number and nomenclature of the cycle phases defined by different authors vary. However, the purpose thereof is essentially similar. The Business Process Modeling phase, called Design, Analysis and Modeling, is the basis and fundamental technique of BPM, used to define, document and understand the business of an institution. It includes an analysis of current functioning of business processes "as-is", with the aim of detecting existing problems and identifying challenges and opportunities for improvement, and then creation of the design process "to-be", representing the desired business. The Business Process Modeling requires time, effort and skills; however, it is essential for value creation in a company (Van der Aalst *et al.* 2006 [48]) (Ko *et al.* 2009 [21]) (López, 2011 [26]) (Weske, 2007 [50]) (Houy *et al.* 2010 [19]) (Reijers *et al.* 2010 [43]) (Wilkins, 2010 [51]) (BizAgi, 2009 [5]).

3 Case Study Description

Basing on the Business Process Modeling concept defined previously, we conducted an analysis of its understanding in the university context CITI-CUJAE form 2009 to 2012. The core activity of this institution is implementation of Research, Development and Innovation projects grouped into seven Research Programs (P), which mainly comprise the following branches: Industrial, Computer, Automation and Telecommunications Engineering.

3.1 Preparation and Sample Selection

To select a sample, it was considered that P1, P6 and P7 are research programs which deal with issues specifically related to BPM and Business Process Modeling. Most of the company's labor force consists of students who perform projects, documented in thesis reports and traineeship reports which run on 3rd and 4th year of the

Table 2. Selected Diploma Thesis

Academic year	Engineering		Total
	Industrial Engineering	Informatics Engineering	
2009-2010	(Fonseca and Martínez, 2010 [11]) (Figueroa and Ermus, 2010 [9])	(Flores, 2010) (Gras, 2010 [16]) (Amador, 2010 [3])	**5**
2010-2011		(Maillo, 2011 [27]) (Riviaux, 2011 [44]) (Vasconcelo, 2011[49])	**3**
2011-2012		(Sánchez, 2012 [46]) (Hernández, 2012 [18])	**2**
Total	**2**	**8**	**10**

Table 3 Selected Traineeship Reports

Academic year	Engineering		Total
	Industrial Engineering	Informatics Engineering	
2009-2010			**0**
2010-2011	(Morán *et al.* 2011 [32])	(León, 2011 [23]) (Serrano, 2011 [47]) (González, 2011 [14])	**4**
2011-2012		(León, 2011 [23]) (González, 2012 [15]) (Nuñez, 2012 [34])	**3**
Total	**1**	**6**	**7**

career. Students who are part of the programs P1, P6 and P7 belong to the specialties of Informatics Engineering and Industrial Engineering. In the period to evaluate, the deadline of projects takes place at the end of each academic year, with three established sub-periods: 2009-2010, 2010-2011 and 2011-2012. From this point, the sample was defined as follows:

Organizational Context: CITI-CUJAE (Research Programs: P1, P6 and P7).

Period: 2009-2012 (academic years: 2009-2010, 2010-2011, and 2011-2012).

Materials and Reports to Analyze: Undergraduate thesis reports and Traineeship reports for 3rd and 4th year students of Informatics Engineering and Industrial Engineering.

Initially projects related to BPM from the total set of papers were selected, where twenty-six reports were obtained, eleven theses and fifteen practices. Ninety-six percent of the works were conducted in P6. Later the jobs where the results were destined to external entities were removed, and remained those being developed and applied to the specified context. Several reports where process modeling was not part of the research objectives were also dismissed. Because of this one Informatics Engineering thesis (Palma, 2010) was removed from the sample and eight traineeship reports (González and Alvarez, 2011 [12]) (Martínez and Martínez, 2011 [29]) (Bejarano and González, 2011 [4]) (Álvarez and Ruiz, 2011 [2]) (Nuñez and Aguilar, 2011 [33]) (González, 2012 [15]) (Martínez, 2012 [30]) (Aguilar, 2012 [1]). Table 2 and Table 3 summarize the seventeen documents selected to review, theses and traineeship reports respectively, grouped by sub periods and specialties.

3.2 Defining Criteria to Analyze

For our analysis of the sample, a set of criteria was defined which represent factors that positively or negatively influence the implementation of a BPM solution in an enterprise, from the studies formalized in (Reijers, 2006 [41]) and (Ravesteyn and Batenburg, 2010 [40]). These criteria are described below.

3.2.1 Process Orientation of the Tackled Context

One of the factors that influence a successful implementation of a BPM initiative is the process orientation of the organization, which is vital to undertake a project of this type (Reijers, 2006 [41]) (Kohlbacher, 2010 [22]). The article submitted by (Reijers, 2006 [41]) presents a validated checklist for determining the degree of business process orientation as the basis for predicting a successful implementation of a BPM solution. This list was designed from a series of questions which match variables grouped into categories to measure the elements of the process orientation. As a result of its application, the traffic light colors whose meaning is described below were obtained:

– **Red:** implies situations where a lack of process orientation would expose serious problems while implementing BPM solution.
– **Yellow:** refers to situations where problems can be expected in implementing BPM solution.
– **Green:** refers to situations where the organization has a sufficient level of process orientation to begin a successful implementation of a BPM solution.

In the present investigation, the organizational context is similar for all elements of the selected sample, because the work was done in the context of CITI-CUJAE, with applicability of the results in the CITI. Due to this, the checklist was applied to that institution in the three sub-periods established: 2009-2010, 2010-2011 and 2011-2012. The list was employed retrospectively to determine the initial position of the organization before starting the projects. Therefore, the beginning of each sub-period was taken as a reference. This allowed a comparison with the results obtained therein. The questions were answered by the leader and leading analysts of the development team of the BPM initiative in the entity belonging to P6.

3.2.2 Modeling Features

This criterion includes a set of elements that constitute key points when taking decisions for the implementation of a BPM solution, because it requires consideration of the particularities of each company. The factors analyzed were taken from (Ravesteyn and Batenburg, 2010 [40]) and are described below.

3.2.2.1 Modeling Language

Different languages are currently used for Business Process Modeling. Some of them are Event-driven Process Chains (EPC), Petri nets, Activity Diagrams of Unified Modeling Language (UML) and Business Process Modeling Language (BPMN) (Bridgeland and Zahavis, 2009 [7]). The last two are considered most popular and having greater possibilities of practical use (Canino, 2009 [8]) (*Ko et al.* 2009 [21]).

UML is a standard language of the Object Management Group (OMG) for specifying, visualizing, constructing and documenting the artifacts of software systems and other types, with the possibility of being extended through profiles or changes in their meta-model (Ortega, 2007 [37]). It represents a collection of best engineering practices proven successful in modeling of large and complex systems (Jacobson *et al.* 2000 [20]) (OMG, 2004 [35]) (Hamilton and Miles, 2006 [17]). UML 2.0 consists of thirteen diagrams, six structural diagrams and seven behavior diagrams. Activity Diagrams, a subset of behavior diagrams, are used to represent business processes (Hamilton and Miles, 2006 [17]) (Eriksson and Penker, 2000) (List and Korherr, 2005 [25]).

BPMN is currently an OMG standard whose main objective is to provide a graphical notation understandable by all business users: analysts, developers, technicians and workers. BPMN is a union of best practices, notations and methodologies among which there are UML Activity Diagrams, EPC, and others (OMG, 2009 [36]). It has several versions, where 2.0 is aligned with the OMG meta-model and has been extended to include orchestrations and choreographies of process models, thus providing portability between modeling tools and model execution without conversion to another language specific for it (Sánchez *et al.* 2010 [45]).

3.2.2.2 Modeling Tool

Different tools can be used for Business Process Modeling ranging from Computer Aided Software Engineering (CASE) to Business Process Analysis (BPA) or BPMS.

In the context of BPM, BPA tools are those designed to support the modeling phase of the cycle. These are intended to facilitate the business understanding to all members of an organization and foster collaboration. They allow business analysts to design and document business processes, to define key performance indicators, to analyze and simulate how activities occur. They may be sold individually or included in a BPMS (Pérez, 2009 [39]).

BPMS in turn provides a set of software utilities integrated in a unique environment that meets entirely the needs of the business process lifecycle. These systems include various tools which can be classified as modeling tools, execution engines, and tools for simulation, monitoring and optimization. In the case of modeling, it provides basic functionality, remaining elements of the business that are better represented with BPA or other tools widely known in the software engineering intended for this purpose.

In software engineering, CASE tools are extensively used for computer system analysis and design. These tools provide many features for business analysis, depending on the incorporated modeling languages, where UML is one of the main languages. These tools follow the approach of Model Driven Architecture (MDA) proposed by OMG, which is one of the best known initiatives of Model-Driven Development (MDD) (Pérez, 2009 [39]).

In the studied context, the tools known widely are BizAgi Process Modeler, Oracle BPM Suite, BizAgi Studio, Bonita Open Solution and Visual Paradigm.

3.2.2.3 Multidisciplinary Composition of the Team

Business process analysis and design require specific skills related to business management and technology development (Bridgeland and Zahavis, 2009 [6]) (Reijers *et al.* 2010 [43]). Because of this, the staff's involvement in the BPM project throughout the organization is necessary. This approach allows analyzing the multidisciplinary composition of the team to carry out the BPM initiative, where the roles that should feature in the modeling stage are as follows (Wilkins, 2010 [51]):

- **Business Analysts:** business management specialists who should perform the following functions: diagnose current business, identify problems and improvement opportunities, identify business processes and make their initial models, identify business rules, define performance indicators and optimize processes.
- **IT Analysts:** IT specialists who perform the following functions: propose business process improvements from the advantages offered by technology, refine process model, define data models, define user interfaces, identify needs for integration of processes and systems in the organization, and design services for the integration of processes and systems.
- **Specialists Responsible for Processes:** those specialists who are familiar with the business being modeled. Also considered as the process owners. They must undertake the following main functions: define rules and activities of business processes, identify indicators to measure and validate the created process models.
- **Process Actors:** these are the entity's employees who realize the process activities. They should be involved with the modeling team to provide information on the execution of activities and existing business rules.

3.2.3 Quality of the Obtained Models

This criterion is used based on the analysis of the business process modeling guidelines proposed in (Mendling *et al.* 2010 [31]), where the authors argue that model usability is an important aspect of the business processes' documentation quality and understanding of these is a crucial task in any analysis technique. As a result of that work, the authors proposed seven Process Modeling Guidelines (7PMG), to guide users to improve the model quality in two main ways: making models understandable to all parties involved and decreasing the number of syntactic errors in models.

The mentioned article also raises the priority of guidelines because several of these can be applied at the same time on a model, guiding toward different directions. The 7PMG, in order of priority, are as follows:

- **G4:** Model structured as possible.
- **G7:** Decompose the model if it has more than 50 elements.
- **G1:** Use as few elements as possible in the model.
- **G6:** Use verb-object activity labels.
- **G2:** Minimize the routing paths per element.
- **G3:** Use one start and one end event.
- **G5:** Avoid inclusive gateway (OR).

3.2.4 Current State of Modeled Processes

This criterion is used to analyze the BPM cycle continuity of different business processes modeled in the works consulted, as the basis of the successful of the BPM initiative. A reference BPM cycle is defined on the basis of the research cited above (Weske, 2007 [50]) (Van der Aalst *et al.* 2006 [4819]) (Ko *et al* 2009 [21]) (López, 2011 [26]) (Houy *et al* 2010 [19]) (Reijers *et al.* 2010 [43]) (Wilkins, 2010 [51]) (BizAgi, 2009 [5]). The cycle consists of four phases which determine the states of the processes within the life cycle. These states are:

- **Modeling:** comprises the processes that have been analyzed and designed in the entity.
- **Implementation:** includes the processes that are in development and configuration in a BPMS, in addition to testing and deployment.
- **Execution:** contains the processes that have been implemented and are in operation and monitoring in the institution.
- **Diagnosis:** includes the processes that have been executed in the organization for a specified time and are in analysis and redesign for continuous improvement.

4 Results and Discussion

The results of the evaluation of each criterion are described in the following tables. Table 4 presents the results of application of the checklist to determine the degree of process orientation in the CITI at the beginning of each sub-time period set. The percentages are obtained in function of the points achieved in each of the parameters

Table 4. Results of application of the checklist process orientation in the CITI

Analyzed variable	2009-2010	2010-2011	2011-2012
Organizational structure	0	1	1
Using process language	1	1	2
Level of process documentation	1	2	3
Using process documentation	2	2	4
Information systems architecture	0	2	4
Level of process performance measurement	0	0	0
Existence of processes responsible	0	2	4
Understanding customer requirements	0	4	4
Result	**8% Red**	**27% Red**	**42% Yellow**

Table 5. Current status of the processes modeled in projects

Status	Projects	Total
Implementation Processes	(Vasconcelo, 2011 [49]) (Sánchez, 2012 [46]) (González, 2012 [15]) (Nuñez, 2012 [34])	**4**
Running processes		**0**
Diagnosis Processes		**0**
Not Valid Processes	(Fonseca and Martínez, 2010) (Figueroa and Ermus, 2010 [9]) (Amador, 2010 [3]) (Flores, 2010) (Gras, 2010 [16]) (Maillo, 2011 [27]) (Riviaux, 2011 [44]) (Morán *et al.* 2011 [32]) (León, 2011 [23]) (Serrano, 2011 [47) (González, 2011 [14) (Hernández, 2012 [18]) (León, 2012 [24])	**13**

measured in the list proposed in (Reijers, 2006 [41]). Meanwhile, Table 5 shows the projects that have processes in each of the states defined. The final column summarizes the total number of projects for each state.

he outcomes of applying this checklist to determine the degree of process orientation in the CITI, despite of having the limitation of being applied according to the opinion of only one group of people, which is selected for its high participation and subject knowledge, show there has been a positive development for this criterion. The percentage obtained in each of the evaluated periods increased with respect to the previous one, until the last 42% (Yellow). This value, although far from the desired situation of more than 66% (Green), shows the maturity which the entity has reached regarding the assimilation of BPM paradigm. Projects considered successful are distributed as follows: one in 2010-2011 (Vasconcelo, 2011 [49]) and three in 2011-2012 (Sánchez, 2012 [46]) (González, 2012 [15]) (Nuñez, 2012 [34]). A lack of process orientation has prevented a greater success of the initiative, but the initiative has in turn helped to introduce, understand and apply the concepts associated with BPM, including process orientation.

Table 6 summarizes the modeling language used in different projects. The last column presents the total amount of projects which used each of the language.

Table 7 summarizes the modeling tools used in the sample projects. The final column shows

Table 6. Modeling languages used in projects

Modeling Language	Projects	Total
UML	(Gras, 2010 [16]) (Maillo, 2011 [27]) (Riviaux, 2011) (Vasconcelo, 2011)	**4**
BPMN	(Fonseca and Martínez, 2010 [11]) (Figueroa and Ermus, 2010 [9]) (Amador, 2010 [3]) (Flores, 2010 []) (Gras, 2010 [16]) (Maillo, 2011 [3]27) (Riviaux, 2011 [44]) (Morán *et al.*, 2011 [32]) (León, 2011 [23]) (Serrano, 2011 [47]) (González, 2011 [14]) (Vasconcelo, 2011 [49]) (Sánchez, 2012 [46]) (Hernández, 2012 [18]) (León, 2011 [23])) (Nuñez, 2012 [34])	**17**
Microsoft BizTalk Server Notation	(Amador, 2010 [3])	**1**

Table 7. Modeling tools used in projects

Modeling Tool	Project	Total
BizAgi Process Modeler	(Fonseca and Martínez, 2010) (Figueroa and Ermus, 2010 [9]) (Amador, 2010 [3]) (Maillo, 2011[27]) (Morán *et al.* 2011 [32]) (Sánchez, 2012 [46]) (Nuñez, 2012 [34]) (León, 2011 [23]) (Serrano, 2011 [47]) (González, 2011 [14]) (González, 2012 [15])	**11**
BizAgi BPM Studio	(Gras, 2010 [16]) (Maillo, 2011 [27]) (Riviaux, 2011 [44]) (Vasconcelo, 2011 [49]) (Sánchez, 2012 [46]) (Hernández, 2012 [18]) (León, 2011 [23]) (Serrano, 2011 [47]) (González, 2011 [14]) (González, 2012 [15])	**10**
Bonita Open Solution	(Flores, 2010) (León, 2012 [24])	**2**
Oracle BPM Suite	(Nuñez, 2012 [34])	**1**
Visual Paradigm	(Gras, 2010 [16]) (Maillo, 2011 [27]) (Riviaux, 2011 [44]) (Vasconcelo, 2011 [49])	**4**
Microsoft BizTalk Server	(Amador, 2010 [3])	**1**

the total number of projects employing each of these tools.

As it can be seen from the beginning, Industrial Engineering students opted for the use of BPA tools (Fonseca and Martínez, 2010 [11]) (Figueroa and Ermus, 2010 [9]) (Morán *et al.* 2011 [32]), while some Informatics Engineering students preferred the CASE tool already known for business analysis, Visual Paradigm for UML modeling (Gras, 2010 [16]) (Maillo, 2011 [27]) (Riviaux, 2011 [44]) (Vasconcelo, 2011 [49]). After that, they consumed extra time in performing the modeling for the second time directly in the BPMS selected for process automation. In the case of (Maillo, 2011 [27]), he additionally assumed a BPA compatible with BPMS. Other authors decided to directly use the functionality offered by the BPMS (Flores, 2010) (León, 2011 [23]) (Hernández, 2012 [18]) (Nuñez, 2012 [34]), failed to reflect important business elements.

However, most projects opted for the use of the functionalities of a BPA compatible with BPMS, then exported the created models to this tool (Amador, 2010 [3]) (León, 2011 [23])

Table 8. Roles present in the project teams

Role	Project	Total
Business Analyst	(Fonseca and Martínez, 2010 [11]) (Figueroa and Ermus, 2010 [9]) (Amador, 2010 [3]) (Flores, 2010) (Gras, 2010 [16]) (Maillo, 2011 [27]) (Riviaux, 2011 [44]) (Morán *et al.* 2011 [32]) (León, 2011 [23]) (Serrano, 2011 [47]) (González, 2011 [14]) (Vasconcelo, 2011 [49]) (Sánchez, 2012 [46]) (Hernández, 2012 [18]) (León, 2011 [23]) (González, 2012 [15]) (Nuñez, 2012 [34])	**17**
IT Analyst	(Amador, 2010 [3]) (Flores, 2010) (Gras, 2010 [16]) (Maillo, 2011 [27]) (Riviaux, 2011 [44]) (León, 2011 [23]) (Serrano, 2011 [4747]) (González, 2011 [14]) (Vasconcelo, 2011 [49]) (Sánchez, 2012 [46]) (Hernández, 2012 [18]) (León, 2011 [23]) (González, 2012 [15]) (Nuñez, 2012 [34])	**14**
Specialist Responsible for Processes	(Fonseca and Martínez, 2010 [11]) (Figueroa and Ermus, 2010 [9]) (Flores, 2010) (Gras, 2010 [16]) (Maillo, 2011 [27]) (Riviaux, 2011 [44]) (Morán *et al.* 2011 [32]) (Vasconcelo, 2011 [49]) (Sánchez, 2012 [46]) (Hernández, 2012 [18]) (Nuñez, 2012 [34])	**11**
Process Actor	(Fonseca and Martínez, 2010 [11]) (Figueroa and Ermus, 2010 [9]) (Riviaux, 2011 [44]) (Morán *et al.* 2011 [32])	**4**

Table 9. Specialties present in the project teams

Specialty	Projects	Total
Industrial Engineering Students	(Fonseca and Martínez, 2010 [11]) (Figueroa and Ermus, 2010 [9]) (Morán *et al.* 2011 [32]) (León, 2011 [23]) (Serrano, 2011 [47]) (González, 2011 [14]) (Vasconcelo, 2011 [49]) (Nuñez, 2012 [34])	**8**
Informatics Engineering Students	(Amador, 2010 [3]) (Flores, 2010) (Gras, 2010 [16]) (Maillo, 2011 [27]) (Riviaux, 2011 [44]) (León, 2011 [23]) (Serrano, 2011 [47]) (González, 2011 [14]) (Vasconcelo, 2011 [49])) (Hernández, 2012 [18]) (León, 2011 [23]) (Nuñez, 2012 [34])	**14**
Executives	(Fonseca and Martínez, 2010 [11]) (Figueroa and Ermus, 2010 [9]) (Flores, 2010) (Gras, 2010 [16]) (Maillo, 2011 [27]) (Riviaux, 2011 [44]) (Morán *et al.* 2011 [32]) (Vasconcelo, 2011 [49]) (Sánchez, 2012 [46]) (Hernández, 2012 [18]) (Nuñez, 2012 [34])	**11**
Others	(Fonseca and Martínez, 2010 [11]) (Figueroa and Ermus, 2010 [9]) (Riviaux, 2011 [44])	**3**

(Serrano, 2011 [47]) (Sánchez, 2012 [46]) (Nuñez, 2012 [34]) (González, 2011 [14]) (González, 2012 [15]). Three of these projects, (Sánchez, 2012 [46]) (Nuñez, 2012 [34]) (González, 2012 [15])., also used BPMN as unique modeling language, proved successful in the organization. The latter is considered the most appropriate technique in order to minimize time and effort as well as to gain understanding between team members.

Table 8 shows the roles performed by members of the development teams of different jobs. Table 9 shows the specialties of its members. In both tables, the final column presents the total number of projects which conceived each role and each specialty, respectively.

Regarding this criterion, it can be said that all jobs conceived business analysts, the role played by both students of Industrial Engineering and Informatics Engineering. The first group took part in only eight papers (Fonseca and Martínez, 2010 [11]) (Figueroa and Ermus, 2010 [9]) (Morán *et al.* 2011) (León, 2011 [23]) (Serrano, 2011 [47])

Table 10 Application of modeling good practice projects

Guideline	Projects	Total
G4	(Fonseca and Martínez, 2010 [11]) (Figueroa and Ermus, 2010 [9]) (Amador, 2010 [3]) (Flores, 2010) (Gras, 2010 [16]) (Maillo, 2011 [27]) (Riviaux, 2011 [44]) (Morán *et al.* 2011 [32]) (León, 2011 [23]) (Serrano, 2011 [47]) (Vasconcelo, 2011 [49]) (Sánchez, 2012 [46]) (Hernández, 2012 [18]) (León, 2012 [24]) (González, 2012 [15])	**15**
G7		**0**
G1	(Fonseca and Martínez, 2010 [11]) (Figueroa and Ermus, 2010 [9]) (Amador, 2010 [3]) (Flores, 2010) (Gras, 2010 [16]) (Maillo, 2011 [27]) (Riviaux, 2011 [44]) (Morán *et al.* 2011 [32]) (Serrano, 2011 [47]) (González, 2011 [14]) (Vasconcelo, 2011 [49]) (Sánchez, 2012 [46]) (Hernández, 2012 [18]) (González, 2012 [15])	**14**
G6		**0**
G2	(Fonseca and Martínez, 2010 [11]) (Figueroa and Ermus, 2010 [9]) (Amador, 2010 [3]) (Flores, 2010) (Gras, 2010 [16]) (Maillo, 2011 [27]) (Serrano, 2011 [47]) (González, 2011 [14]) (Vasconcelo, 2011 [49]) (Sánchez, 2012 [46]) (Hernández, 2012 [18]) (Serrano, 2011 [47])	**11**
G3	(Fonseca and Martínez, 2010 [11]) (Amador, 2010 [3]) (Gras, 2010 [16]) (Maillo, 2011 [27])(Gras, 2010) (Maillo, 2011) (Riviaux, 2011 [44]) (Riviaux, 2011) (Morán *et al.* 2011 [32]) (León, 2011 [23]) (Serrano, 2011 [47]) (González, 2011 [14]) (Vasconcelo, 2011 [49]) (Sánchez, 2012 [46]) (Hernández, 2012 [18]) (León, 2012 [24]) (González, 2012 [15]) (Nuñez, 2012 [34])	**15**
G5	(Figueroa and Ermus, 2010 [9]) (Serrano, 2011 [47]) (Vasconcelo, 2011 [49]) (Sánchez, 2012 [46]) (León, 2012 [24])	**5**

(González, 2011 [14]) (Vasconcelo, 2011 [49]) (Nuñez, 2012 [34]), in three of them where there were no IT analysts (Fonseca and Martínez, 2010 [11]) (Figueroa and Ermus, 2010 [9]) (Morán *et al.* 2011 [32]). This implied the non-inclusion of important elements in the models, mainly associated with the technology architecture of the organization, which led to later refinement for automation. In the initial period 2009-2010, a lack of a link between the two specialties was demonstrated; industrial and computer projects did not have the participation of members of the other specialty. This process gradually evolved, and in the period 2010-2011, five projects involving both specialties were found: (León, 2011 [23]) (Serrano, 2011 [47]) (González, 2011 [14]) (Vasconcelo, 2011 [49]) (Nuñez, 2012 [34]). However, in some cases the computer students assumed the role of business analyst and IT analyst in a project (Sánchez, 2012 [46]) (Hernández, 2012 [18]) (León, 2011 [23]) (González, 2012 [15]). These two groups contain the four projects which were successful in the CITI. This indicates that the coordinated work of business analysts and IT analysts facilitates obtaining higher quality models, which exploit the advantages and strengths of business and technology. The specialties to which the people performing each of these roles belong is not significant, the most important are their skills and competencies.

Furthermore, process actors were involved only in four projects (Fonseca and Martínez, 2010) (Figueroa and Ermus, 2010) (Riviaux, 2011 [11]) (Morán *et al.* 2011 [32]), who worked together with a specialist responsible for the processes. Three of these works corresponded to industrial students, indicating the skills developed in analyzing business during their professional training. This element was ignored by computer students despite of them being part of the skills needed in software engineering, or in some jobs it was replaced by involvement of the specialist responsible for the processes. In this regard, most investigations (Fonseca and Martínez, 2010 [11]) (Figueroa and Ermus, 2010 [9]) (Flores, 2010) (Gras, 2010 [16]) (Maillo, 2011 [27]) (Riviaux, 2011 [44]) (Morán *et al.* 2011 [32]) (Vasconcelo, 2011 [49]) (Sánchez, 2012 [46]) (Hernández, 2012 [18]) (Nuñez, 2012 [34]) had an executive in charge, who provided and negotiated requirements. The latter group contains three of the successful works (Vasconcelo, 2011 [49]) (Sánchez, 2012 [46]) (Nuñez, 2012 [34]), which shows that the existence of a responsible specialist or business process expert as part of the development team of the BPM solution should be a priority, as well as the involvement of end users or process actors, elements that still need to be improved in the institution.

Table 10 shows the unfulfilled modeling guidelines in each project. These were analyzed in BPMN process models. The last column presents the total number of projects that did not meet each practice.

The use of 7MPG was not a component differentiator in the success of the models obtained, mainly because the 7MPG had a low compliance in all projects, essentially two of the most important G4 and G1, related to the structuring of models and using the fewest possible elements. These aspects are vital to a better understanding of the processes and usability. On the other hand, the other two priority guidelines G7 and G6 were applied to all jobs, which helped to offset quality. Generally, all projects violated at least one of the practices. The higher quality models were (León, 2011 [23]) and (Nuñez, 2012 [34]), while the lower ones were (Serrano, 2011 [47]) (Vasconcelo, 2011 [49]) and (Sánchez, 2012 [46]). These five projects present authors in Informatics Engineering as IT analyst role, which included the participation of business analysts with industrial training, therefore, they did not follow the relationship between the employment of the 7MPG and team's composition. The project (Nuñez, 2012 [34]) was more understandable than the rest of the projects because of the constraints and validation errors of Oracle BPMS, thus demonstrating the importance of proper technology selection.

The findings of this study support the conclusions reported in (Reijers, 2006 [41]) and (Kohlbacher, 2010 [22]) in relation to the importance of process orientation to ensure a successful implementation of a BPM solution; however, it can be stated that the degree of orientation processes must be above a certain threshold, but this alone is not decisive. The success or failure is determined by the influence of a set of factors defined in (Ravesteyn and Batenburg, 2010 [40]) including the participation and commitment of the institution members, the alignment between initiative and business strategy, the correct definition of project objectives, proper methodology, composition, preparation and communication of the team and selection of appropriate technologies, some of them were analyzed in this study. Therefore, the real value of application of this checklist is to provide support for an early detection of critical values in the parameters measured, which influences the successful development of the BPM solution. It is therefore a good practice to use it to start an implementation of a BPM initiative in a company.

5 Conclusions

The results of this study are the basis of good practices and lessons learned in the CITI regarding the assimilation of the concept of Business Process Modeling from the BPM paradigm. At the beginning of the project, the process orientation in the institution had a low level, which led to a set of problems that prevented a successful development of most processes. These problems include: absence of multidisciplinary composition, lack of experience, lack of unity and project team communication, and the use of different modeling languages and tools. Gradually, these difficulties were solved, demonstrating the maturity present in the enterprise.

The research permitted to validate that the evaluated criteria (process orientation, modeling languages and modeling tools used, multidisciplinary composition of the project team and application of modeling guidelines) are actually the factors that influence the development of a BPM initiative. However, they should be viewed as a whole, because the separate influence of each of them is not enough to determine success or failure.

The findings of this research can be extended to applying a process orientation checklist, taking into account other perspectives such as the opinion of managers and end users in the organization, which have not been considered in this study. Other factors that influence the implementation of BPM solutions proposed in (Ravesteyn and Batenburg, 2010 [40]) can also be evaluated. The work provides a validation of the guidelines for implementing BPM solutions which have been defined in CITI, in the modeling phase. This will improve future work in the company, help transfer knowledge and provide the basis to establish the factors that influence the successful implementation of BPM solutions in the Cuban context. It also helps to establish guidelines that facilitate a simpler and faster assimilation of Business Process Modeling from the BPM paradigm, taking in account the complexity and effort required in this task.

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