# Business Process Families: a Case Study in the Brazilian Public Sector

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**Abstract.** Configurable process models enable reusing existing process models by combining them, significantly reducing their modelling and maintenance costs. This paper proposes a systematic approach to incorporate reconfigurability in a set of validated business process models by the Brazilian Federal Government. Inspired by the Software Product Lines paradigm, our idea is to create families of business processes, where feature models are used to represent the commonalities and variabilities of each family. These feature models are built by identifying both patterns of processes in the source business process models and the variation points between those models.

**Keywords:** business process family, public sector process, configurable process model, process-oriented feature model.

# 1 Introduction

The importance of Business Process Management (BPM) in the public administration is increasing due to (i) the growing pressure to reduce costs, (ii) lack of resources, and (iii) the demand for high quality services from citizens and private sectors. Our work focuses on the business process modeling activity and was conducted in the Brazilian public sector. Existing literature shows low maturity of the BPM in the Brazilian public sector [1, 2] and also limited willingness to share knowledge about business processes. This represents a severe problem since public entities have huge overlaps of the services they provide. Hence, the exchange of process knowledge could efficiently support public entities with lower maturity in identifying optimization opportunities. This limitation is not a problem exclusive to Brazil; it can be witnessed in [3, 4].

Established by law, GesPública is an initiative of the Brazilian federal government to promote excellence of public management, in order to contribute to the public services quality provided to citizens and to increase the country's competitiveness. GesPública proposes guidelines for public management based on BPM concepts [5, 6].

In the Brazilian public sector, similar business processes are executed differently by different entities, and the exchange of knowledge between BPM projects is very low. Many public entities face analogous challenges, offering subsets of similar or overlapping services. However, the desire to share knowledge on business processes is very limited, despite the Brazilian federal government's efforts to recognize that the exchange of knowledge about the processes could lead to a reduction of costs [7].

In general, Brazilian public entities have an area of Information Technology (IT) that supports other business areas processes and the provision of information systems. This led to the creation of the Resources Management System of Information Technology, or SISP<sup>1</sup>, which holds specific legislation [7, 8]. SISP promotes the integration and coordination between government programs, projects and activities in the definition of policies, guidelines and standards for the management of IT resources. It encourages the rational use of IT resources, its development and enhancement, standardization, integration, interoperability, and decentralized information dissemination. It aims at achieving the IT area objectives aligned to government actions with greater efficiency, effectiveness and economy in the use of public resources [8]. Currently, more than 210 public entities are part of SISP [7, 8]. In order to increase effectiveness, efficiency and transparency of the public sector, the Brazilian federal government develops BPM initiatives through SISP, to improve the management of their processes and enhance collaboration within the public sector [8].

The goal of this paper is to propose a systematic approach to incorporate reconfigurability in the set of already validated business process models that exist for particular domains and offered by SISP. Inspired by the SPL (Software Product Lines) paradigm [9], our idea is to create families of business processes, where feature models are used to represent the commonalities and variabilities of each family. These feature models are built by identifying patterns of processes in the source business process models, as well as the variation points between those models. So, this paper proposes a family of business processes to the software development processes domain. Configurable process models enable reusing various existing process models by combining them, what should significantly reduce their modelling and maintenance costs.

This paper is organised as follows. Section 2 offers some background about the reference process models in the Brazilian public sector, the study of families of business process, and concepts about feature models. Section 3 shows a domain analysis involving processes from SISP. Section 4 details our approach to the Brazilian public sector, showing process patterns examples, a configurable process model for the case study, and the configuration questionnaire. Section 5 relates our approach with existing work on configurable process models and public administration. Finally, Section 4 concludes the paper and suggests directions for future work.

<sup>&</sup>lt;sup>1</sup> SISP, from the Portuguese "Sistema de Administração dos Recursos de Tecnologia da Informação"

# 2 Background

This background starts by discussing the reference process models in the Brazilian public sector, follows by offering an overview of what we understand by business process families, and finishes with a brief summary on process-oriented feature models.

## 2.1 Reference process models in the Brazilian public sector

Reference process models capture practices and recurrent business operations in a given domain. They are designed in a generic manner and allow a manual configuration to fit the requirements of specific organizations or IT projects [10].

Among the major SISP initiatives to project management, we can count: SISP Methodology of Project Management or MGP-SISP<sup>2</sup> [11]; SISP Software Process or PSW-SISP<sup>3</sup>, [12]; SISP Software Projects Guide to Agile Practices [13]. These are reference process models in the area of IT project management for Brazilian public entities. The use of these reference process models in public entities depends on several factors, namely reality, culture, project management maturity, organizational structure, and projects size. Therefore, the processes and procedures described in these reference process models can be adapted to the reality of each public entity.

## 2.2 Business process family

Configurable process models are an evolution of reference process models [14]. A configurable process model provides multiple alternatives of a business process model, identifying the variation points in a process, and their variations options, which refer to the various members of a family of business processes.

The study of families of business processes is based on the concepts of Software Product Lines (SPL) [9]. It aims at applying the principles of systematic and planned reuse in the development of high quality business processes at a low cost, coining the term *Business Process Lines* (BPL). Similarly to SPL, BPL defines families of business processes through the identification of variable and common processes in a domain. BPL promotes the reuse and integration of the process models, also supporting changes in the process, when enabling the insertion of new variation options. So, BPL can be defined as a set of business processes models where each BPL member has a set of common processes and a set of variable processes [9, 15, 16].

Organizations in a given domain have similarities in their business processes that determine variation points that can be used to build configurable process models. Ideally, a configurable process model should come with a configuration mechanism at design time [17].

<sup>&</sup>lt;sup>2</sup> MGP-SISP, from the Portuguese *Metodologia de Gerenciamento de Projeto do SISP*.

<sup>&</sup>lt;sup>3</sup> PSW-SISP, from the Portuguese Processo de Software para o SISP.

#### 2.3 Process-oriented feature model

A process-oriented feature model is a feature model constructed from reusable processes modules. Features are represented by root, abstracts and concretes sub-processes. The root represents the configurable process model for a BPL. Concrete subprocesses have their semantics defined through their internal specification and abstract sub-processes through their child sub-processes. Process patterns are defined through abstract modules that represent an abstraction to one or more mandatory, optional, alternative and/or multiple modules [18]. Section 4 presents examples using these concepts.

This process-oriented feature model is implemented as a BPMN extension. This work is not intended to detail this BPMN extension, but to present a case study. Here only the concepts necessary to understand the proposed model are presented. The relationship types found between the process modules are: mandatory, optional, multiple, and alternative. The lines in a process-oriented feature model represent the relationships between the modules. The small empty circle informs that the module is optional. The small filled circle informs that the module is mandatory. The empty arc defines mutually exclusive modules. The filled arc defines mutually inclusive modules. Examples using these concepts also are presented in Section 4.

# 3 An approach to the Brazilian public sector

Our approach proposes the following steps: perform a domain analysis; build a process-oriented feature model to represent the variability of the business process lines; and, finally, perform a specific configuration. The approach facilitates the design and implementation of a business process lines. This section shows the domain analysis and the remaining steps are presented in Section 4.

#### 3.1 Domain Analysis

The goal of domain analysis is to identify, describe and model the set of business processes that compose the business process line. It starts with an empirical semantic analysis of the commonalities and variabilities observed among the models and other documents (e.g., official documents with proposed rules for the service acquisition), and then continues by conducting a technical analysis of the BPMN process models in search of process patterns. The models used for the domain analysis have been taken from a collection of the SISP business process models. These business processes are Software Development Processes for the Brazilian federal government, comprising the MGP-SISP, PSW-SISP and SISP Software Projects Guide to Agile Practices. Table 1 summarizes the information about the process models collection studied with activities and sub-processes. During domain analysis, all original processes were adjusted by identifying reusable modules, and their names have been changed to use the same no-menclature.

The MGP-SISP is a generic software development process with the sub-processes shown in Table 1 [11]. The PSW-SISP is quite broad, and this work will see only the process models concerning software development processes [12]. The PSW-SISP software development process is based on traditional methods of software development with a flexible timebox, comprising the phases shown in Table 1. According to PSW-SISP, the definition of a software development methodology is a fundamental requirement for the public entities. The legislation does not determine which development paradigm and methodology should be used, but there is an explicit guidance for choosing a methodology. So, a software development process for the Brazilian public entities should ensure the use of a software development methodology.

Process	Sub-	process and Activ	vities	Features
MGP-	Starting	Running	Monitoring	All possibilities
SISP	Planning	Closing		
PSW-	Initiation	Construction		Any labor contracting device
SISP	Preparation	Transition		Timebox flexible
				Organized by phases
Guide	Planning	Service order	management	Any labor contracting device
	Release and transition	n Monitoring		Iterative paradigm
		IT environme	nt management	Any methodology
PDS-BC	Project planning	Iteration meeting	g	Co-Sourcing
agile	Release planning	Show release		Iterative paradigm
	Iteration planning	Publishing iterat	ion	Timebox effort
	Perform iteration	User acceptance	testing	Organized by tasks (pipeline)
	Daily meeting	Non-functional	requirements testing	
	Show iteration	Release to manu	facturing.	
MIDAS-	Planning	Development	Closing	Outsourcing
IPHAN				Iterative paradigm
				Timebox effort
				Organized by functionalities
MGDS-	Initiation	Execution	Closing	Co-Sourcing
INEP				Iterative Paradigm
				Timebox effort
				Organized by functionalities

Table 1. Comparison between software development processes.

This Software Projects Guide to Agile Practices for SISP [13] defines a reference model focused on software development projects with agile practices and outsourcing. The reference model is based on grouping similar activities related to producing software. Its activity groups are shown in Table 1. This reference model is presented in a free format diagram, followed by a textual description of the roles and its activities in the reference model. A role is responsible for one or more activities and some activities belong to more than one role. The roles are divided in two sets, those that can be played by an in-house agent (SISP entity) and those that can be performed by the outsourcing agent, named "supplier" [19, 20].

The Software Projects Guide to Agile Practices for SISP was prepared from the process models of the following public institutions: Central Bank of Brazil, INEP e IPHAN. This reference model complements the PSW-SISP. It is based on PDS-BC Agile [21], MIDAS-IPHAN [22], and MGDS-INEP [23]. All references are available on the SISP Portal [8], but a brief summary is presented below. Next, each organization is presented along with its business area and features.

#### 3.2 Central Bank of Brazil and the PDS-BC agile process

The Central Bank of Brazil is a federal agency, part of the National Financial System. It determines the guidelines for National Monetary Council and is responsible for ensuring the purchasing power of the national currency. The activities of the PDS-BC agile process are shown in Table 1. The Central Bank of Brazil has its own staff of IT and uses outsourcing due to the large number of projects. So, PDS-BC agile uses a cosourcing model. PDS-BC agile uses iterative development and timebox effort. The iteration planning involves selecting a subset of functionality and defining tasks for each iteration, for example, an iteration may include documenting requirements to many functionalities and not implement any functionalities. Therefore, the iteration planning contains a subset of functionalities with associated tasks. Generally, these functionalities are not completed in a single iteration. So, functionalities are received, detailed, specified, implemented, or tested. Fig. 1 is an adapted fragment of the PDS-BC Agile and represents the initial project planning sub-process.

#### 3.3 IPHAN and MIDAS-IPHAN processes

The IPHAN is an agency of the Ministry of Culture with the mission of preserving the Brazilian cultural heritage. The MIDAS-IPHAN process is divided into three phases also shown in Table 1. The IPHAN does not have its own staff of IT and uses outsourcing for all the activities. MIDAS-IPHAN uses iterative development and time box effort. The iteration planning contains a set of functionalities. These functionalities are completed in a single iteration (e.g., received, detailed, specified, implemented, and tested). Fig. 2 is an adapted fragment of the MIDAS-IPHAN, with a subset of activities related to the initial *Project Planning* sub-process.

## 3.4 INEP and MGDS-INEP processes

The INEP is a federal agency under the Ministry of Education, responsible for promoting studies, research and reviews of the Brazilian Educational System. The MGDS-INEP's sub-processes are shown in Table 1. The INEP does not have its own staff of IT and uses outsourcing for most activities. MGDS-INEP reports activities that can be made optionally in-house or outsourced. The activities that may be made in-house are exclusively those whose delegation is not recommended by law. MGDS-INEP uses iterative development and time box effort. The iteration planning contains a set of functionalities. These functionalities are completed in a single iteration (e.g. received, detailed, specified, implemented, and tested). Fig.3 is a fragment of the MGDS-INEP with a subset of activities related to the initial project planning.



Fig. 1. An adapted fragment of the PDS-BC Agile.



Fig. 2. An adapted fragment of the MIDAS-IPHAN.



Fig. 3. An adapted fragment of the MGDS-INEP.

# 3.5 Discussion

The results reveal two important variability points for the collection of process models: the labor contracting device and the software development methodology. It is possible to identify three types of labor contracting device: in-house, outsourcing and cosourcing. There are two development paradigms: waterfall and iterative. And, there are three development methodologies for the iterative paradigm: with flexible timebox and organized by phases (inception, elaboration, construction, and transition, each ending in a defined milestone); with timebox effort and organized by tasks (pipeline); with timebox effort and organized by functionalities (developing software in small iterations) [24]. The common processes are: project planning, project development and project acceptance, open service order, manage service order, perform plan. So, all entities use the MGP-SISP guidelines and thus divide their processes in these five sub-processes. This domain analysis is used to build a process-oriented feature model for the BPL using BPMN extension.

# 4 An Approach of the Process-Oriented Feature Model

A process-oriented feature model is obtained by compositions of abstract and concrete sub-processes, each denoted by the *«Abstract»* and *«Concrete»* stereotypes, respectively. Constraints are represented in the form of propositional logic constraints, and parameterized sub-processes are denoted by the stereotypes *«Parameterized»*. Type, range, and optionally a default value for the parameter are specified in internal specification.



Fig. 4. Process-oriented feature model in the BPMN extension.

Additionally, the process-oriented feature model supports the configuration process by means of a mapping between the process-oriented feature model and a questionnaire with a set of questions (about the variability points) and its answer choices (variant options), to help the stakeholder in the configuration process. Fig. 4 illustrates a process-oriented feature model.

The root sub-process is a concrete module named Software Development Process. It represents the configurable process model for a BPL. The following will be presented: process pattern examples, the configurable process model, the configuration question-naire, and a configuration example.

## 4.1 Process Patterns

Process patterns are defined through abstract modules that represent mandatory, optional, alternative and/or multiple modules. For example, *Perform Planning* is a mandatory concrete sub-process for *Project Planning In-House*, *Project Planning Out-Sourcing*, and *Project Planning Co-Sourcing*. This relation is defined explicitly in *Project Planning In-House* in Figs. 1, 2, and 3 and is represented in process-oriented feature model in Fig. 4. Another example, where *Iteration* is an abstract sub-process with two alternative (XOR) concrete sub-processes: *By Phases with Time Box Flexible*; *By Task with Time Box Effort*; and *By Functions with Time Box Effort*.

The Figs. 1, 2 and 3 are used to illustrate in detail how a business process can be obtained from a collection de BPMN models using our approach. These three process models correspond to a multiple (OR) process pattern. Thus, they are represented in the process-oriented feature model as the abstract module *Project Planning* with two multiple (OR) concrete sub-process, *Project Planning In-House* and *Project Planning Outsourcing*. The concrete sub-process *Project Planning Co-Sourcing* is obtained by both selections. This process pattern determines a variation point and their variation options are the three concrete modules in Figs. 1, 2 e 3.

The *Project Planning In-House* sub-process shown in Fig. 5 is similar to the PDS-BC Agile sub-process shows in Fig. 1.



Fig. 5. Project Planning In-House.

The *Project Planning Outsourcing* is a concrete sub-process shown in Fig. 6. It is similar to the MIDAS-IPHAN planning process shown in Fig. 2, and the *Project Planning Outsourcing* has two mandatory concrete sub-processes, *Open Service Order* and *Manage Service Order*.

*Perform Planning* is the mandatory parameterized concrete sub-process shown in Fig. 7. So, the parameters are defined as follows: *paramA* = *paramB* = '*Supplier*' in *Perform Planning Outsourcing* sub-process; *paramA* = '*Manager*' and *paramB* = '*Team*'

in *Perform Planning In-House*. Parameters determine a multi-perspective process variability and in this example represent a degree of the variability of domain-specific processes among stakeholders.



Fig. 6. Project Planning Outsourcing.

Fig. 8 shows the *Project Planning Co-Sourcing* option when both options are selected (*Project Planning In-House* and *Project Planning Outsourcing*) and Fig. 9 shows the *Project Planning Co-Sourcing* module with the composition of their sub-processes. This sub-process in Fig. 9 is similar to the MGDS-INEP planning process shown in Fig. 3.



Fig. 7. Perform Planning.



Fig. 8. Project Planning Co-Sourcing.



Fig. 9. Project Planning Co-Sourcing is a composition.

There are many other process patterns and after building the process-oriented feature model, depending on the business requirements, different compositions possibilities are offered.

## 4.2 Software Development Process

The Software Development Process is a concrete sub-process illustrated in Fig. 10 that implements four abstracts sub-processes: *Labor Contracting Devices, Project Planning, Development*, and *Acceptance Product*. Each abstract process is a variation point of the BPL. So, the configurable process model illustrated in Fig. 10 is determined by a concrete sub-process. Each abstract sub-process is detailed below.

The Software Development Process comprises the sub-process: Labor Contracting Device, Project Planning, Development, Product Acceptance. The sub-process Labor Contracting Device has three modeling options and allows the choice between contracting options available to organizations: In-House, Outsourcing or Co-Sourcing. This essentially ensures the team definition. The sub-process Project Planning has a mandatory sub-process and three modeling options that let choose between the planning options available to organizations: In-House, Outsourcing and Co-Sourcing. The sub-process Development allows choice the development paradigm and methodology to be used in project execution (In-House, Outsourcing or Co-Sourcing). The Acceptance Product sub-process allows run the process activities In-House, Outsourcing or Co-Sourcing or Co-Sourcing. More, the sub-processes Open Service Order and Manage Service Order are

mandatory for the *Project Planning Out-Sourcing*, *Perform Iteration Outsourcing* and *Acceptance Outsourcing*.



Fig. 10. Software Development Process.

## 4.3 Configuration questionnaire

Table 2 shows the questionnaire for the process-oriented feature model illustrated in Fig. 4. Each variation point corresponds to a question, and each answer corresponds to the variation options according to the process. One configuration option is shown in highlight.

Table 2. Questionnaire for a process-oriented feature model with its configuration options.

Select an option for each configuration item for the Software Development Process					
A. Labor Contracting De	vices	•			
1. In-House	2. Outsourcing	3. Co-Sourcing			
B. Options for Project Planning					
4. In-House	5. Outsourcing	6. Co-Sourcing			
C. Development Paradig					
7. Iterative Development 8. Waterfall Development					
D. Development Methodo	80				
9. Phases in Timebox Flexible <b>10. Task in Timebox Effort (pipeline)</b>					
E. Perform Iteration					
11. Phases in Timebox Flexible; In-House Team					
12. Task in Timebox Effort (pipeline); In-House Team					
13. Functions in Timebox Flexible; In-House Team					
14. Phases in Timebox Flexible; Outsourcing Team					
15. Task in Timebox Effort (pipeline); Outsourcing Team					
16. Functions in Timebox Effort; Outsourcing Team					
17. Phases in Timebox Flexible; Co-Sourcing Team					
18. Task in Timebox Effort(pipeline); Co-Sourcing Team					
19. Functions in Timebox Effort; Co-Sourcing Team F. Waterfall Development Team					
20. In-House Team		22. Co-Sourcing Team			
G. Acceptance Product	21. Substiteing feam	22. Co Sourcing Team			
23. In-House Team	24. Outsourcing Team	25. Co-Sourcing Team			

The configuration process is realized via questionnaire to identify adequate BPL members for the organization. The configuration process uses a set of questions about the variability points and its answer choices (variant options). It is elaborated according to all variability perspectives (control-flow, data, resource, operations). Each question connects one variability point to its correspondent variant options. The questions are

showed according to the options selected along the configuration process and its dependencies rules, and the configuration of BPL member can be obtained by abstract and concrete composition operations defined early. Fig. 11 is an example BPL member. This complete composition is selected from the highlight options in Table 1 and retrieves a BPL member.



Fig. 11. BPL member.

Other models can be configured from the selection of other configuration options available in the questionnaire.

# 5 Related Work

BPMN is the modeling notation adopted by institutions of the Brazilian public sector where this approach will be validated. Our approach is implemented as a BPMN extension, given that BPMN version 2.0 [25] provides an extension mechanism for attaching additional attributes and elements to its original elements. This section shows some works related with configurable process models for public sectors. These works are case studies in other countries and use other notation languages. Finally, we show some approaches related with BPMN extensions to model variability using feature model and compare them with our approach.

Gottschal *et al.* [26] show a configurable process models for Dutch municipalities. For each process the authors identify the variations among municipalities and integrated them into a single, configurable process model, which can be executed in the YAWL workflow environment. Lönn and Uppströml [27] show a configurable process models based in C-EPC and reports on difficulties for a municipality in Sweden to utilize the configurable approach due to a number of reasons connected to low process maturity.

Schnieders and Puhlmann [28] show an approach that uses SPL concepts and techniques to design business process model with BPMN with one single diagram. Landre *et al.* [29] extend this work with the concept of Inclusive-OR. Gröner *et al.* [30] show a mapping between a variability model represented in a feature model and a reference model in BPMN that represents a business process family, which is represented in one single diagram BPMN. Terenciani *et al.* [31] present an extension to BPMN based on feature modelling. The authors identify in other works the elements of BPMN where variability can occur [28, 30], such as process, sub-processes, activities, events, data object, pools, and control flow. All these BPMN extensions represent variability in one single big diagram, what may be inappropriate for large models. These BPMN extensions do not provide an easy way for the configuration.

Montero *et al.* [32] propose a mapping between feature models and business process models using ATL (Atlas Transformation Language). This transformation obtains the basic structure of the business process that needs to be completed manually. This transformation is based in a context-free grammar.

Our approach defines a higher level of abstraction that allows capturing a complete business process family, modelling variability through business process patterns, called also sub-processes, that maintain the individual semantic of the modules, and a configuration process that also maintains semantic properties that must be preserved during the composition operations to obtain BPL configurations.

# 6 Conclusions

This paper presents an approach for modeling configurable process models for the Brazilian public sector. A domain analysis is performed for a collection of business process models for build a process-oriented feature model. A model configuration is obtained through a questionnaire. The models obtained are in compliance with the collection of models used.

As a future work, we plan to perform a validation with SISP entities to assess the completeness and correctness of the process models. Additionally, we intend to apply this approach to other case studies on Brazilian public sector such as collections of the ombudsman process models. Despite our particular interest in collections of processes of the public sector, this approach can also be widely used by other sectors.

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