Business Processes Compliance in Partially Observable Environments

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Abstract. This paper aims to provide an answer: how to obtained compliance through observation and control in instances of business processes modelled on Business Process Management(BPM), in partially observable environment. An organization is a dynamic system where actors play roles and produce results and decisions autonomously, changing the overall state of the system. These decisions often occur in environments that are not fully observable. In order to face with the market demand and legal impositions, organizations need to come up with innovative solutions by optimizing their business transaction models allowing them to assist in decision-making processes. The business process models are intended to represent an organizational reality and restrict the freedom of design to allow common understanding between stakeholders and to define the roles of the actors, who instantiate the state transactions of business process. Organizations need to ensure that operational processes are performed in a controlled way to meet predefined requirements, complying with regulations, laws and agreements established between internal and external stakeholders. This project concerns the beginning of a proposal to master this problem. The solution was implemented in enterprise simulation environment, using Enterprise Cartography(EC). The results obtained demonstrated the ability to observe and control the process instances as a contribution to improving the compliance of Business Process, modelled in BPMN.

Keywords— Compliance, Enterprise Cartography (EC), Business Process Models, Development process.

1 Introducion

An organization includes a network of people and machines that work and communicate in an integrated way. While organizations operate to meet optimization requirements to increase their effectiveness and efficiency, unexpected endogenous and exogenous situations occur continuously. It is the case of requirements, social and legal changes. The control and management functions are responsible for optimizing the use of runtime resources. These functions, which must conform to predefined restrictions on individual and collective runtime observations. This organizational activity can be divided into three intervals: the ex-ante: what happens before execution; the ex-dure: what happens during execution; and the ex-post: after the events have run. This phase includes decision-making processes to estimate future behaviour from the data available from past executions. The integration of these three time intervals provides a complete description of the control of organizational behaviour and leads to the problem that organizations have, an incomplete understanding of the facts and yet, have to make ex-post organizational decisions based on partial information collected in partially observable environments. This problem is recognized with high impact in the health industries, financial, public administration, etc.

2 Background

2.1 Enterprise Cartography

An organization [1] is seen as a dynamic system operating a network of actors that collaborate and produce results that can be represented through cartographic maps. Actors collaborate with each other over time, creating a dynamic collaborative network and produce autonomous behaviours that can change the overall state of the system. These actors, humans and machines, work as a network in a domain and produce events, some unexpected and with state changes. They are continually interacting and producing behaviours. The change produced by a human being can only be observed after the completion of the action, as well as the action produced by a computer actor in Information Systems. Although the predictability of automated computer actions is exponentially greater than in human beings. However, systems may have flaws or be misaligned with the business, which makes it unfeasible to estimate with certainty the outcome of the interactions. Enterprise Cartography is fundamental to managing the transformation processes of an organization. The cartographic representations of the company, through artefacts, represent the structure and dynamics of an organization from three temporal views: as-was (past), as-is (present), a-being (future). Dynamically displayed and generated through a continuous process of collecting operational data from an organization. The transformation is seen as the set of initiatives that change the current state to an intended state. The two states span organizational variables at different points in time. The as-is status is the variables that have changed due to past events, the to-be state represents an expected state configuration of the organizational variables. Between these two states the organization reacts to other events triggered by the operation of the transformation processes. It is important to observe and manage the organization during the transition of states, even if some of the events may not be related to the transformation activity. It can condition the transformation process by diverting the organization from the objectives.

Enterprise Cartography deals with providing up-to-date model-based views of an enterprise architecture and its goal is facilitating its communication and analysis.[1]

2.2 Business Process Compliance

The verification of compliance is a very current issue with great importance to management and auditing business process in communities, due to the availability of event data on the one hand and on the other hand, due to changes in legislation [3]. The organizations need to ensure that operational processes are run in a controlled manner, as deviations can expose the organization to serious risks and incur high costs. In order to meet predefined requirements, complying with the regulations, laws and agreements established between the internal and external actors of the organization. In this way, organizations need to continually check whether processes, supported by information systems, are executed within a set of limits. The deviations can be pointed out as negligence, frauds, risks and inefficiencies. Increasingly, organizations are subject to laws and regulations, in compliance with contractual standards and obligations and there is a need to optimize response times for processes subject to these guidelines. At the same time technological advances offer an increasing opportunity to systematically observe processes at a detailed level, with a record of all relevant events in the process. However, increasing computerization of business processes increases opportunities for alternative solutions. Employees use alternative solutions to deal with poor technology and process performance [15]. Information Systems also increase the risk of illusion of control, which means that information systems present information that does not reflect the actual instances of the process (Sobreperez et al., 2005). Similarly, employees exploit information systems to create "compliance fakes," which means that employees use information systems to pretend to comply (Cunha ’ʿCarugati 2009).

2.2.1 Actor

An actor performs several activities over time. For the performance of an activity, an actor explicitly or implicitly fulfils a certain role. According to (Winograd, 1986), the actors of an organization are the fundamental part of a company and are organized in social systems. An actor is usually associated with a person but can be a machine. According to (Dietz et al., 2013) in a company can coexist individual and collective views of the same reality. These actors are endowed with their own will and freedom of action, acting according to their purpose and orchestrations [14]. They are therefore autonomous in deciding what to do next. In companies, some tasks can be automated by software systems, while others are performed by human actors.

2.2.2 Model and instance of a business process modelled on BPM

In this work, we study the organizations oriented to business processes. For this purpose we use a business process model created in BPM - Business Process Management. [9] "In the face of a BPM initiative, an organization must begin by ensuring that the business processes covered by BPM lead to consistent and positive results, providing maximum value to the organization in customer service." A business model [9] is taken as a collection of interrelated events, activities and decision points involving a number of actors and objects, and collectively leading to a result that is of value to at least one client. The figure 3 describes the ingredients of this definition and their relationships.

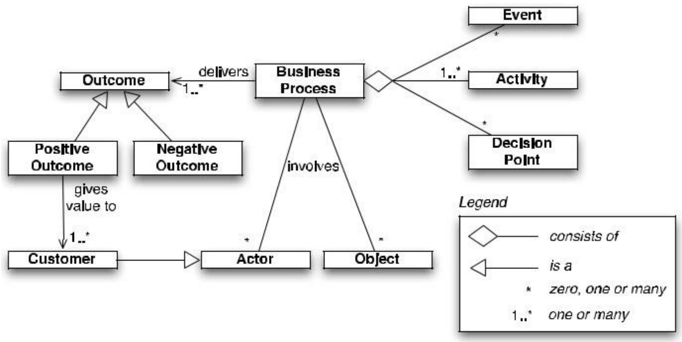

Figure 1: Ingredients and relationships of a BPM Business Process [9]

This definition reflects the importance that the business process has in BPM. In addition to BPM involve different phases and activities in the life cycle of the business process.

It is necessary [14] that the previously designed models be implemented in systems (manual, semiautomatic or automatic) and be contained in the organization, so that they can be instantiated later. The instantiation occurs when actors perform their activities throughout the day. It is the multiple instances of the business process, occurring concomitantly, that reveal the existence of the organization on a day-to-day basis. A business process model defines which roles of the actors are involved in each state transaction. It is these same actors who instantiate the state transitions of the business process. In the same way that business process models can be represented, the instances of business processes can also be represented, making it possible to observe if any of the instances of the business process is not respecting the prescription of the model. The functions of organizational control should be invoked whenever the model is not observed.

The BPM [9] is the art and science of overseeing how work is done in an organization to ensure consistent results and take advantage of opportunities for improvement. The term improvement described in here may have several meanings, depending on the organization's objectives. Some examples of improvement goals are cost reduction, reduced runtime, and reduced error rates. Improvements can be punctual or continuous. BPM is not about how activities are best executed, but about how to manage chains of events, activities, and decisions that add value to the organization and its customers. These "chains of events, activities and decisions" are called processes. IT specialists see BPM as a way of communicating with various parts of the business through a common language.

2.2.3 Observation

Observation is one of the stages of the scientific method and consists in understanding, seeing and not interpreting. And it refers to the action and result of observing something or someone. In control of dynamic systems, Franklin et al. (2009) state that "...a system is completely observable if each system state variable affects some of the outputs. Many times, it is desirable to obtain information on the state variables of the output and input measurements. If any of the states cannot be observed from the measurements of the outputs, the state is said to be unobservable and the system is not completely observable or simply unobservable ... ".

2.2.4 Action Controls

In a system, there are two types of control variables, those that are controllable and those that are not controllable. A process is called fully controllable if each state variable of the process is controlled to achieve a certain finite-time objective by an unconstrained control u(t). of the state variables is independent of the control u(t), this means that there is no way to act, in finite time, that state variable for the desired state. an uncontrollable state, then the system is called not totally controllable or simply uncontrollable.

In the scope of business processes, a control action can result in two different possibilities: (i) Negative control: it is the action controls on the instances of the business processes to avoid that situations of purposely detriment compromise the operation of the organization. For example, an actor who has no access to the system. (ii) Positive control: action controls on the business process models if it is found that the deviation situation represents innovation. For example, perform an activity, but in an optimally way. In these cases, the new prescription is incorporated into the organization's models.

2.2.5 Time

Shewhart (1980) proposes a control cycle of a system, composed of the classical sequence PDCA: (i) intelligence to observe an organizational problem, (ii) the design of potential solutions, (iii) the choose of best solution, (iv) implementation of the solution and verification if it satisfies the fulfilment of the intended objectives. Among the different control activities there are time delays, for example, when a controller decides for a control action u(t) this is based on observations from the past. y(T-1), y(t-2), ..., y(t-1), and (t-n). This means that when the control u(t) is triggered, it may no longer be valid in the operational reality of the system to be controlled. Conceptually, everything that happens before the execution of business processes is called ex-ante, for example, the prescription of business processes. What happens after the execution of business processes is called an ex-post, relating, for example, to the reaction that is needed when something unexpectedly occurs. The decision processes on the most correct action u(t) to be taken consider the ex-ante models of the business processes as a control reference to be followed.

2.2.6 Control Pattern

The goal [14] of the control is to allow the operation of the business process instance(s) to be conducted, using a limited effort to a stable state previously defined by the organization. And being able to react to the exogenous and endogenous changes and disorders that are occurring. In conceptual terms, Kuo (1995) defines the stability of a system as "...considering the response of a system to inputs or perturbations: a system that remains in a constant state, except when it is affected by an external action, but is capable of returning to the initial constant state soon after this external action is removed then can be considered stable...". The classic patterns for a control system are shown in Figure 2. In (A) a system is presented as not controlled. The disturbance always affects the output delivered by the system. In this model, the behaviour of the output system cannot be guaranteed. In (B), a forward feed pattern is shown, showing that the system input changes according to the disturbance. Thus, the specific dynamics of the system are not included in the control action. At the bottom of the image, at (C), a feedback control pattern is shown, which calculates the input of the system according to the actual misalignment obtained between the output and the input. In this case, the calculation of actuation control takes into account the disturbance of the system dynamics. Thus, the output of the system depends on the perturbation applied in the system and on the dynamics of the system itself.

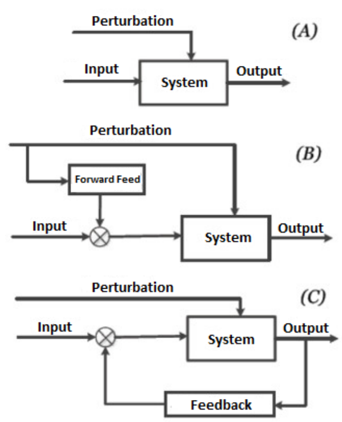

Figure 2: Design patterns of a control system. A-uncontrolled, B-control forward feed C-feedback control. [14]

Based on the definitions of the control standards, we can conclude that in order to obtain a control system that produces the expected results, it is necessary to provide observation and performance capabilities in the system to be controlled.

3 Related Work

Approach 1: 2013 MDP and DEMO

The article [10] propose a novel approach to elicit the set of business rules that optimize the value function of business transaction operations, combining the theory of Markov decision process (MDP) with the DEMO business transaction space. Following the general system theory and DEMO the three fundamental dimensions for a business transaction space are considered: State space, representing the set of allowable states of a system; Transition space, representing the set of allowable sequences of transitions of a system; Actor role space, representing the set of allowable competences, authorities and delegations of a system.

The conclusion: During operation, the business rules are the component responsible to decide which control action to take: the controller. The decision could be executed on a Human-based basis, a machine-based basis or a hybrid on, depending on the nature of the process to be controlled. Decisions are supported by the observed variables, and are implemented by the control variables. However, organizational steering is most of the time considered as an independent and isolated organizational add-on component that reacts according with the behavior of the part of the organization that is supposed to control. Moreover, elicitation of the business rules is usually an intuitive and error-prone process. This is refer due to the organizational complexity, these actual approaches are insufficient because it is impracticable to preview the results of a given business rule without using supporting simulation tools to aid the process-decision.

Approach 2: 2016 Risk and DEMO The article [6], aims to propose an innovative risk-based approach supporting compliance in complex business processes. The core concept, is the business transaction, which consider equivalent to a business process. On the one hand, a business transaction model is the result of applying design constraints for a particular organizational reality, valid over a given period of time, and are useful to share a common understanding between the stakeholders that have a diverse interpretation of it. On the other hand, business transaction models, per se, do not guarantee that the business actors perform them accordingly. However DEMO theory and methodology introduces capabilities to deal rigorously with the dynamic aspects of the process-based business transactions using an essential ontology that is compatible with the communication and production, acts and facts that occur in reality between actors in the different layers of the organization.

The conclusion: Business transactions prescriptions are fundamental to represent and share a common understanding between the different stakeholders of an organization. However, due to the raising complexity, and fast changing pace of the surrounding environments, many risks occur during business operations. When managers get aware about a change in the operational conditions, it is often too late to enforce a change in the business transactions prescriptions. Therefore, a new business process compliance solution, able to evolve along with the real-time occurrence of risks, is needed.

4 Solution Proposed

4.1 Methodology

The investigation use DSRM. Based on the process model to develop and evaluate an investigation in Information Systems. The DSRM consists of an interactive process with six steps and includes rigorous methods for the creation and evaluation of the proposed artifacts [8]. The figure 1 shows the DSRM step:

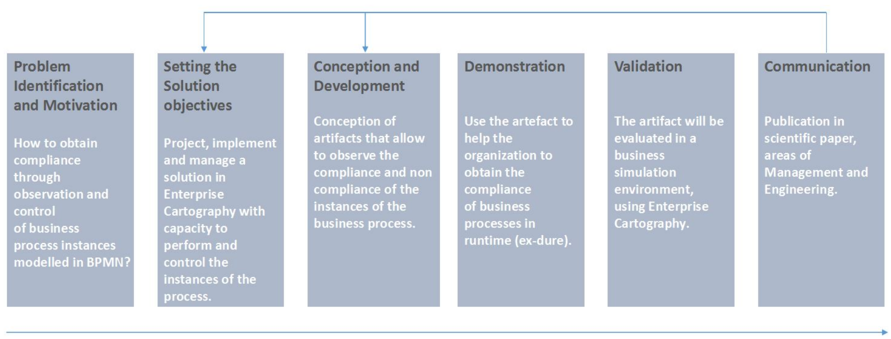

Figure 3: The DSRM process adapted from Peffers et al.[8]

The proposal for the solution is made using the Atlas tool, a commercial tool that is used in several medium and large corporate architectures. [1]

4.2 Problem Clarification

In order to explain the problem to be solved, we used the process modeling in BPMN, view Figure 4. This process was created by the company where our case study focuses, Link Consulting.

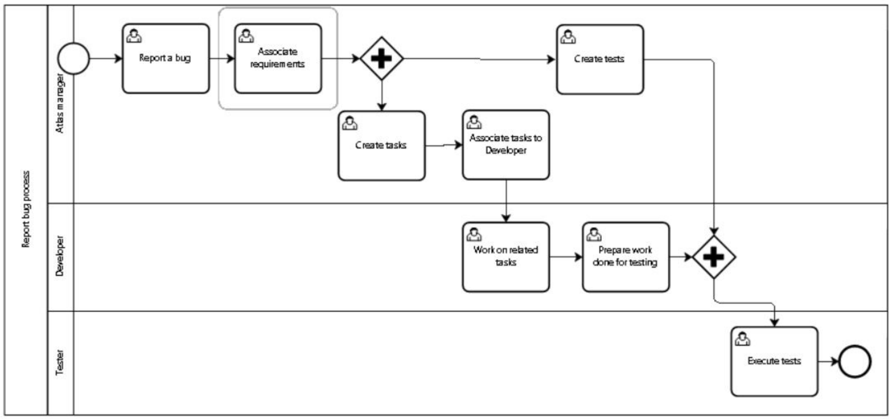

Figure 4: BPMN Process 'Report a Bug'

The process was created by Link Consulting and is used by the company using the Atlas tool. Atlas, is a Enterprise Cartography tool that supports the organizational transformation of an organization.

Figure 5 shows the Form, produced by the Atlas tool. Whenever an actor find a bug, he must register it through the Bug Form.

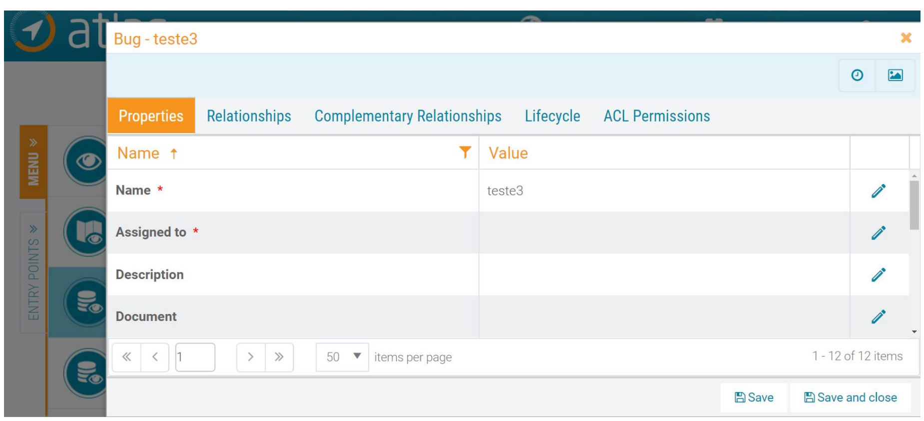

Figure 5: Form "Report a Bug"

An actor in this context, can be an Atlas manager, a programmer or a tester. Registration of Bugs allows:

- That the company has a repository of the bugs found and reported by the actors.
- That the company has the ability to observe at any time the current state of a particular Bug, by actor.

When the instances of the Report a Bug process are executed, they go through three states: **ex-ante**, it refers to the state of the process instances before it is executed; **ex-dure**, during the execution of the process instances and **ex-post**, after executing the process instances.

It is during the ex-dure phase (execution of the process instances) that non compliance can occur. Non compliance relate to non-fulfilment of business rules or prescriptions defined by the business.

Description of the activities of the 'Report a Bug' process during the state transitions:

Estado ex-ante: an actor identifies a Bug.

Estado ex-dure: the actor enters in the Atlas tool and accesses the Form to report a new Bug. The associated activities of the Report a Bug process are:

- Activity Report a Bug. Restrictions: The actor must fill the properties (fields): Start Date and the field State: On Going.
- Activity Associate Requirement. Restrictions: The actor must fill the property (field) Requirement.
- Activity Create Task. Restrictions: The actor must fill the property (field) State: Start.
- Activity Associate Tasks To Developers. Restrictions: None. Not observable.
- Activity Work On Related Tasks. Restrictions: None. Not observable.
- Activity Prepare Work Done For Testing. Restrictions: The actor must fill the property (field) Tests.
- Activity Create Tests. Restrictions: The actor must fill the property (field) State: Validated.
- Activity Execute Tests. Restrictions: The actor must fill the property (field) State: Finished, if the task is completed; or Rejected if the task is not completed.

State ex-post: the problem to be solved, it is then: find a way to observe and control, ex-post (after the process instances are executed) the compliance and non compliance that occur during the execution of the instances of the Report a Bug process, ex-dure. From the activities identified above, those in which there are no restrictions are considered as unobservable activities. This is the case of the Associate Tasks To Developers activity and Work On Related Tasks activity.

4.3 Solution Proposed

The solution proposed was designed and developed in Enterprise Cartography, through the Atlas tool.

1. Create Class SystemBPMN

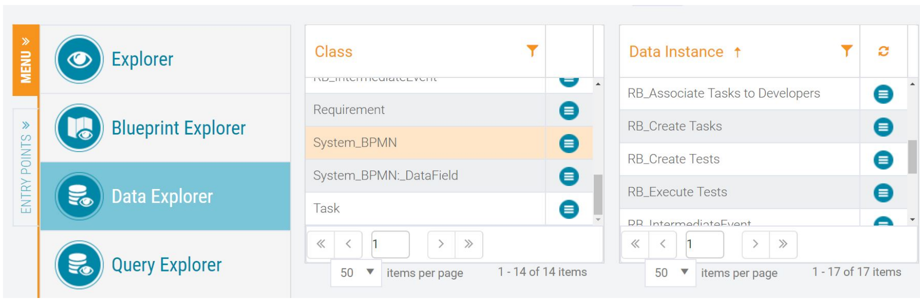

Figure 6: Class SystemBPMN and the respective instances from the process Report a Bug

2. Mapping all the activities in Report a Bug process, according to decision rules.

			RB_StarteEvent	RB_Report Bug	RB_Associate Requirement	RB_Create Tasks	RB_Associate Tasks to Developers	RB_Work on Related Tasks	RB_Prepare Work done for Testing	RB_Create Tests	RB_Execute Tests	RB_TerminateEvent
Activity				x	x	x	x	x	x	x	x	
Event			x									x
Property	Name / Assigned to (*)			x	x	x	x	x	x	x	x	
	End Date										x (red)	x
	Owner			x	x	x	x	x	x	x	x	
	Requirement				x (red)	x	x	x	x	x	x	
	Start Date			x (red)	x	x	x	x	x	x	x	
	State	Start				x (red)	x	x	x			
		On Going		x (red)	x							
		Finished									x/or (red)	
		Validated								x (red)		
		Rejected									x/or (red)	
	Tests								x (red)	x (red)	x	

Figure 7: Matrix of Decisions Associated with Report a Bug Activities. In Red: Compliance restrictions

3. Creation of Blueprint in ERML language, using the Atlas tool, contenied Observavel and Not Observable .

Algorithm 1: All Instances Algorithm

```
Data: All Bugs
Result: List of compliance bugs and non-compliance bugs from all
        instances
begin
    if (instance = "Report A Bug") then
        if (Start Date != NULL) and (State == On Going) then
            Compliance = TRUE;
        else if (Start Date == NULL) and (State == 0) then
            Compliance = FALSE;
    end
    if (instance = "Associate Requirements") then
        if (Requirement != NULL) then
            Compliance = TRUE;
        else if (Requirement == 0) then
            Compliance = FALSE;
    end
    if (instance = "Create Tasks") then
        if (State == Start) then
            Compliance = TRUE;
        else if (State == 0) then
            Compliance = FALSE;
    end
    if (instance = "Create Tests") then
        if (State == Validated) and (Tests != NULL) then
            Compliance = TRUE;
        else if (State == 0) and (Tests == 0) then
            Compliance = FALSE;
    end
    if (instance = "Prepare Work Donw for Testing") then
        if (Tests != NULL) then
            Compliance = TRUE;
        else if (Tests == 0) then
            Compliance = FALSE;
    end
    if (instance = "Execute Tests") then
        if (State == Finished or State == Rejected) and (End Date !=
          NULL) then
            Compliance = TRUE;
        else if (State != Finished or State != Rejected) and (End Date
          == 0) then
            Compliance = FALSE;
    end
end
```

The Output As we can see, an extract of Blueprint from Actor David Moreira, with Observable and Not observable instances of the Process Report a Bug.

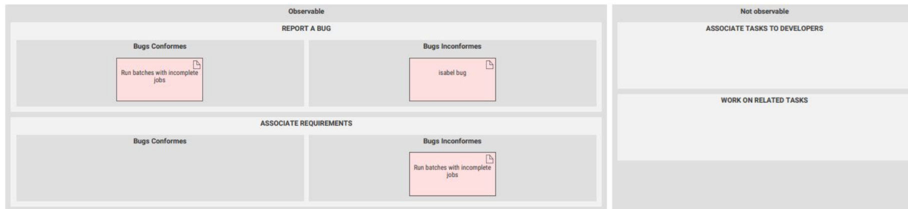

Figure 8: Blueprint from Actor David Moreira

5 Demonstration

In this section we present the case study that follows within a business simulation environment. A solution developed in Enterprise Cartography was used to provide observation and control of the instances of the Report a Bug business process. The approach used in the design, development and implementation of the solution was based on the methodology DSRM [8]. The application in real context, from this solution, aims to provide the company with greater compliance in the business process instances, at runtime: ex-dure. The compliance achieved by complying with the predefined restrictions allows the organization to have a better understanding of what is going on in the company, rewarding it in decision making.

Memory of the past state (as-was) and the future state (to-be) define the behaviour of an organisation. The to-be state specifies the goals of transformation projects. Without the to-be state the transformation processes cannot be executed or measured since no project goals are defined. [1]

5.1 Validation

During the study period, 80 instances of the Report a Bug process were considered. Corresponding to some 480 operations performed by the actors. On these instances, cartographic maps, were extracted where it is possible to observe the activities of the Report a Bug process described in 5.2.

For the observation and control of the compliance from instances of the process, cartographic maps have been created - Blueprints. Blueprints and schematic representation are common ways of communication between people, namely to express an architectural description of things, like a system, an object, a model or, in our case, an Enterprise.[5]

The Blueprints were produced by Actor. On a total of 9 Blueprints. In these Blueprints we can observe 78 instances of the 80 contemplated, divided by activity, between Compliance and Non Compliance.

Based on the initial problem "How to obtained compliance through observation and control in instances of business processes modeled on BPMN, in partially observable environment", we can then verify that the solution allows the observation and control of process instances, through the predefined restrictions as a contribution to improving the Business Process compliance, modeled in BPMN.

6 Conclusions and Future Work

The present article presents an innovative solution that allows to observe compliance, ex-dure, during the execution of business process instances using the Enterprise Cartography.

The results obtained through the simulation, show us that through the Enterprise Cartography it is possible to observe the Compliance and Non Compliance associated with each instance of the business process. Thus contributing so an operational improvement in the execution of business processes modelled on BPMN.

We can more easily identify deviation situations in order to carry out corrective actions to encourage the Actors that operate in the instantiation of the business process.

When compared with existing solutions, this solution allows the identification of situations of deviation from the prescriptions, ex-dure, during the execution of the instances.

In order to achieve greater compliance, is identified the need to:

- Increase the actors' awareness of compliance with restrictions.
- Create an automatism that allows the observation and controlling the process instances in run time, 'ex-dure'.

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