Principles Inspired by DEMO to Model BPMN Collaborative Diagrams

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Abstract: The representation of business processes is an area that has appeared within companies. This representation is typically done with Business Process Modeling Notation (BPMN). The models produced in this modeling language may present several problems related to complexity, ambiguity, and subjectivity at the level of semantics, ant there may be several representations for the same process. These problems usually result from not using modelling methodologies. The hypothesis of solution to this problem explored here was the possibility of proposing a set of methodological principles for the development of BPMN models following the principles already proposed for Design & Engineering Methodology for Organizations (DEMO). The presented solution was validated applying the principles and solving the problems identified in the diagram studied during the analysis of the problem. The results obtained through the validation and demonstration of the principles allow to conclude that it is possible to create a set of principles for modeling in BPMN, being possible to construct diagrams in a less ambiguous way taking advantage of the method used in DEMO. However, it is possible to realize that there are limitations about the variety of BPMN elements that are used.

1 INTRODUCTION

Nowadays companies are increasingly able to respond to various business processes, for example, developing a new product, generating and fulfilling an order, creating a marketing plan, and hiring an employee (Laudon and Laudon 2013).

To represent business processes Object Management Group (OMG), in 2005, released a modelling language known as Business Process Modelling Notation (BPMN) (Object Management Group (OMG) 2011). BPMN is a language used to represent business processes, with artifacts and a notation that intentionally intends to help business stakeholders understanding the processes.

However, since there is no reference method to apply BPMN, inconsistencies may appear in the results. Therefore, the addressing of that problem is the main motivation for this project.

According to Recker J, Indulska M (Recker et al. 2006), problems in BPMN models related to inconsistencies may appear, such as, in the atributtion and division of responsabilities, in the possibility of recovery from a bad state of a process, and in the possibility of model the same flow with different activities and events.

In order to produce better models and to avoid some inconsistencies, this work proposes a set of principles based on the modelling guides used in Design & Engineering Methodology for Organizations (DEMO)(Dietz 2006a). These guidelines will help, make more concise and concrete the production of BPMN models.

DEMO provides a definition of business process as a collection of casually related transaction types. The way of thinking in DEMO could solve the problem of ambiguous semantics and interpretations of models, because its accuracy identifies with precision the actors' roles, services and rules of a business process. This is the reason for the selection of DEMO as a reference for the principles here proposed.

To understand DEMO, it is important to introduce the concepts of Enterprise Engineering (EE) and Enterprise Ontology (EO). EE is the subject of science of modelling that focus on represent clearly the behaviour of organizations, to easily implement an enterprise in a comprehensive, coherent and consistent way (Dietz and Hoogervorst 2008). EO is the way of describing an enterprise in its essence, ignoring all the unnecessary information.

DEMO is a methodology for modelling, (re)designing and (re)engineering organizations and networks of organizations (Dietz 2003). It is aligned with the concepts described above, namely, EE and EO.

This research will follow Design Science Research Methodology (DSRM) as research methodology. DSRM has a set of guidelines and principles to follow and address a right way of research. There are six main steps that must be followed and they are: Problem identifications and motivations, Definition of the objectives for a solution, Design and Development, Demonstration, Evaluation and Communication.

This report is structured as follows. Section 2 contains a very extensive explanation of the problem with examples. In section 3, the document presents a set of related work, namely topics that are related with modelling business processes and BPMN. In section 4, a solution for the presented problem is presented and the main ideas of the solution are described and explained. Section 5, contains the validation and demonstration of the proposed principles, by applying them to the identified problems during the problem analysis. Finally, some conclusions, limitations and future work will be presented in section 6.

2 PROBLEM

Nowadays the representation of business processes is an increasingly present reality in organizations.

The processes represented through BPMN could face some problems related to their semantic. Some errors could arise and there is ambiguity when we try to model them. Example of ambiguity exists when one does not know when to model a pool or a lane to represent an entity of a process. Another complex situation is the problem of understand the context of the process, namely when it starts and when it ends (Dijkman et al. 2008).

Regarding the ambiguity of the BPMN models, the problem addressed is that **using principles when model with BPMN can diminish the inconsistencies in models.**

2.1 Problem Analysis

Some authors (Leopold et al.) made a study where they identified issues in BPMN models in about 582 processes from six companies. They subdivided the issues in three categories, such as structure, layout and labelling.

Examples of these issues are presented in the diagram below.

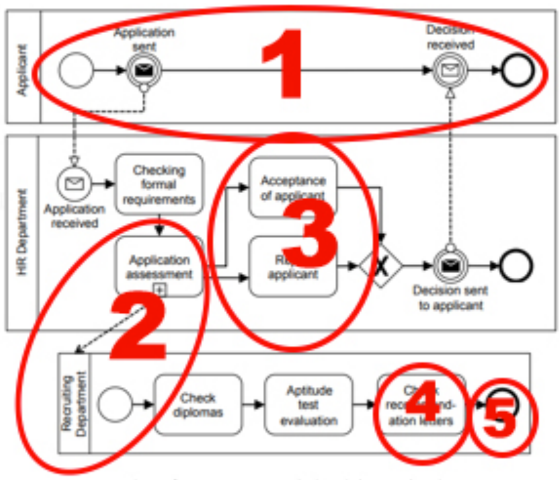

Figure 1: Example of BPMN model with typical errors

In the figure above, we can identify the following problems:

1. The behaviour of the applicant is being modelled;
2. A sub-process is triggered in the "Application Assessment" activity;
3. The registration of the applicant never happens;
4. The validation of the preconditions is not all made at the beginning of the process;
5. There is no communication of the result of the process that is carried out in the "Recruiting Department".

Also, there is a lack of interaction between the applicant and organization entity; In general, the labelling of activities in the diagram is not coherent.

Regarding the first problem, it is not correct to model the behaviour of an entity that is external to the context of the organization of which the process is part. It is not possible to define the behaviour of an external entity since it is not known what skills and resources the entity has and what kind of activities it can carry out.

The second problem concerns a sub-process that is triggered to validate a series of requirements in another department. There is no exchange of information between one process and another and therefore it is in doubt whether the sub-process contains all the information necessary to proceed. In fact, there is also no clear division between the process that is developed in the "HR Department" and the "Recruit Department".

The third problem identified concerns the production of the outcome that is expected with the process. It is known if the assessment was accepted or not, but that act of effective this assessment never take effect. This is a recurring problem in business process models. All the activities are accomplished until the outcome of the process is achieved, but there is no concrete activity where this outcome is obtained.

Another problem identified in this BPMN diagram is the late validation of the prerequisites to reach the expected outcome. In the example above, it is possible to verify that there are validations that are made at a later stage in the process that takes place in the "Recruit Department" pool, for example, with "Check recommendation letter" activity. The ability to validate all the prerequisites of the process at an early stage saves time and resources during the process.

Also, the lack of interaction in this process is something evident. The applicant after making his request only receives feedback from the organization when the decision is communicated to him. This way the aspirant does not know if the process is running in its normal flow or not since it receives no notification to inform that his request will be attended. This problem is also visible when the sub-process whose pool is "Recruit Department" is launched. This process is launched without an explicit request flow. It is also not known if the process is taking place since the “HR Department” does not receive any information about the progress of the process. Finally, the result of the sub-process is not reported to the "HR Department". This is a small example of what happens in many other processes. Lack of interaction can introduce inconsistencies in business processes.

The nomenclature of the objects in the diagram must be made according to the glossary of the business context where the process is inserted. The study cited by the authors mentioned that of the 582 processes studied, the majority presented inconsistencies between the glossary and the given names. In addition, there was also reuse and ambiguity in the names. This phenomenon can make reading and interpreting of business processes more difficult and complex.

Another problem of the BPMN diagrams is related to the representation of the multiple instances (Mraz et al. 2017). BPMN allows to define the multiple instances of an activity using loop type activities or cycles. This decision creates some ambiguity and therefore must be considered. By using cycles, it is necessary define a counter to control the child transactions. This approach can lead with big diagrams. Also, by using multiple instance activity a signal must be sent in order to trigger a new transaction. This approach produces a smaller diagram but there is no control of how much instances were triggered.

Finally, there is another problem associated with business processes. Sometimes when a business process is created not all considerations are taken into account to define the process context. That is, the expected outcome of the process is not identified in advance. Often a process is modelled when is necessary to execute a set of activities, but in fact a process consists of changing the state of a system, by producing a result. If the expected outcome of the process is not correctly identified, it becomes complex to define its context, that is, to define when it starts or ends.

3 RELATED WORK

3.1 Design & Engineering Methodology for Organizations (DEMO)

Design & Engineering Methodology for Organizations (DEMO) is a methodology for modelling, (re)designing and (re)engineering organizations and networks of organizations (Dietz 2003). The propose of DEMO is develop high-level and abstract models of the construction and operation of the communication patterns between human actors, i.e., models of organizations from a responsibility and communication oriented perspective (Huysmans et al. 2010).

To support this approach, there is a theory called Ψ-theory (Psi-theory) that underlies the notion of enterprise ontology. With this theory, that emphasizes four axioms (described below) define an enterprise as a (heterogeneous) system in the category of social systems.

3.1.1 The Operation Axiom

The operation axiom states that the operation of an enterprise is formed by the activities of actor roles, which their goals are achieved by performing acts. An actor role is defined as elementary chunks of authority and responsibility, fulfilled by subjects.

When the acts are successfully performed, their result are recorded in a fact, and consecutively there are two types of acts and facts. First appear de production and coordination acts (P-acts and C-acts), and if the result of these acts is positive they are stated in facts.

By performing production acts the subjects contribute to bringing about the goods or services that are delivered to the environment of the organization. On the other side, by performing coordination acts, subjects enter and follow commitments towards each other about the performance of production acts, i.e., they communicate, negotiate and commit themselves. At this stage, it is possible to conclude that C-acts are performed by an actor role (performer) and are directed to another actor role (addressee), and that C-acts are always, directly, and indirectly, related to P-facts. The result of this acts is stated in facts, namely production facts (P-facts) and coordination facts (C-facts).

Considering the difference between these two types of acts (P-act and C-fact), there is also the distinction between the two worlds in which both acts have effect: Production world or P-world and the Coordination world or C-world. These worlds are characterized by its state which is defined as the set of P-facts or C-facts, respectively, created so far.

3.1.2 The Transaction Axiom

The transaction axiom states that coordination acts are performed as steps in universal patterns. These patterns, also called transaction, always involve two actor roles and are aimed at achieving a result. Each transaction distinguishes two actor roles: the initiator, who starts the transaction and might complete it, and the executor, who is responsible for the performance of the production act and the creation of the respective P-fact.

There are three phases: the order phase (O-phase), the execution phase (E-phase), and the result phase (R-phase).

In the order phase, the initiation, and the executor work to reach an agreement about the intended result of the transaction, i.e., the production fact that the executor is going to create as well as the intended time of creation.

The execution phase is characterized by the production of the P-fact by the executor.

Finally, the R-phase is the stage where the initiator and the executor negotiate and discuss about the result of the transaction.

It is importance to clarify that performing a C-act does not mean that there is an explicit oral or written communication because most of them are often performed by non-verbal acts, or may even performed tacitly, which means that there is no act at all that counts as performing the C-act.

3.1.3 The Composition Axiom

The composition axiom states that every transaction is enclosed in some other transactions, or is a customer transaction of the organization under consideration, or is a self-activation transaction. Resuming the composition axiom says that is possible one transaction result on the combination of interrelated P-facts of other transactions that requires coordination between them. This axiom describes how these transactions can interact.

A definition for business process could be extracted with this axiom because it gives a notion that a business process is a collection of causally related transaction types, such that the starting step is either a request performed by an actor role in the environment (external activation) or a request by an internal actor role to itself (self-activation). Every transaction type is represented by the complete transaction pattern (Dietz 2006a).

3.1.4 The Distinction Axiom

The distinction axiom states that there are three distinct human abilities playing a role in the operation of actors, called performa, informa and forma. These abilities regard communicating, creating things, reasoning, and information processing.

The performa ability concerns the creation of new, original things, directly or indirectly by communication.

An infological act or the informa ability focus on the content aspects of communication and information, fully abstracting from the aspects. Typically, these acts are inquiring, calculating, and reasoning.

The forma ability concerns the forms aspects of communication and information. Even so, this axiom differentiates three modelling layers: datalogical, infological and ontological. The datalogical level describes the organization as a system of collaborating actors which produce, store, copy, transport and destroy documents. The infological level sees the organization as a system of rational actors that exchange information and perform computation to derive information. Finally, the ontological level regards the organizations as social systems, where actors engage in commitments to create new and original things.

To obtain an ontological model of an organization, one has only to consider the performa ability, in both coordination and production.

3.1.5 The Organization Theorem

The organization theorem states that the organization of an enterprise is a heterogeneous system that is constituted as the layered integration of three homogeneous systems: B-organization, the I-organization, and the D-organization.

The coordination parts of these three systems are similar, they only differ in the kind of production: B-organization has an ontological production, the I-organization has an infological production and the D-organization has an datalogical production. It is also possible see that the D-organization supports the I-organization, and the I-organization supports the B-organization, which, in its turn, provides a complete knowledge of the essence of the enterprise(Dietz 2006b).

3.2 Consistency of Business Processes using DEMO

A. Caetano, A. Assis and J. Tribolet published an article (Caetano et al. 2012) where they analyse the consistency of business processes using DEMO.

The authors focused on how to define a method that facilitates the analyse of process consistency. To solve this problem, the authors proposed a method that is divided in two approaches, namely, “bottom-up” and “top-down”.

The **bottom-up** phase receives as input a business process diagram, modelled with BPMN, and the output result are two types of DEMO models, such as an ATD and PSD models. The main goal of this phase is to capture the conversation between actors and the results that are produced. The main steps of this phase are: **Analyse the process model; Build DEMO models (ATD and PSD) based on the ontological collaboration and production acts; Analyse the DEMO models; Revise the DEMO models so that they comply with the axioms of the Ψ-theory.**

The **top-down** phase receives as input DEMO models from bottom-up phase and the BPMN process model. The produced output is the revised BPMN model, and the main goals of this phase is check the compliance and the revision of the input BPMN model with the DEMO models. The main steps of this phase are: **Perform gap analysis between the DEMO and BPMN models; Revise the BPMN model so that the process complies with the DEMO model**.

After tested the solution in a large organization the authors observed the results and concluded that the consistency of BPMN process models can be assessed using DEMO and the revised BPMN models are not a silver-bullet solution. Revised BPMN models could serve to discuss design issues and optimization opportunities with the stakeholders.

This solution does not solve the problem of this research because it is very focused on the evaluation of the produced models, that is, it does not help us to model a business process with BPMN. It focuses on assessing their compliance with DEMO and identifying possible points of improvement.

3.3 The way of thinking of DEMO applied to BPMN

Dieter Van Nuffel et al, identified some drawbacks of BPMN (Van Nuffel et al. 2009), such as the lack of formal semantics, limited potential for verification and ambiguous description of the constructs.

The authors presented as solution of this problem the application of the way of thinking of DEMO. First and to exemplify the proposed solution they present a universe of discourse where a customer orders a pizza and then model it in BPMN. This model is produced taking in mind the way of thinking of DEMO, so, at the end of the modelling process, they try to map the activities and events of BPMN with the elements of ATD.

This paper concludes that Enterprise Ontology, combined with the DEMO methodology can provide a formal foundation to BPMN models. Moreover, revising existing BPMN models with DEMO can be used to verify completeness and consistency of the modelled business processes. Finally, the main contribution the paper is thus combining the rich representational aspects of BPMN with the formal correctness of DEMO.

This solution does not solve completely this research problem because, despite of pointing the same problems and using the same ways of solving the problem, they do not provide any principles or methods to apply the solution. They only conclude that is possible to map some logic and artifacts modelled in BPMN to DEMO models. With this, an inexperienced business manager can not apply in their BPMN models the way of thinking in DEMO.

3.4 Converting DEMO transaction pattern into BPMN

(Mraz et al. 2017) recently published a paper that describes a method for converting the transaction pattern DEMO into BPMN. This paper is well founded theoretically since it tries to map the concepts of DEMO with the concepts of BPMN languages. In this way, they can apply the method with rigor.

The authors begin by mapping the c-acts / c-facts and p-acts / p-facts into BPMN language objects, which then take up the composition axiom to address the problems that may arise with the creation of threaded transactions as well how to solve the problem of blocking processes that are related.

Still, based on the transaction pattern, the authors suggest a set of conditions and measures to revoke a process. This mechanism works according to a set of requirements that are suggested, so that the cancellation of the process is done in an effective and coherent way.

When they apply the composition axiom, the authors argue the compound transactions can be modelled in two distinct ways. The first strand states that it is possible to model all transactions in a single diagram, and the second strand states that transactions can be modelled in different diagrams.

Both approaches are valid, but represent distinct levels of complexity. In one case, we will have huge diagrams and in another case, we will have many diagrams.

To control composite transactions authors, use BPMN loop activities and, catching events to unlock the execution of parent processes.

This paper focuses on the transaction pattern and the composition axiom, and forget other DEMO features. Despite this, there are some interesting ideas in this paper to solve the problem identified in this research, and these ideas can be complemented with more features coming from DEMO.

This solution does not solve completely our problem because its mechanism could generate too much activities that are not necessary, and the complexity of diagrams increase very much.

4 PROPOSAL

This research proposes **a set of principles to model BPMN according to the methodology used in DEMO** (identify ontological services, processes, actors' roles, business rules, and data objects)**.** These principles will facilitate and make more consistent the activity of modelling in BPMN.

To define these principles, it is necessary that exists a pre-made idea of the architecture of the processes. These principles can help define the context in which processes exist, but they do not serve to identify process architecture.

It is understood that when speaking in a process context, it is intended to define when a process begins and ends and what outcomes it can provide.

4.1 Define the process context

The first principle helps to identify the result that is intended to be achieved with a certain business process, also defining the begin and end of the process.

To identify the context of a process it is necessary to identify an outcome to be reached. Next, it is necessary to understand what sets of activities and responsibilities are necessary to achieve the outcome.

With this, it is necessary to identify the activity that initiates the process (typically a request that is made) and which activity ends the process (typically a message confirming the end of the process).

To explain the context of the process and its start or end the transaction axiom of DEMO is used. This axiom helps to define which are the essential activities through which the process must pass, such as: request, promise, state and accept. With the request activity, we are starting the process and with the accept activity the result is accepted and then the process can finish. Also, in the middle of processes, there is a set of activities chained together, whose functions are to inform, coordinate and produce the result.

In summary, this principle is intended to identify a result, which activities start and end the process, and which are the activities that support the business process.

Regarding to chained activities these are explained with the axiom of the composition and the axiom of the distinction of DEMO.

DEMO composition axiom tells us that each transaction can be enclosed in another transaction, such as a request from a customer to an organization, as well as a transaction that activates itself. From this axiom, we can define the context of the process, since it gives a notion that a business process is a collection of transactions chained together with a well-defined beginning and ending.

Also, the axiom of distinction tells us that there are three types of human abilities, namely, performa, forma and informa, regarding to the ability to communicate, create things, reasoning and inform.

This axiom reinforces this principle because it is through this set of skills used in the context of defined transactions that it is possible to achieve a defined result for each transaction.

4.2 Definition of pools and lanes

A pool is modelled when it is intended to achieve a certain outcome that the organization can meet. Also, a pool could represent a resource or role that is responsible for a set of activities.

In addition, a pool corresponds to an area of responsibility over the activities contained in it, i.e. there is always a set of entities and resources inside or outside the organization that are responsible for executing a set of activities until the result of the business process is achieved.

For pools that represents the internal context of the organization, its behaviour must be modelled, and the behaviour of pools outside the organization context should not be modelled. Also, the pool must be represented in order to show the interactions between pools.

Regarding the roles of responsibility, the BPMN still has in its notation the lanes. This principle defines lane as a graphical representation for a more refined delegation of responsibility within the process.

In DEMO, there are the actor roles. These roles are assigned depending on the responsibilities that are present in the transactions. Thus, by making the analogy between BPMN and DEMO, we associate pools and lanes with the responsibilities associated with each business process. That is, as in DEMO, also in BPMN, we will have responsibility roles associated with each transaction.

4.3 Multi-instance activities

When a process that intends to reach a given set of results that depends on the execution of multiple instances of another process, then the request and accept activities must be modelled using loop type activities.

This principle is supported in a paper presented at the EWC conference (Mraz et al. 2017), where the authors rely in the composition axiom of DEMO to better explain the way where multiple instances are created. They present two solutions to instantiate multiple child transactions, such as, loop activities and cycles. Modelling by cycles a counter is needed to know how many times the activities run, and to know the number of transactions must be completed to proceed with the process.

Otherwise, modelling by loop, the activities are modelled as sub processes where a signal is sent to start a new child transaction and the process is complete when child transactions are completed.

With the first approach (cycle) it is possible to have a better control in the counter of instantiated child transactions, but its complexity increases with the number of child transactions.

To model in BPMN, and to have a generic approach for multiple instance transactions, the loop modelling way is preferred, because there is less complexity in model's despite of not having the control of the counter.

4.4 Interaction between pools

Interaction between pools helps define the process and achieve the ultimate result. To facilitate interaction, we propose, based on DEMO (Dietz 2006), a pattern of activities that help to have control over the phases of interaction of the process and the responsibilities defined.

In this way, it is essential that the process contains at least the following activities:

- **Request**: the request activity is for an entity to start the process that produces an expected result.
- **Promise**: the promise activity consists of informing the requester that a request is going to be executed or not.
- **State**: the state activity consists of informing the requester that the process is over.
- **Accept**: the accept activity consists of an interaction flow in which the requester informs the executor whether the outcome of the process is the expected one or not.

This pattern of activities helps to define a flow of interaction in which all parties involved in the process are aware of the state of the process as well as the responsibilities within the process.

To be able to make the promise of a request, it is first necessary that the person receiving the request understands and is fully informed about what is being requested. Therefore, in the request phase, two-way interaction can and should exist to arrive at an understanding of what is being requested. After that, the organization can promise or decline the request.

It is important to note that in activities in which it is necessary to decide based on a request or message that has been sent to the requester, it is necessary to wait for a message from the requester (in an intermediate event) so that it can be treated in

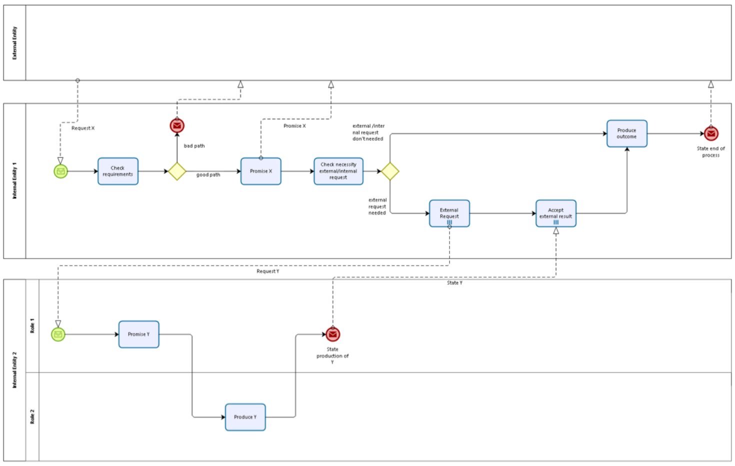

Figure 2: Example of process that implements all suggested principles

a specific activity (ex: promise or accept) and thus define the correct outcome of the process. Also, it is important to note too that the outcome of the process is obtained between the promise and accept activity.

Considering the explained pattern, and based on operation axiom of DEMO it is noticed that there are production activities and coordination activities. However, to achieve the goal there may be activities or sets of activities that are interleaved or encapsulated, such as asking someone within the same branch of responsibility to validate a given form or result.

Regarding operation axiom, this principle suggests the usage of interaction pattern used in DEMO, that fulfil completely the utilization and properties of P-acts and C-acts.

4.5 Activities name

Based on the previously defined principles we realize that there are at least five activities that are indispensable in the process, being the request, promise, production of outcome, state and accept.

Given these activities, the name that can be given are: **Request X; Promise X; X; State X; Accept X.**

Other activities that can be included in the model should not escape this nomenclature and must contain the action followed by the name of the desired result (e.g. calculate X, insert X).

This principle proposes names that follow the names of DEMO interaction pattern. The given names are self-explanatory and it facilitates to understand the propose of each activity.

By compiling these principles, it is possible to arrive at a representative diagram of what could be a process modelled in BPMN that follows all principles described in Figure 2.

5 DEMONSTRATION AND EVALUATION

This section concerns the validation of the proposal submitted and it corresponds to the Evaluation and Demonstration step of DSRM. In this section, we will consider the analysis that has been done on the problems identified and try to solve them by applying the principles defined in the proposal.

First, the presented principles for modelling in BPMN are in line with most of the problems identified. Then, as explained, DEMO was used as the basis for creating the principles since the methods used in DEMO are precise and concise.

The following figure contains the application of the principles to the BPMN diagram used in the analysis of the problem made in chapter 2.1, figure 1. This new version solves all the problems that are within the scope of the proposal, that is, problems related to the structure or semantics of the process, and the problems related to the labelling of roles, activities and events.

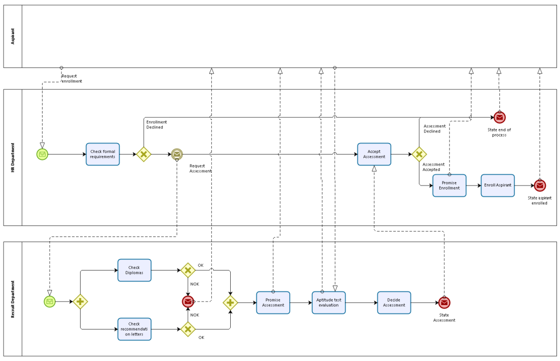

Figure 3: Application of principles in a problematic model

By applying the "Define process context" principle, it is possible to solve two of the problems identified as shown in the diagram. With this principle, it was possible to define the beginning and end of the process, as well as the expected outcome of the process. In the diagram, the use of this principle is notorious when performing the activities where results are produced, for example, "Decide Assessment" and "Enroll Aspirant".

The application of the second principle allows solving two problems. First, it is possible to realize that the behaviour of the client should not be modelled since it is an external behaviour. In addition, and considering the first principle, it is possible to realize that the sub-process that was launched, is only a process that is realized in the “Recruit Department” and that arises from a request by the “HR Department". Considering that this produces an ideal outcome and that takes place in another department, there is a need to define a new pool and consequently a new process.

The principle of "pool interaction" is one of the most complex principles. This principle defines the structure of the process and the interactions that must exist between existing pools. The validation of this principle is evident in the diagram since it is possible to identify the key activities of the process, namely the request, promise, production act, accept and state. Also, the problem of interaction and communication between pools is solved with this principle. In several activities represented in the diagram it is possible to verify that there are flows of communication or interaction between the entities represented. Also, the validation of the preconditions of each process are considered in this principle and it is possible to validate with the activities "Check Y" in the diagram.

Reactively to the nomenclature of activities is also defined a principle that can be validated in the diagram presented. Having the outcome of the process well defined the nomenclature of the activities becomes easier using the principle. It is possible to validate this principle by checking in the diagram that we have activities whose name is Request X, Promise X, X, Accept X, where X is the expected outcome name of the process.

The problem of multiple instances is explained in figure 2 of chapter 4. When there is an activity in the process where it is necessary to make several requests (for example to the kitchen of the pizzeria) there is a multi-instance “Request” activity. This activity represents the various orders that are made, thus triggering the orders needed to fulfil the customer's request. As the requests are being completed, there is an “Accept” multiple instance activity. In this activity, the results of the processes that were triggered previously are accepted. In this way, there is no risk that the processes will be blocked, since things are processed as the requests are made and the results accepted. It is also notable that the diagrams produced are not large in size, since it is not necessary to introduce counters or additional complexity to solve the problem of multiple instances.

6 CONCLUSION

Nowadays many companies try to represent their business processes through models.

By doing this research some important lessons must be taken. First, some organizations and researchers identify some problems when modelling BPMN. Addressing a set of principles that help overcome some of the ambiguities of BPMN is largely facilitated by the development of these IT processes.

The principles proposed in this research seek to help solve some of the problems of ambiguity and inconsistency related to the use of BPMN. These principles combine the methodology used in DEMO with some principles of Enterprise Ontology and Enterprise Engineering.

In addition, it is also easier to see when a process begins and ends. There is a principle that helps to distinguish clearly when a pool or lane is to be modelled. Exists another principle that helps to define the pattern of activities that must be considered as well as the interaction flows that must exist. There is another defined principle that helps labelling the activities in BPMN models according to the name used in the DEMO.

Finally, it was possible to validate that it is possible to link the methodology used in the DEMO to the modelling in BPMN, giving here opportunity to several types of approaches in future investigations.

Also, the limitations associated with this research are diverse. First, it was necessary to deal with the lack of bibliography that references methods for modelling business processes. Subsequently, the lack of references or a catalog of problems associated with BPMN also made it difficult to analyse the problem in greater depth.

There are also some limitations about the proposed principles. When we apply the principles to a complex business case, it can result in large diagrams.

Defined principles also do not help define the most appropriate type of BPMN activity for each case, except for multi-instance activities. With this, we are making it simpler to implement process logic but more complex definition of BPMN syntax.

Finally, considering that the principles are based in DEMO framework, unfamiliarity of this framework can make the interpretation and use of principles a complex and strange activity.

Regarding to future work, there are three guidelines. The first is related to the definition of new principles to improve the usage of BPMN notation of the diagrams produced when using the principles described in this research.

The second option concerns DEMO. With this investigation, it was noticed that the DEMO is not very clear to define the follow-up of the processes after an activity of promise or decline. In this sense, it would be interesting to provide DEMO with a treatment of outcomes for these two types of activities.

Finally, considering the layout of the diagrams, it would also be interesting to align the principles defined with the recommended metrics for the size of the models created.

REFERENCES

Caetano A, Assis A, Tribolet J (2012) Using DEMO to analyse the consistency of business process models. In: Advances in Enterprise Information Systems II - Proceedings of the 5th International Conference on Research and Practical Issues of Enterprise Information Systems, CONFENIS 2011. pp 133–146

Dietz JLG (2006a) Enterprise Ontology: Theory and Methodology.

Dietz JLG (2003) The atoms, molecules and fibers of organizations. Data and Knowledge Engineering 47:301–325. doi: 10.1016/S0169-023X(03)00062-4

Dietz JLG (2006b) Enterprise Ontology - Understanding the Essence of Organizational Operation. In: Enterprise Information Systems VII. pp 19–30

Dietz JLG, Hoogervorst JAP (2008) Enterprise Ontology in Enterprise Engineering. Proceedings of the 2008 ACM symposium on Applied computing SAC 08 28:572–579. doi: 10.1145/1363686.1363824

Dijkman RM, Dumas M, Ouyang C (2008) Semantics and analysis of business process models in BPMN. Information and Software Technology 50:1281–1294. doi: 10.1016/j.infsof.2008.02.006

Huysmans P, Ven K, Verelst J (2010) Using the DEMO methodology for modeling open source software development processes. Information and Software Technology 52:656–671. doi: 10.1016/j.infsof.2010.02.002

Laudon K, Laudon JP (2013) Management Information Systems: Managing the Digital Firm, Global Edition, 13th edn. Pearson Education Limited

Leopold H, Mendling J, Oliver G What we can learn from Quality Issues of BPMN Models from Industry. 1–9.

Mraz O, Náplava P, Pergl R, Skotnica M (2017) Converting DEMO PSI Transaction Pattern into BPMN: A Complete Method. Springer International Publishing 85–98.

Object Management Group (OMG) (2011) Business Process Model and Notation (BPMN) Version 2.0. Business 50:170. doi: 10.1007/s11576-008-0096-z

Recker J, Indulska M, Rosemann M, Green P (2006) How good is BPMN Really? Insights from Thory and Practice. In: Proceedings 14th European Conference on Information Systems. p 13

Van Nuffel D, Mulder H, Van Kervel S (2009) Enhancing the formal foundations of BPMN by enterprise ontology. In: Lecture Notes in Business Information Processing. pp 115–129