Towards Outsource-ability Enabled BPMN

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Abstract: Business process outsourcing to the Cloud is increasingly being adopted as a strategy to save costs, improve the business process performance, enhance the flexibility in responding to costumers' needs, etc. However, the adoption of an outsourcing strategy faces several challenges like the enterprise data security, vendor-lock-in and labor union. Weighing the pros and cons of outsourcing one's business process is an arduous task. This paper provides for assistance means: it extends the BPMN language to explicitly support the specification of outsourcing criteria, and it presents an automated approach to help decision makers identify those parts of their business process that benefit most from outsourcing to the Cloud.

1 INTRODUCTION

Face to the increasingly stringent business competition, small and medium size enterprises strive to excel in the marketplace by adopting different strategies and solutions. Outsourcing their business processes has been among the most widely adopted strategies (Yang et al., 2007). Business Process Outsourcing (BPO) is seen as a means to save costs, improve the business process performance and make it more flexible, etc. These advantages along with others explain the exponentially growing number of manufacturers which are outsourcing substantial parts of their supply chain processes to outside contractors (Adesta and Agusman, 2004).

In the recent years, the Cloud became the most chosen outsourcing environment. Indeed, according to the National Institute of standards and technology (NIST) (Mell and Grance, 2011)), Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction. It is a pay-as-you-go model providing customers with the possibility of using its various offerings and pay only for the used resources. When thinking about the suitability of BPO, business experts must address several issues to properly choose those parts of the business process to outsource. This explains the fact that enterprises decision makers spend almost 80% of their time to decide about the suitability to outsource theur business processes (Yang et al., 2007). Indeed, BPO affects and depends on several aspects of an enterprise: social, economic, legal, and IT (information technology) aspects. To make a judicious outsourcing decision, business experts must have a clear specification of each of these aspects; we believe that such specification should be through a set of valued criteria integrated as much as possible with the business process model. For example, it is easier to delimit the social/economic/IT effects of an outsourcing decision when the business expert has an explicit description of the personnel in charge, costs and IT requirements of each business activity. Currently available business process modeling languages, and in particular the standard BPMN ((OMG), 2011)), do not provide for most of these criteria; this is justified by the fact that these languages' primary concern is the business modeling and not the outsourcing.

To overcome this expressive power shortage, this paper proposes OutyBPMN, a lightweight BPMN extension for the specification of outsource-ability characteristics of business processes. Because our research work deals with the Cloud as an outsourcing environment, OutyBPMN extends BPMN with outsourcing concepts pertinent to the Cloud, e.g., cost as cloud may be a pertinent solution to save overhead cost, security to prevent outsourcing sensitive data, etc. In a second contribution, this paper presents

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an automated approach that uses OutyBPMN to identify the business process parts that benefit most from outsourcing to the Cloud. The identification is in fact a multi-objective optimization problem that can be resolved through evolutionary algorithms such as genetic algorithms, neuroevolution, genetic programming, etc (Deb and Kalyanmoy, 2001). The herein presented approach applies the penalty based genetic algorithm (Hu et al., 2005) to select the activities candidate to outsourcing according to the criteria specified in OutyBPMN. Initially randomly selected activities are generated as potential solutions. According to their quality, only best ones are kept from generation to another allowing thus to keep solutions that best meet specified criteria.

The remainder of this paper is structured as follows. Section 2 enumerates the criteria pertinent to business process outsourcing to the Cloud. Section 3 presents how OutyBPMN extends BPMN to provide for the explicit specification of these criteria. Section 4 presents the proposed solution design whose evaluation is discussed in Section 5. Section 6 summarizes the work status and highlights its extensions.

2 BUSINESS PROCESS OUTSOURCING CRITERIA

BPO is the process of delegating one or more ITintensive business processes to third parties that may perform the business process more effectively and efficiently. Deciding whether to outsource ones business process is not a trivial task. To assist with the outsourcing decision making, (Yang et al., 2007) suppose that a set of potential determinants have been gathered from experts. Indeed, enterprises expect from the outsourcing to save costs, focus on core competence and gain flexibility in management. Other dimensions may urge enterprises to outsource their business processes such as speeding the time to market and improving service quality (Li and Meissner, 2009). Despite these advantages, some drawbacks may prevent enterprises from outsourcing their business processes. BPO inconveniences are related to security issues, loss of management control, and vendor's service quality. In fact, cost saving is not always guaranteed owing to an inadequate business case or the inability to predict all business requirements. Moreover, security concerns, loss of control and vendor lock-in are among risks that may prohibit enterprises from outsourcing their business processes. More detailed risks are exposed in the research elaborated by (Gewald and Rouse, 2012). A judicious outsourcing decision needs to fix a set of criteria that can help decision maker in weighing the pros and cons of each outsourcing solution. In the next sections, we provide a detailed definition for the most important set of criteria that are widely considered when outsourcing business processes to the Cloud.

2.1 Cost Saving

Almost all researchers and practitioners, agree on the fact that cost saving is the most determinant factor that attracts enterprises to outsource their related business processes. In their analysis of data collected from trade reports, (Rouse and Corbitt, 2004) showed that outsourcing may yield a cost saving of 20%. (Yang et al., 2007) argue that outsourcing is guided essentially by overhead costs; that is, parts of a business process to be outsourced are selected by ascertaining firstly how much money they may save. To calculate the cost of a business process, one should have a knowledge about expenditure of setting up, executing and monitoring each of its a tasks/activities. An activity's cost is calculated essentially by investigating on expenditure related to its enactment cost (EC) and realization cost (RC). The former corresponds to the cost necessary for achieving essential steps in the business process management life-cycle starting from its design to the monitoring of its behavior. The latter corresponds however, to the data transfer rate, transaction, or pre-payment for a period of time (Saeedi et al., 2010).

2.2 Focus on Core Competence

Focusing on core competencies means that enterprises are spending financial expenditure and business efforts on activities expected to bring competitive advantage. As stated by Tom Peters, an expert in the outsourcing area, an enterprise should follow the rule of "Do what you do best and outsource the rest" (Soiva, 2007). The activities which are typical for outsourcing are those considered as noncore. More specifically, the less strategic the activity is, the more likely it can be outsourced. In this sense, business activities can be categorized into three types according to their strategic importance, listed from most to least critical:Core competence, critical noncore and noncritical noncore. Although the general attempts when outsourcing is to delegate noncore activities/processes to external provider, some enterprises are trying to outsource also some of their related core business processes (Theo Lynn et al., 2014).

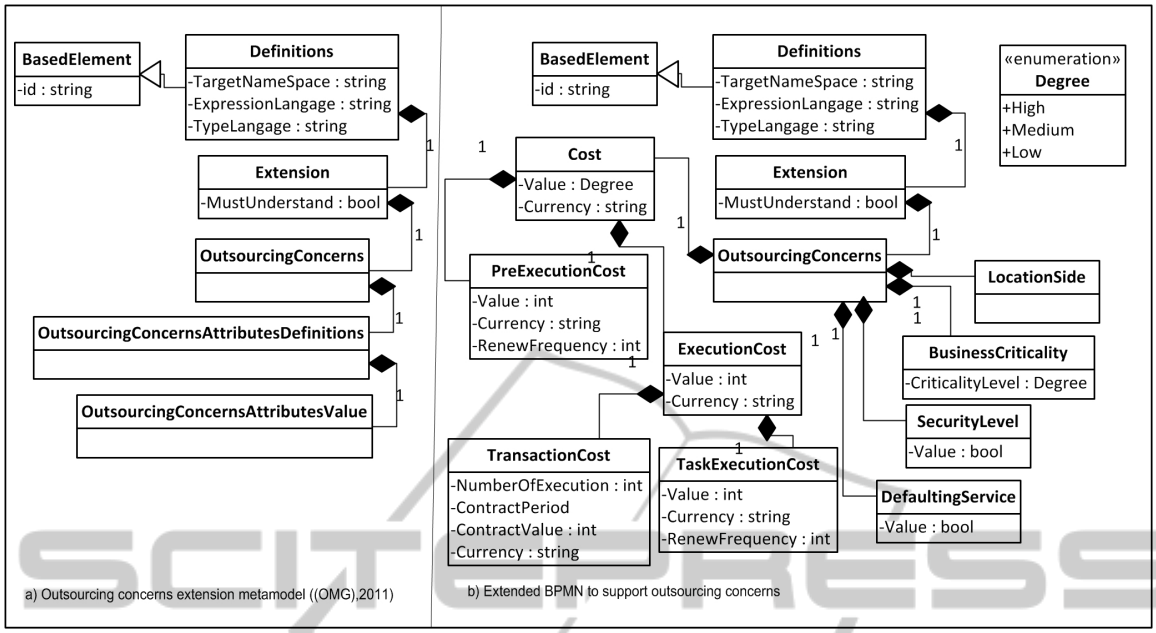

Figure 1: OutyBPMN metamodel: BPMN2.0 extensions with outsourcing concerns.

2.3 Security Concerns

When outsourcing its business processes, an enterprise should be aware about risks that may lead to undesirable outcome. Security concerns are the most prominent factor that may prohibit enterprises from outsourcing to external provider (Yang et al., 2007). This concern is due to the fact that service providers have control over the outsourced activities including those dealing with the confidential data of costumers. This risk increases when the service provider lacks the means to encrypt data of outsourcing enterprises (Gewald and Rouse, 2012). Moreover, the Internet-based connectivity between the outsourcing enterprise and its service provider can present vulnerabilities of unauthorized access to personal data, intrusion and hackers. To overcome this situation, an outsourcing enterprise should think to keep confidential business data or activities dealing with high level security data in premise. This way, it will be sure that vital information and data are secured and protected (Pathak and Joshi, 2009). It is worth noting that, in spite of the existence of multitude solutions, security issues still remain a serious problem when outsourcing due to lack of trust in service providers.

2.4 Quality Improvement

Besides cost reduction, outsourcing relies on the hypothesis that the service providers are capable of performing the outsourced activities more efficiently and effectively. The satisfaction of this hypothesis presumably leads to an increased customer satisfaction (Gewald and Dibbern, 2009). Indeed, the majority of outsourcing cases are elaborated after making sure that the quality of the services provided by the external party is better compared to internal outcomes (Yang et al., 2007). In addition, outsourcing enterprises may benefit from external expertise as the service supplier may have skills, platforms specialists and technical staff for enacting business processes; the outsourcing enterprise is often unable to provide such human resources.

3 BPMN EXTENSION WITH OUTSOURCING CONCERNS

Business processes are devoted to present the workflow of activities within enterprises. In a service oriented architecture, the business process is considered as a set of logically interrelated services. In this context each service is supposed to perform an activity (Saeedi et al., 2010). Modeling a business process is considered as a means to improve the way of the business process operation. In general, the prominence of modeling processes is due to the possibility it offers for sharing knowledge between enterprise stakeholder which allows to work harmoniously towards goals (Eriksson and Penker, 1998). Several number of process modeling languages and notations have been emerged in the aim to assist en-

terprises in the documentation and presentation of their processes. However, BPMN (Business Process Modeling Notation) ((OMG), 2011) is considered as the de facto standard (Rodríguez et al., 2007) approved by ISO/OSI (ISO 10303-203:1994, 1994). BPMN is defined by OMG in order to make the understanding of business processes easier from business analysts to technical developers. Its elements can be classified into five categories: Data, Flow Objects, Connection Objects, Swimlanes and Artifacts; we refer readers to ((OMG), 2011) for more details. BPMN2.0 introduces an extensibility mechanism for extending standard BPMN elements with additional attributes and elements to specify a specific need. The BPMN2.0 extension consists essentially on four different elements which are: Extension, ExtensionDefinition, ExtensionAttributeDefinition, and ExtensionAttributeValue. The ExtensionDefinition class defines additional attributes, however ExtensionAttributeDefinition presents the list of attributes that can be attached to any BPMN element. ExtensionAttributeValue contains attribute value. Finally the extension element imports the ExtensionDefinition and its related attributes to a BPMN model definition. Several works focus on the BPMN extension for different purposes. In fact, the extension allows to give additional comprehension for business process models. Moreover, adding new concepts to business process modeling allows to switch the way to use the BPMN from the contemplative manner to the productive one by automating the analysis of the business process or even its implementation (Bocciarelli and D'Ambrogio, 2011). In this context, (Rodríguez et al., 2007) presents a new extension of BPMN to incorporate security requirements to business process diagrams. Additionally, the adding of the quality of service into the business process modeling is considered in (Saeedi et al., 2010). Despite the multitude researches dealing with business process extension, there is no work which deals with the extension of BPMN for outsourcing concerns. In our elaborated extension, we propose a generic concepts that helps experts to decide the suitability of BPMN elements to be outsourced such as cost, business criticality, security and specific concepts such as the location side concept (in premise, in the cloud) and defaulting service concept as we aim to enhance the web service quality by enacting it in the Cloud environment. This paper adopts BPMN2.0 to support the aforementioned outsourcing concerns. Figure 1 a) presents the proposed class diagram corresponding to the meta model used for illustrating the outsourcing concerns. The outsourcing concerns class presents the ExtensionDefinition class containing extension attributes classes which are: Cost, BusinessCriticality, SecurityLevel and DefaultingService. These latter classes present the ExtensionAttributeDefinition illustrated in details in figure 1 b). The extension proposed is intended for adding new concepts to the activity element as our aim is to identify then which activities are the most suitable for outsourcing. The activity is the generic term for work that enterprise performs. Table 1 presents the graphical representation of the extensions over activity element and their corresponding description. Only information about location side (in premise/in cloud) are designed to be on the pool element. In fact, we aim to group activities selected to be outsourced into one BPMN element which is the pool. The implementation of the proposal is done using Eclipse Modeler as a tool.

4 OUTSOURCED ACTIVITY IDENTIFICATION

Our work aims to find a good solution corresponding to the appropriate set of activities suitable for outsourcing respecting the enterprise experts preferences. These latter are specified in OutyBPMN. Our solution search adopts penalty based genetic algorithm. In this section, we first present the problem model. Secondly, we present our algorithm for the identification of activities to be outsourced. A report on the algorithm performance is presented in Section 5.

4.1 Problem Formulation

The input to our search algorithm is an OutyBPMN model identifying in particular, the following activities:

- Expensive when executed in premise compared to when executed in the cloud;
- Noncore;
- Handling and processing non sensitive data;
- Presenting a defaulting behavior when executed as a service within the enterprise.

To look for an optimal set of activities best outsourced, we will use the following problem formulation:

1. A=$\{A_1, A_2, A_3, ..., A_n\}$ is a set of activities composing the business process.
2. The weights for outsourcing concerns, W_1, W_2, W_3 and W_4 for Cost (C), Business Criticality (BC),

Table 1: Extensions graphics for BPMN elements.

Graphical extension	Description
	This icon means that experts should precise the business criticality, namely the activity is core {high level of business criticality}, critical noncore {medium level of business criticality} or noncritical noncore {low level of business criticality}. To simplify for users, one can precise the level of criticality by choosing one of proposed graphics presented in the last row of this table.
	IT and business experts should collaborate to identify whether the activity handle confidential data or not. The security graphic is used when experts observe that the activity proceed sensitive data .
	In the context of this paper, IT experts should precise the cost of the hardware supporting the activity. More specifically, experts should be able to present in detail required expenditure of hardware maintenance, monthly bills, and all corresponding costs for realizing an activity. These information will help next to compare between financial cost of executing the activity in premise and in the cloud. Techniques used for calculating two prices is out of this paper scope. However, based on the difference between two prices, experts can categorize the cost of doing the activity internal {high,medium,low}.
	As previously said, among potential determinants urging enterprises to outsource their business processes, is the need to improve service quality. As we focus on business processes running within Small and Medium Enterprises (SME) that lack sufficient IT expertise, cost and required determinants for well realizing their business processes, we decide to choose defaulting services most suitable for outsourcing. Defaulting services are those have leading to the degradation of the business process performance, more specifically, those preventing business processes from attaining their goals. Discovering defaulting services is done in our previous work. We use "defaulting service" term and "activities presenting a default behavior when executed as service" interchangeably to refer the same thing.
	Whenever the algorithm of selecting appropriate activities to be outsourced is done, experts should analyze results and precise on each activity its location side {in premise, in the cloud}.
	These graphics help experts to specify level of importance of the extended elements (business criticality, security, and cost). They refer respectively to, high , medium and low level.

Defaulting Service (DS), and the number of activities composing the solution (L) respectively.

$$\sum_{k=1}^{4} W_k = 1 \quad (1)$$

3. S=$\{S_1, S_2, S_3, ..., S_n\}$ is a set of security constraints imposed on data handled by corresponding activities.

Our aim is to give a set A' of activities that are most suitable for outsourcing where A'$\subset$ A. We should notice all the process may merit to be outsourced which make A'=P where P is the entire business process although it is not a preferable case. A' is selected according to the fitness function (4).

We convert the optimization problem from a multi-objective to single objective one by assigning weights to each objective function composing the function (2).

Max F'=

$$W_1 * F'_1(A') + W_2 * F'_2(A') + W_3 * F'_3(A') + W_4 * F'_4(A') \quad (2)$$

Where

- $F'_1(A') = \frac{\sum_{i=1}^{N} C(a_i)}{N}$
- $F'_2(A') = \frac{\sum_{i=1}^{N} BC(a_i)}{N}$
- $F'_3(A') = \frac{\sum_{i=1}^{N} DS(a_i)}{N}$
- $F'_4(A') =$

$$\begin{cases} 1 + (\frac{(N-N')}{(N'-1)}) & if \quad 1 < N < N' \\ 1 - (\frac{(N-N')}{(L(P)-N')}) & if \quad N' < N < L(P) \end{cases} \quad (3)$$

- a_i is an activity that belongs to A'.
- N is the number of activities composing the solution A'.
- N' is the preferred length of the solution A'. This metric is added to F'_4 to prevent foster solutions having greater number of activities. The value of this metric is automatically calculated by counting the number of activities having a defaulting behavior when executed as services and not dealing with sensitive data.
- L(P) is the number of activities composing the process.

4.2 Implementation of Genetic Algorithm to Select Suitable Activities for Outsourcing

Genetic algorithms (GAs) (Gewald and Rouse, 2012) are evolutionary algorithms. Their main idea is to simulate the evolution of population composed of diversified individuals. These individuals are subject to operations such as recombination and mutation allowing thus, by selecting best individuals, to enhance the population quality. Choosing to work with GA is due to the fact that it allows to find solutions which best meet different criteria. The genetic algorithm presents solutions as individuals in a population that varies each time its quality is enhanced. The individuals composing a population vary when undergoing a set of operations such as crossover and mutation. Their quality is evaluated using a fitness function.

4.2.1 Individuals Encoding

To find out suitable solutions for the optimization problem, appropriate encoding of individuals is necessary. First of all, we should note that individuals composing a population have variable lengths. Each gene, composing an individual, corresponds to an integer referring an activity that belongs to the business process. Figure 2 presents examples of individuals encoding.

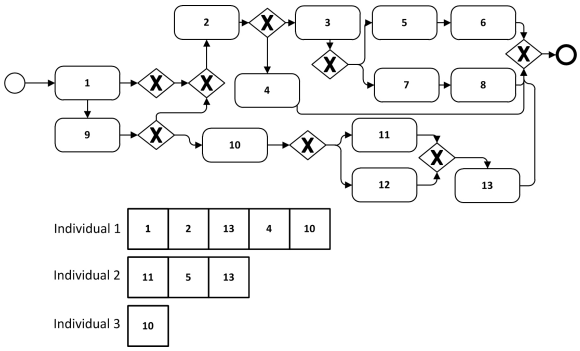

Figure 2: Individuals encoding.

4.2.2 Infeasible Solutions

In our research case, some solutions are infeasible as they violate security constraint. An individual may be composed of one or more activities handling sensitive data, we consider each activity dealing with sensitive data as a constraint violation.

4.2.3 Crossover and Mutation

We apply in our proposal the crossover and the mutation operations. We adopt the classical one-point crossover to generate each time two offsprings. Concerning the mutation operator, we have use it in three different ways:it can select randomly a position in the individual and replace it by another activity, add an activity, or delete existing one. An additional control should be done in this level to prevent repeating the same activity within an individual.

4.2.4 Fitness Function

An individual composed of activities requiring securing their data is considered as infeasible. To guaranty that GA reaches an optimal or near-optimal solution, these infeasible individuals should be kept as their presence is essential in the building of solutions. Thus, the idea is to give a penalty to fitness values relative to infeasible solutions. This leads to lower fitness values compared to those corresponding to feasible solutions. Moreover, infeasible solutions having more activities requiring security are more harshly penalized. This process helps to reenforce the presence of feasible solutions and the disappearance of the infeasible ones from generation to another. The equation (4) presents the definition of the fitness

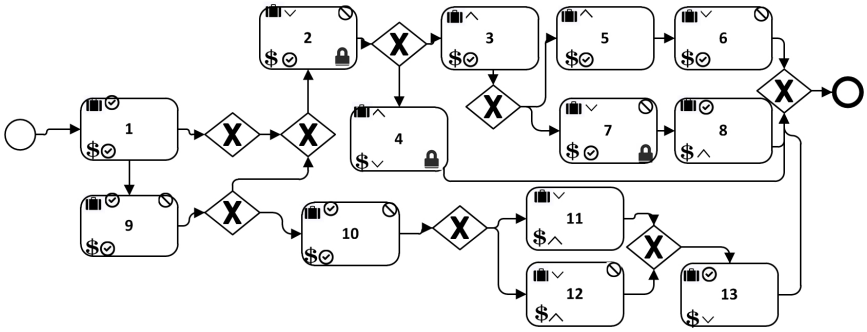

Figure 3: The business process used for the evaluation of the proposed GA.

function.
Fitness(X)=

$$\begin{cases} F' * 0,5 + 0,5 & \text{if} \quad v(X) = 0 \\ F' * 0,5 - (0,1 * v(X)/v_{max}) & \text{otherwise} \end{cases} \tag{4}$$

F' is the objective function presented in section 4, v(X) presents the total number of activities composing an individual requiring security, and v_{max} stands for the total number of activities requiring security in the entire business process. The presented fitness guaranties that infeasible solutions have always less fitness values compared to feasible ones.

5 EXPERIMENT AND RESULT

We applied the penalty based genetic algorithm using Java as a development language. Simulations were conducted on a laptop computer with 2.5 GHz Intel Core i7 CPU and 4GB RAM.

The business process illustrated in figure 3 presents an example of a case study that we analyzed.

As shown, the business process is composed of 13 activities. The suitable activities appropriate for outsourcing is unknown rendering the research space huge despite that experts define the preferred number of activities to be outsourced. Preferred number of activities to be outsourced in this example is 4 (the number of activities presenting defaulting behavior when executed as services and not requiring security constraints). As shown, three activities require high level of security which are: 2, 4, and 7. Individuals encompassing one or more of these three activities are penalized but they still present solutions of our problem. The evaluation of our penalty based GA is twofold: we evaluated firstly the performance of our genetic algorithm and then we verified the pertinence of the results. A comparison between our algorithm and a greedy algorithm was also elaborated in terms of performance and the pertinence of results.

5.1 Experiment A

Table 2 presents parameters values we used to experiment our algorithm. We evaluate the validity of our penalty based genetic algorithm by comparing its time cost in different computing scale.

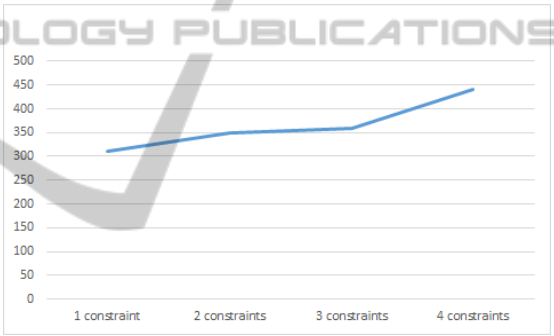

Figure 4: The execution time consumed when increasing the number of constraints.

We begin by observing the execution time consumed by our algorithm when increasing the number of constraints. Figure 4 shows that the number of constraints influences the execution time of the algorithm which can be explained by the additional number of treatment to be done.

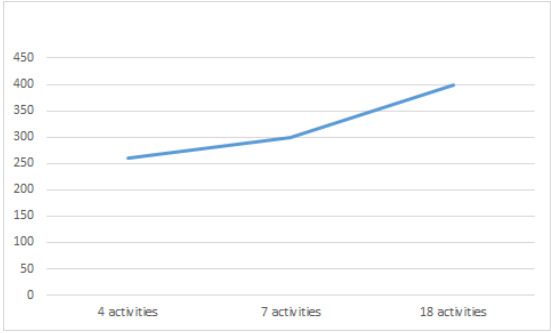

Figure 5: The execution time consumed when increasing the number of activities.

The number of activities composing a business process increases the time of execution as shown in figure 5.

Table 2: Parameters used for our penalty based genetic algorithm.

Parameters	Description
Population size	50
Selection technique	Tournament selection
Termination condition	Number of generation=100
Crossover probability	0.5
Mutation probability	0.015

We compared our genetic algorithm with another optimization algorithm namely the greedy algorithm (Kodaganallur and Sen, 2010). Greedy algorithms are known by their ability to find quickly solutions. Generally, generated solutions are approximate, and optimal ones are founded in few cases. The comparison was done by testing the execution time of both algorithms when applied to different number of business processes. As shown in figure 6, the GA consumed a bit more time to generate results compared to greedy algorithms.

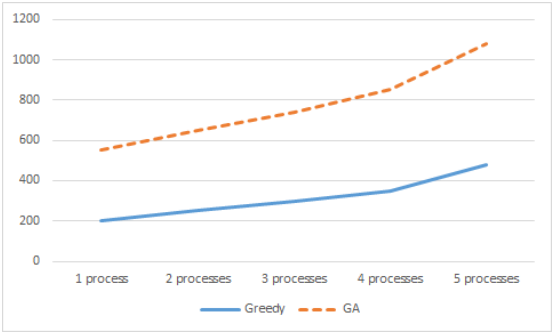

Figure 6: Comparison between the execution time consumed corresponding to both algorithms.

5.2 Experiment B

To evaluate the pertinence of our algorithm, we interviewed 5 business experts having knowledge on business processes. We first asked experts to rank the outsourcing concerns according to their preferences, the results of this interview are shown in table 3.

According to the experts preferences, we attributes to the weights explained in section 4.1, the following values: W1=0.4 for (BC), W2=0.25 for (DS), W3=0.25 for (C) and W4=0.1 for (L).

The extended BPMN illustrated in figure 3 is presented to the same experts to depict, according to them, the most appropriate activities to be outsourced.

Table 3: Ranks of outsourcing concerns according to experts.

Rank	Outsourcing Concern (OC)	% experts how select the corresponding OC
1	BC	100%
2	DS & C	60%
3	L	100%

Among the thirteen activities, four experts chose the activities 12 and 6 and one expert select in addition to these activities, the activity 11. When we applied the GA, the individual having the best quality according to its fitness is composed of two activities: {6,12} where fitness=0.8437. The greedy algorithm generated an individual composed of 3 activities {12,9,1}. Table 4 presents the precision and recall of our penalty-based genetic algorithm and the same values corresponding to greedy algorithm.

Table 4: Evaluation of our GA.

precision of GA	recall of GA	precision of greedy	recall of greedy
100%	66%	33%	33%

As shown in above table, the GA has a high value of recall and precision which make it a relevant and pertinent way to assist experts in the decision of business process outsourcing. Moreover, despite that the greedy algorithm take less time to generate results, our GA generate better results if we refer to the comparison of the recall and precision of the two algorithms. According to experiments, we can affirm that the proposed genetic algorithm is a pertinent way to decide about the business process activities to be outsourced. However, in term of performance and more specifically the response time, the genetic algorithm may not be the most suitable one.

In the context of our research, when applying the GA on the business process, the BPMN should be redesigned so that, activities selected to be outsourced are putted within a pool element designed to be entirely in the cloud as presented in figure 7.

6 CONCLUSIONS

This paper presents a method to assist experts in the fastidious task of BPO to the cloud decision. The method offers a modeling language, OutyBPMN, an extension of the BPMN to take into consideration the outsourcing criteria. In addition it uses a penalty based genetic algorithm to identify most appropriate

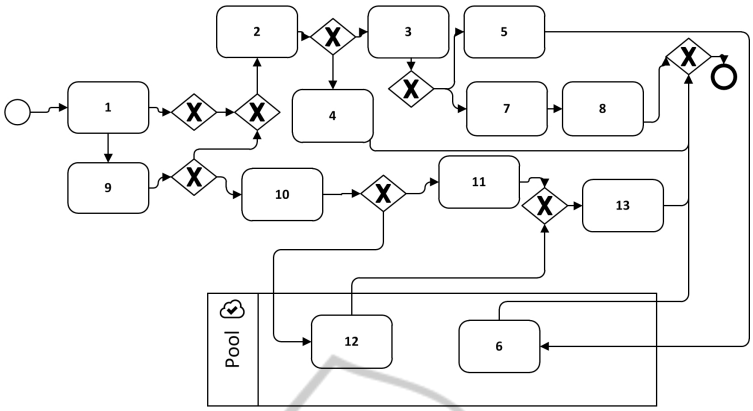

Figure 7: BPMN with deployment location data.

activities of a business process to be outsourced. In the herein presented work, activity appropriateness is determined based on its business criticality, cost, its quality when executed and constrained by security level of handled data. Based on our preliminary experimental results, the proposed penalty based genetic algorithm generates satisfactory results. Indeed, the evaluation of the method presents its accuracy and the similarity with experts preferences. We are elaborating a deployment model for the execution of the business process when part of it is located in the cloud. Moreover, we are working on defining a decision model to weight the importance of outsourcing the selected pool against keeping it in premise. Additional experimental evaluations are needed to adjust the fitness function and its related parameters to thoroughly examine the performance of the proposed algorithm.

REFERENCES

Adesta, E. and Agusman, D. (2004). The evolution of supply-chain management into extended enterprise. In *Engineering Management Conference, 2004. Proceedings. 2004 IEEE International*, volume 3, pages 1298–1302 Vol.3.

Bocciarelli, P. and D'Ambrogio, A. (2011). A bpmn extension for modeling non functional properties of business processes. In *Proceedings of the 2011 Symposium on Theory of Modeling & Simulation: DEVS Integrative M&S Symposium*, TMS-DEVS '11, pages 160–168, San Diego, CA, USA. Society for Computer Simulation International.

Deb, K. and Kalyanmoy, D. (2001). *Multi-Objective Optimization Using Evolutionary Algorithms*. John Wiley & Sons, Inc., New York, NY, USA.

Eriksson, H.-E. and Penker, M. (1998). *Business Modeling With UML: Business Patterns at Work*. John Wiley & Sons, Inc., New York, NY, USA, 1st edition.

Gewald, H. and Dibbern, J. (2009). Risks and benefits of business process outsourcing: A study of transaction services in the german banking industry. *Inf. Manage.*, 46(4):249–257.

Gewald, H. and Rouse, A. (2012). Comparing business process and it outsourcing risks–an exploratory study in germany and australasia. In *System Science (HICSS), 2012 45th Hawaii International Conference on*, pages 275–284.

Hu, Y.-B., Wang, Y.-P., and Guo, F.-Y. (2005). A new penalty based genetic algorithm for constrained optimization problems. In *Machine Learning and Cybernetics, 2005. Proceedings of 2005 International Conference on*, volume 5, pages 3025–3029 Vol. 5.

ISO 10303-203:1994 (1994). Information technology – object management group business process model and notation.

Kodaganallur, V. and Sen, A. (2010). Greedy by chance - stochastic greedy algorithms. In *Autonomic and Autonomous Systems (ICAS), 2010 Sixth International Conference on*, pages 182–187.

Li, H. and Meissner, J. (2009). Improving quality in business process outsourcing through technology. Working Papers MRG/0009, Department of Management Science, Lancaster University.

Mell, P. M. and Grance, T. (2011). Sp 800-145. the nist definition of cloud computing. Technical report, Gaithersburg, MD, United States.

(OMG), O. M. G. (2011). Business process model and notation (bpmn) version 2.0. Technical report.

Pathak, R. and Joshi, S. (2009). Secured communication for business process outsourcing using optimized arithmetic cryptography protocol based on virtual parties. In Ranka, S., Aluru, S., Buyya, R., Chung, Y.-C., Dua, S., Grama, A., Gupta, S. K. S., Kumar, R., and Phoha, V. V., editors, *IC3*, volume 40 of *Communications in Computer and Information Science*, pages 205–215. Springer.

Rodríguez, A., Fernández-Medina, E., and Piattini, M. (2007). A bpmn extension for the modeling of security requirements in business processes. *IEICE - Trans. Inf. Syst.*, E90-D(4):745–752.

Rouse, A. C. and Corbitt, B. J. (2004). It-supported business

process outsourcing (bpo): The good, the bad and the ugly. In *PACIS*, page 126. AISeL.

Saeedi, K., Zhao, L., and Sampaio, P. (2010). Extending bpmn for supporting customer-facing service quality requirements. In *Web Services (ICWS), 2010 IEEE International Conference on*, pages 616–623.

Soiva, J. (2007). *business process outsourcing case study:How to develp Deloitte S2Gs shared service activities in the Bercelona costumer response centre*. PhD thesis, , Lahti university of applied sciences.

Theo Lynn, N. O. C., John Mooney, M. H., David Corcoran, G. H., Lisa Van Der Werff, J. P. M., and Healy, P. (2014). Towards a Framework for Defining and Categorising Business Process-As-A-Service (BPaaS). In *21st International Product Development Management Conference*. Citations: Not Avail. ().

Yang, D.-H., Kim, S., Nam, C., and Min, J.-W. (2007). Developing a decision model for business process outsourcing. *Computers and Operations Research*, 34(12):3769 – 3778. Operations Research and Outsourcing.