Path simulation in BPMN workflow using resource aggregation

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Abstract
Workflow solution aims to give an enterprise the possibility to master its activities to save time, money and to increase the quality of service. To do so, simulation attempts to bridge the gap between process specifications and process implementation. Nevertheless, a number of studies concentrated in analyzing flow of control and data while less focus was paid to the resources used. In this paper we propose a visualization approach of simulation results by displaying the performance outputs of each path the simulation gone through. Also, we introduce an approach of resource performance aggregation since a task could be executed by several resources.

Keywords 1
BPMN, Resource, Path, Simulation

1. Introduction

Many researchers suggested new methodologies for process design and automation. Among these methodologies, we can find Model Driven Service Engineering Architecture (MDSEA). MDSEA categorized the resources of a system into three types (IT, Physical Mean and Human). It also emphasizes the importance of distinguishing the type of resources at the first step of design phase [1]. A model, primarily provides a static representation of a process, however simulation allows the experimentation of its behavior which make easier the identification of fragile areas [2]. In process automation methodologies, a number of studies concentrated in analyzing flow of control and data while less focus was paid to the resources used [3]. In our previous work we introduced a MDSEA framed approach to take into consideration the resource analysis. We have also improved and extend a previous simulation work eBPMN [4] by distinguishing resources type: IT, human and physical means during design phase (modelling and simulation) [5]. In this paper, we introduce another extension of eBPMN to display the performance outputs of each path the simulation gone through. In addition to that, we propose an approach of resource performance aggregation since a task could be executed by several resources. Our proposal may be applied to different fields, such as Cyber-Physical System (CPS). CPS is a mechanism that brings together the physical world with the virtual world. Therefore, it uses the three resource's type (IT, Physical Mean and Human). We assume that the techniques we propose will increase the ease of discovering the performance issues between the behavior phase (Cyber part) and both the monitoring and actuating phase (physical part).

2. Contribution

Proccedings of the Workshops of I-ESA 2020, 17-11-2020, Tarbes, France
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2.1. Aggregation of resource performance

Multiple resources can perform a task, hence the performance of a task is linked to the performance of the assigned resources. As a result, the performance aggregation of the resources assigned to a task represents its performance.

The resource aggregation consists of determining how some resources operate together as single organized, cohesive entity. Therefore, the performance measurement of the aggregate resource consists of correctly integrating all the measurements associated with the allocated resources of each task. The structure of the resources carrying out a task could be arranged in many ways. We select three ways in this work: Sequential: All tasks are carried out consecutively; Or: Just one of the tasks is performed; And: Both tasks are performed in parallel.

After the example of process reduction method, we have opted to use the algorithm of the stochastic workflow reduction (SWR) [6]. SWR makes possible to calculate the overall workflow's efficiency by applying iteratively a set of reduction rules to the process, until only one task is left. For typologies of aggregation we use the decomposition technique proposed by the [7]. First of all, in this work we propose to decompose a task into an organized atomic sub-tasks. That implies each atomic sub-task is performed by only one resource (Figure 1). Then, the performance aggregation is applied according to the configuration defined in [7] and [6] following the decomposition. In this work the decomposition is carried out by the business analyst using the attribute "composition = seq/and/or".

Figure 1: Task decomposition to atomic task

2.2. Process path measurement

This work aims to outline the process path performance measurement selected by the user. To choose a path we propose two options: 1) Assigning probabilities to each path as eBPMN already allow it. 2) Specifying the user's response clearly. For example, within a process two paths are possible: path A if the user approves the task or path B if the user rejects the task. The path to analyze could be selected by using the first option by giving an execution probability to each path; A: 20% and B: 80% or by mentioning the user's response "approve/refuse".

Thus the stakeholders and the business analyst could focus on seeking solutions for the most likely process cases than can be performed (removing unnecessary tasks, enhancing resources…).

eBPMN languages uses the token for BPMN model simulation. The token show the behavior of each BPMN element. It goes through the sequence flow from the beginning of a process to its end. Therefore, a token may be considered as a process case, thereby we utilize the token to display the path it went through during simulation phase.

To implement this feature, we use the eBPMN objects matching the original BPMN metamodel to show the different paths the token went through, and we use the eBPMN objects derived from PyBPMN [8] metamodel to show the performance measurement of each path after the simulation.

We also implement the choice feature so the business analyst could select the path to analyze using path probabilities technique or mentioning the response of the user by using the attribute userchoice = "choice".

2.3. Use case

In order to illustrate the techniques presented below, we use a sub-workflow of one of our IT partner clients.

The client "Market" wants to automate its process of assessing quality documents. The assessment is based on qualitative parameters. The user produces the quality document, then fills a form with some informations to better help the approvers in their assessment. Then the form and the document are sent to the approval circuit.

In order to perform the simulation, the first thing the business analyst does is to define the functional specifications using BPMN language, by defining tasks and their sequence flow.

In addition, to add the non-functional specifications, he uses text annotation following PyBPMN syntax in the same model. Therefore, he links to each resource's type its non-functional properties. Then he assigns to each task its resources (Figure 2). (In this use case we will only provide the results of the service time).

Figure 2: Resources definition and annotated task

Table 1
Execution times for each resource

Activity/ Event	Processing time/waiting time	Resource
Fill template file	95 min	Evaluator
Fill request	30 min	Evaluator
	30 min	Technology A
Save data	5 min	Technology A
Request validation	0.5 day	Methods Manager
	60 min	Technology A
Give opinion	0.5 day	Stores manager
	60 min	Technology A
Request validation	1 day	Quality Manager
	120 min	Technology A

The execution code is automatically generated thanks to the Model to Model transformation and Model to Text transformation. The business analyst could select one of the options below to launch the simulation:

1) Getting detailed results: showing the service time of each task and each single resource
2) Getting global results of each resource's type: showing the service time of each path the simulation gone through and the service time of each type of resource (IT, Physical means and Human)
3) Getting global results by resource aggregation: service time of each path the simulation gone through by utilizing the resource aggregation technique described above

Our enhancement was to add the option 1 and 2 to eBPMN tool, thus we illustrate only the below results: Global results showing the execution time of each resource type (Figure 4). Global results by resource aggregation technique (Figure 3). The business analyst might analyze alternative configurations after the results of the simulation, repeating the same steps until getting the configuration and scenario that fulfil the target requirements. As shown in Figure 4, displaying the results of each resource's type helps to gain further viewpoints on the involvement of the resources within a process case. And that increase the ease making decision (Assign the right to a task…).

In this example the structure of resource arrangement is the parallel structure. As stated in the references [6] and [7], the service time aggregation of two tasks in a parallel structure is the maximum value between the two of them. By using the resource aggregation technique as described above, we note that the finalization of the evaluation took 3.5 days (Figure 3) instead of 5.2 days (Figure 4). And

that demonstrates the importance to take into account the arrangement of the resources that performed à task, which provides a more accurate and finer measurement results and it also avoids making needless modifications.

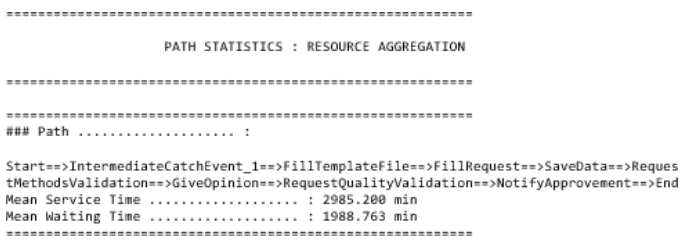

Figure 3: Global Results using Resource Aggregation

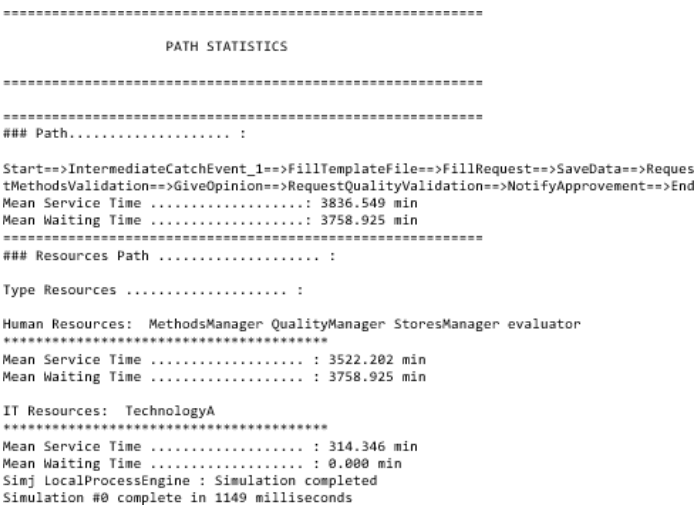

Figure 4: Global results including the type of each resource

3. Conclusion

An enhancement of process design and simulation in eBPM was described in this paper. It first proposes to take into account the different resource's type involved in CPS (IT, Human and Physical Means). As well, it is showing each path the simulation gone through and its outputs which eases the comparison of various scenarios. We also propose two new options for selecting the path to analyze. Thus, instead of using only full path probabilities, the business analyst could now select the path to investigate according to the preferably usage or field knowledge. Furthermore, to compute and show a global path measurement, we propose to combine the performance aggregation SWR and task decomposition techniques to aggregate resource's performance. Regarding the previous work, now we have a more detailed overview of the performance measurement of each type of resource: IT, physical means and human. In addition to that, considering the arrangement of the resource's assigned to a task helps to bring better results and take more precise decision.

4. Acknowledgements

We would like to thank Andrea D'Ambrogio from Tor Vergata University Roam Italy for providing the eBPMN tool and his team for helping us to set up it. We also would like to thank our IT partner Exakis Nelite for providing process automation cases of their client and helping us investigate them.

5. References

[1] Ducq Y., An Architecture for Service Modelling in Servitization Context: MDSEA, Enterprise Interoperability, 2014.
[2] Zacharewicz G., Pirayesh-Neghab A., Seregni M., Ducq Y., Doumeingts G., Simulation-Based Enterprise Management, Guide to Simulation-Based Disciplines, 2017.
[3] D'Ambrogio A. and Zacharewicz G. 2016. Resource-based modeling and simulation of business processes. In Proceedings of the Summer Computer Simulation Conference (SCSC '16). SCS, Montreal, Article 63, 1–8.
[4] Bocciarelli P., D'Ambrogio A., Giglio A., Paglia E., A BPMN Extension to Enable the Explicit Modeling of Task Resources, INCOSE Italia Conference on Systems Engineering, CIISE 2016, Turin, Italy, 2016.
[5] Ougaabal K., Zacharewicz G., Ducq Y., Tazi S., Distinguishing Resource Type in BPMN Workflows at Simulation Phase, Spring Sim Multi – Conference, Tucson, Usa, 2019.
[6] Cardoso J., Sheth A., Miller J., Arnold J., Kochut K., Quality of service for workflows and web service processes, Journal of Web Semantics, 2004.
[7] Ducq Y., Vallespir B., Definition and aggregation of a Performance Measurement System in three Aeronautical workshops using ECOGRAI Method, Production Planning and Control 16, 2005.
[8] Bocciarelli, P. D'Ambrogio, A., A BPMN Extension for Modeling Non Functional Properties of Business Processes, SpringSim '11, Boston, MA, USA, 2011.