A BPMN-BASED APPROACH TO SUPPORT SMALLHOLDERS' BUSINESS MODEL SIMULATION

Sihem Mallek-Daclin[a] , Mariane El-Kassis, Nicolas Daclin and Gregory Zacharewicz

[a] Laboratory of the Science of Risks, IMT Mines-Alès, 30100, Alès, France
sihem.daclin-mallek@mines-ales.fr

ABSTRACT

Smallholders are facing challenges and are looking for ways to improve their business model. We propose an approach to transform a business model into BPMN (Business Process Model and Notation) to enable its simulation and provide KPIs (Key Performance Indicators) of resource, time, and cost types. BPMN model is a graphical business process representation , easy to understand and analyze. Then, simulation of the BPMN model can provide valuable insights into the performance of the business process and identify potential bottlenecks. Finally, the KPIs can be used to measure the efficiency of the business process. This approach can support farmers to understand their current business model better, identify potential improvements, simulate different scenarios and make informed decisions about how to improve their business and optimize the use of resources, time, and costs. The proposed approach can be a valuable tool for small farms to improve their business model and increase their competitiveness.

Keywords: Business Model, business process modelling, BPMN standard, simulation, small farmers.

1 INTRODUCTION

The COVID-19 pandemic, as well as other similar crises over the years, have highlighted the need for more resilient food systems that can effectively and efficiently cope with supply chain disruptions [1]. For instance, during the COVID-19 pandemic, many governments took drastic measures to limit the spread of infection, resulting in the closure of key smallholder distribution channels, such as bars, restaurants, school canteens and open-air markets [2]. As a result, food waste increased significantly due to delays in harvesting activities and perishable goods remaining in produce warehouses, resulting from various distribution restrictions.

In this context, the proposed research work is part of Smallders[1] project which overall objective is to conduct fundamental research as well as industrial research and development activities with the aim of identifying a framework that encompasses innovative strategies, methodologies, technologies and business models to increase the resilience of smallholders in the Mediterranean region, to effectively and efficiently cope with unexpected and disruptive events such as the COVID-19 pandemic. For this purpose, the research work presented in this paper is linked to the needs of smallholders to improve their Business Model. It is therefore proposed to use the BPMN (Business Process Model and Notation) language as a pivotal language between a Business Model and a simulation model [3]. This will provide a clearer vision of the evolution

[1] https://smallders.com

Proc. of the 2024 Annual Simulation Conference (ANNSIM'24), May 20-23, 2024, American University, DC, USA
S. Mallek-Daclin, M. El-Kassis, N. Daclin and G. Zacharewicz.

of the business model by offering a simulation result with performance indicators (cost, time and resource) [4].

In this case, the objective of this proposed research work is related to the proposition of a methodology based on BPMN model to improve the business model of smallholders. The paper is structured as follows. After this brief introduction, Section 2 describes a state of the art about BPMN and Simulation. Section 3 introduces the proposed approach to improve Business Model using BPMN and simulation approach. Then, to illustrate the proposed method, a simple example with a case study is developed in section 4. Section 5 presents discussion related to the limits of this research work. Finally, section 6 presents a conclusion and some perspectives for this research work.

2 STATE OF THE ART: BPMN AND SIMULATION

BPMN has emerged as an indispensable standard within the domain of business process management. Offering a graphical notation that simplifies the communication of complex business processes, it effectively bridges the comprehension gap among various stakeholders. Furthermore, the introduction of BPMN model simulation marks a considerable advancement in the analysis and optimization of business processes. This enables stakeholders to simulate BPMN models within dynamic environments, assessing the potential impacts of hypothetical changes without their actual implementation. Such predictive capability is crucial for identifying process bottlenecks and opportunities for improvement, thus enhancing strategic decision-making [7].

There exist currently Business Process Management tools with simulation capabilities. These tools are generally grouped into categories [8]: Stand-alone business process simulation tools (e.g., Bimp), general-purpose simulation tools (e.g., Arena, AnyLogic) and modeling tools that facilitate simulation (e.g., ADONIS, ARIS Toolset, Bizagi Modeler, L-SIM, Simul8). A significant limitation of current simulation tools is their lack of transparency, making it difficult to understand how simulation results are derived. Our methodology leverages the Discrete Event System Specification (DEVS) formalism to overcome this limitation, providing a clear, modular framework that enhances transparency and allows for detailed model analysis and construction [9].

Numerous scholars have engaged in the simulation of BPMN models, with a significant emphasis placed on conceptual modeling. This approach is instrumental in distilling the complexities of business processes into more manageable forms, a fundamental step necessary for conducting effective simulation analysis. Discrete Event Simulation presents a significant potential in the field of BPMN simulation, yet it also presents challenges. This integration aims to enhance the analytical capabilities applied to business processes, revealing insights into system dynamics and optimization opportunities. DEVS serves as a general-purpose framework that supports hierarchical and modular discrete event modeling and simulation. This structured formalism improves the simulation process, allowing for detailed construction and analysis of models [9].

The use of DEVS for simulating BPMN models is a significant area of research. Initial efforts to map BPMN concepts to DEVS were outlined in [10], with subsequent expansions in [11] and [12] to include a broader range of BPMN task categories and explore the integration of resource allocation and failure mechanisms in [13]. Despite these advancements, the mapping has covered only a limited selection of BPMN concepts, leaving out several key components like message flows, interrupting events, and intermediate events. Related works [3] and [4] have advanced the transformation of BPMN into DEVS, emphasizing a modular and incremental approach to address existing research gaps. Their focus on modeling the interaction between BPMN models and simulation parameters, aimed at enhancing simulation accuracy, serves as the foundation for the transformation methodology applied to BPMN simulation models in this study, effectively bridging the gap between modeling and simulation practices.

3 PROPOSED METHODOLOGY

This research work is developed at the crossroads of Business Model, Business Process and Simulation. A business model is a framework highlighting how a company creates, delivers, and captures value. It describes the company's core products or services, its target market, marketing and sales strategy, and its cost structure [14]. In the Smallders context, the best business model for a smallholder will depend on several factors, including the farmer's products, its target market, and its competitive landscape. A well-defined business model is essential for the success of any smallholder [15]. It provides a roadmap for how the company will create, deliver, and capture value. It also helps the company to make strategic decisions about its products, its target market, and its marketing and sales strategy [16]. In this way, the simulation of a business model becomes a major issue for smallholders. However, the use of simulation on these models, requires to generate first a process model in BPMN. Indeed, BPMN language allows to have a process vision of what smallholders will have to do and achieve in order to improve their business model and enable the transition to a simulation model [4].

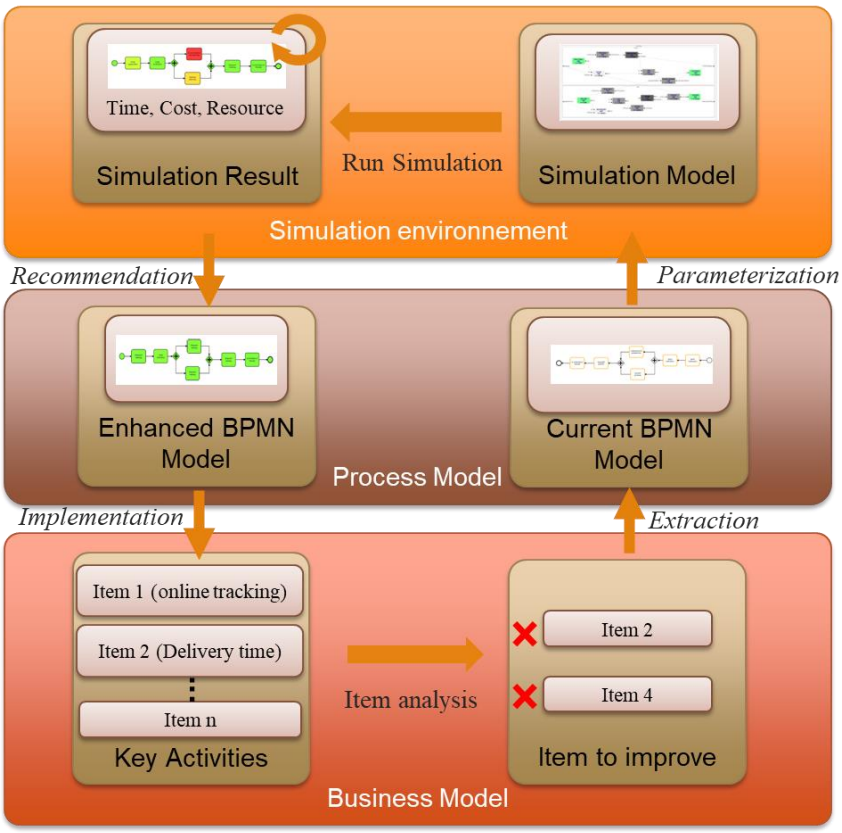

Figure 1: Methodology proposed to improve business model smallholders.

In this way, Figure 1 shows the proposed methodology. The objective is to improve the business model by providing information to the farmer on the cost, time and resources necessary to enable this improvement. In a business model several items must be considered such as key resources, key activities or even customer relations [17]. After an initial diagnosis (item to evaluate in Figure 1) of the business model and its items [18], some items will be highlighted for possible improvement (e.g. online tracking – item 2 in Figure 1). Indeed, it is possible that some items are not yet considered or very little developed in the current structure of the business model. In this case, a business process will therefore be proposed with BPMN language to develop or improve this item (e.g. process and activities based on good practices to improve online tracking). A second diagnosis is realized using simulation environment offering recommendations with KPI's results (resource, time, cost). To enable this simulation, the BPMN business model is transformed into a

DEVS simulation model using the techniques described in [3] and [4]. This simulation will give KPIs in terms of resources that have to be used, the expected time and cost to achieve the objective and complete the missing item. Finally, if the model is approved, it will be implemented and added to the initial business model. In order to show the use of this methodology, an application case is presented in the following section.

4 APPLICATION CASE STUDY

A small farm business model can have several items related to customers, key activities and resources. In the case of key activities, several items are defined such as: delivery in a minimum time, optimized transport cost, online tracking… In the case of the delivery item, 6 tasks are set to achieve the goal of delivering products in minimum time: (1) order preparation, (2) order verification, (3) documentation and labelling, (4) delivery planning, (5) shipment tracking and (6) confirmation of receipt. These tasks can be shown in the business process in Figure 2.

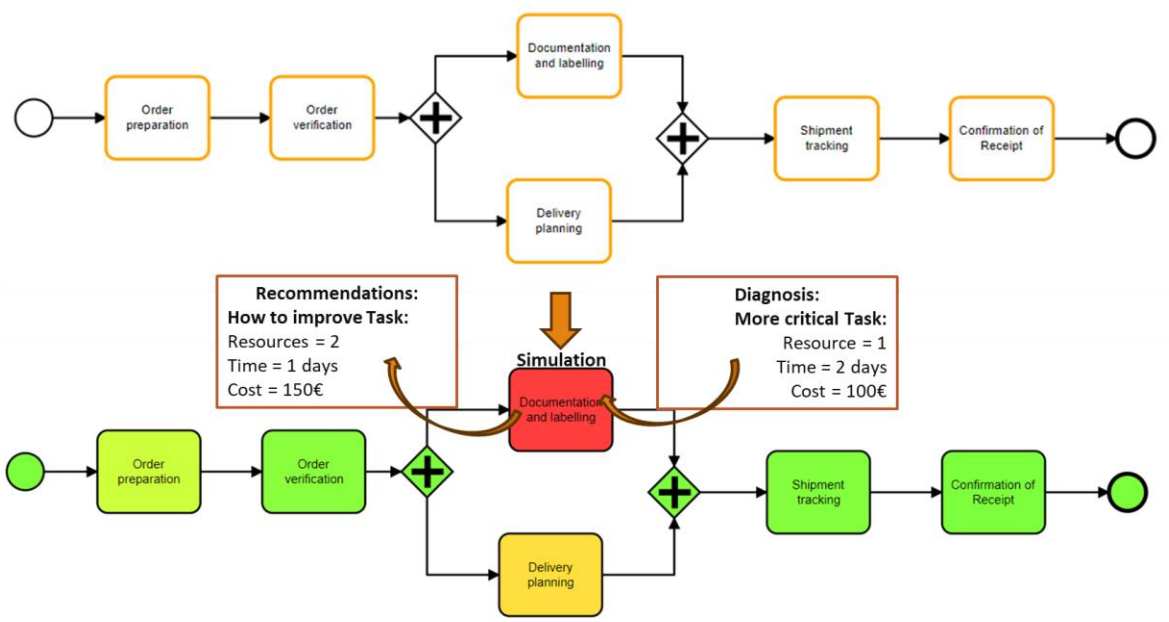

Figure 2: Diagnosis and recommendations for a delivery kay activity.

The simulation parameters (resources, allocation, time, cost…) for each activity are entered in the simulation tool used in the Smallders project. The aim of the simulation will be to provide indications on the KPI's of each task involved in the process in terms of cost, time and resources. After an initial run, the simulation shows the task "Documentation and labelling" in red and taking the longest to execute. In fact, this task requires a resource with a cost of €100 for two days of work. To reduce the execution time of this task, the simulation suggests adding a resource with a total cost of €150 but a flagrant reduction of one day. With these results, the farmer can improve his deliveries by adding a resource with a moderately high cost or to keep his current structure and take the risk of not being competitive with the market over the duration of his deliveries.

5 DISCUSSION AND FUTURE WORKS

The presented research work aims to develop a methodology helping smallholders to improve their business model. The objective is to offer a vision of the desired business model with the KPI's related to resources, cost and time necessary to achieve it in a simulation environment. However, these results, even if they are

very close to reality, remain theoretical and not representative of a real situation if a disruption/deviation or even a Covid 19 type crisis were to disrupt the current business model. It would therefore be interesting to integrate a digital twin approach [19] which would respond in real time to these deviations and disruptions [20].

It is possible to propose recommendations model to improve the business model in real time, but the question that arises is: what is the impact of possible modification done in a process onto others processes? What to be done if the impact decrease the performance of the whole process?

In this way, the future objective of this research work is to propose a digital twin solution that can be able to follow the process in real-time and adjust the model as it evolves. This last step is still under development and represents a question of this research work.

6 CONCLUSION

This research work focuses on the proposition and the presentation of a BPMN-based methodology using simulation to improve business models for smallholders. Indeed, the objective is to define business model for each item to evaluate and improve. In order to enable this improvement, it was proposed, in this paper, to provide a vision of the necessary resources, costs and times it takes to achieve this item.

This simulation-based approach allows smallholders to predict their costs and resources as quickly as possible. In order to enable this simulation, it was proposed to use a pivotal language, the BPMN language, which also offers a graphical view of the processes implemented by the smallholders.

Future works are related to the proposition of a digital twin to follow the process in real-time monitoring and respond to possible deviations.

ACKNOWLEDGMENTS

This research is part of the Smallders project. We thank our colleagues participating in this project who provided insight and expertise that greatly assisted the research.

REFERENCES

[1] Mohd Suib N.A.B., Salleh N.H.M., Ahmad M.F. (2023): The economic well-being of smallholders and challenges during COVID-19 pandemic: A review. Agric. Econ. – Czech., 69: 35–44.

[2] Dennis P. Poppi, Kusmartono Kusmartono, Kasmyati Kasmyati, Simon P. Quigley and Karen J. Harper. Feeding strategies for improving ruminant productivity in the post-COVID 19 pandemic era particularly for small holders. Journal Ilmu-Ilmu Peternakan 31(1): 84-94. ISSN: 0852-3681 E-ISSN: 2443-0765. Available online at http://jiip.ub.ac.id DOI: 10.21776/ub.jiip.2021.031.01.11 84

[3]M. El Kassis, F. Trousset, G. Zacharewicz, N. Daclin, Incremental transformation of bpsim-enriched bpmn models into devs, in: 2023 Winter Simulation Conference (WSC), IEEE, 2023, pp. 2542–2553.

[4] M. El Kassis, F. Trousset, G. Zacharewicz, N. Daclin, Bridging the gap between business process and simulation: transformation from bpmn to devs, IFAC-PapersOnLine 56 (2) (2023) 11888–11893.

[5] BPMN, Business Process Modeling Notation, V2.0. http://www.bpmn.org/, 2022

[6] Chinosi, M. and Trombetta, A. (2012) BPMN: An Introduction to the Standard. Computer Standards & Interfaces, 34, 124-134.

[7]M. A.-u.-r. Pasha and S. Pasha, "Bloom's Taxonomy for Standardizing BPM Education," J. Comput. Appl., pp. 6–13, 2013.

[8]L. Pufahl, et al., Design of an Extensible BPMN Process Simulator, in Bus. Process Manag. Workshops, 2018, pp. 782–795.

[9] B. P. Zeigler, et al., Theory of Modeling and Simulation, Elsevier, Academic Press, 2nd ed., 2011.

[10]D. Cetinkaya, et al., MDD4MS: A model driven development framework, in Proc. 2011 Summer Comput. Simul. Conf., 2011, pp. 113–121.

[11]H. Bazoun, et al., "Business Process Simulation: Transformation of BPMN 2.0 to DEVS Models," in SCS/ACM/IEEE Symposium on Theory of Modeling and Simulation part of SpringSim 2014, Tampa, United States, 2014. [Online]. Available: https://hal.archives-ouvertes.fr/hal-00990758.

[12]S. Boukelkoul and R. Maamri, Optimal model transformation of BPMN to DEVS, in AICCSA, 2015, pp. 1–8.

[13]A. D'Ambrogio and G. Zacharewicz, Resource-based modeling and simulation of business processes, in SCSC '16, Montreal, Canada, 2016.

[14] Massa, Lorenzo, and Christopher L. Tucci. "Business model innovation." *The Oxford handbook of innovation management* 20.18 (2013): 420-441.

[15] VERMEULEN, Sonja et COTULA, Lorenzo. Making the most of agricultural investment: A survey of business models that provide opportunities for smallholders. Iied, 2010.

[16] Longo, Francesco, et al. "An overview of approaches and methodologies for supporting smallholders: ICT tools, blockchain, business models, sustainability indicators, simulation models." *Procedia Computer Science* 217 (2023): 1930-1939.

[17] Sparviero, Sergio. "The case for a socially oriented business model canvas: The social enterprise model canvas." Journal of social entrepreneurship 10.2 (2019): 232-251.

[18] Miranda, F. Javier, et al. "A systematic review of the literature on agri-food business models: critical review and research agenda." British Food Journal 125.12 (2023): 4498-4517.

[19] Camara Dit Pinto, S., Villeneuve, É., Masson, D., Boy, G. A., Barron, T., & Urfels, L. (2021). Digital twin design requirements in downgraded situations management. IFAC-PapersOnLine, 54 (1), pp 869-873.

[20] Sihem Mallek Daclin, Nicolas Daclin, Souad Rabah, Grégory Zacharewicz. Product Development Plan Monitoring: Towards a Business Process Digital Twin (I). IFAC 2023 - The 22nd World Congress of the International Federation of Automatic Control, Jul 2023, Yokohama, Japan.

AUTHOR BIOGRAPHIES

SIHEM MALLEK-DACLIN is a Research Engineer in the Laboratory of the Science of Risks at the Engineer School Ecole des Mines d'Alès where she received her PhD. Her research interests include modeling, simulation and verification of Business Processes. Her email address is sihem.daclin-mallek@mines-ales.fr.

MARIANE EL-KASSIS is a Ph.D. candidate at IMT Mines Alès, France, specializing in business process simulation and distributed simulations. She is currently focused on creating a web-based platform for M&S of business processes. Her email address is mariane.el-kassis@mines-ales.fr.

NICOLAS DACLIN is an Associate Professor at IMT Mines Alès, His research interests focuses on process-centric ecosystems for process management, orchestration, and M&S. He received his Ph.D. from the University of Bordeaux in 2007 and his Habilitation to lead Research from the University of Montpellier II in 2017. His email address is nicolas.daclin@mines-ales.fr.

GREGORY ZACHAREWICS is a Full Professor at IMT Mines Alès. He received his Ph.D. from Aix-Marseille University in 2006, and his Habilitation to lead Research from the University of Bordeaux in 2014. His research focuses more generally on distributed DES M&S, DEVS, ERP, BPMN and workflow. His email address is gregory.zacharewicz@mines-ales.fr.