Integration of BPMN Modeling and Multi-actor AHP-aided Evaluation to Improve Port Rail Operations

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Abstract

Selecting the best scenario of intervention to improve the functioning of complex systems represents a troublesome task both for public and private decision makers, since it requires the deployment of appropriate analysis and evaluation tools. In the case of intermodal transport systems, complexity is given by the execution of different types of activities using various resources, and by the presence of several actors operating in the same environment with diverse goals. In this paper, an integrated approach to assess design alternatives regarding rail port operations is proposed by combining business process modeling and multi-actor multi-criteria evaluation. As a matter of fact, railway processes have been graphically represented by means of the standardized modeling language called Business Process Modeling and Notation (BPMN) at different levels of detail, i.e. taking into account not only the actual transport operations but also the necessary documentary procedures to perform the freight transfer services. In addition to the identification of possible bottlenecks, the analysis of the considered railway processes has enabled the determination of their most significant features. These parameters have been subsequently used as some of the criteria according to which the performances of the examined scenarios of intervention have been evaluated, adopting the Analytic Hierarchy Process (AHP) technique. Furthermore, the appraisal has been enhanced by explicitly including the key stakeholders involved in the railway processes at hand. The developed methodology has been applied to the case study of the Port of Trieste, Italy, in order to investigate possibilities for an increase in railway capacity.

Keywords: Intermodal transport systems; rail port operations; BPMN modeling; AHP evaluation.

1. Introduction

Problem solving related to business processes in complex contexts generally requires the adoption of an approach combining specific analysis and evaluation tools, that are able to support decision makers in selecting the best course of action. In this regard, it is common practice to first examine business processes by means of a modeling language, since it permits to visualize them and thus facilitate the comprehension of their elements. Then, based on evidences from literature as reported by Yen (2009), the performances of business processes against a certain goal are usually evaluated through a set of measurements, that capture the interest of only one of the stakeholder categories engaged in the considered process. Therefore, the limitation of the outcome characterizing such appraisal technique highlights the need of coming up with a method that enables the evaluation of the various aspects of business processes in an aggregated form. In the transport field, and especially referring to intermodal systems like seaport terminals, the multiplicity of activities to be carried out and the involvement of several related stakeholders definitely contribute to make project assessment a quite challenging task. For this purpose, the present paper suggests an integrated methodology resulting from the combination of the standardized modeling language called Business Process Modeling

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and Notation (BPMN) and the Analytic Hierarchy Process (AHP) method, in order to perform a multi-actor multi-criteria assessment of diverse scenarios of intervention, with the aim of increasing rail port capacity. Some of the considered criteria have corresponded exactly to the process features resulting from the first phase of the proposed approach. Finally, the application to the case study of an Italian port has proved the validity of the developed method.

2. Methodology

Similarly to the approach used for industrial business processes to examine a potential increase in enterprises’ competitiveness, the BPMN standard has been initially deployed to model rail port operations, since it enables the creation of expressive flowcharts based on a precise notation. The obtained BPMN models represent activities, events, gateways and exchanged data concerning the processes at hand, distinguishing the diverse actors related to those elements. The graphical visualization of railway processes have primarily led to the identification of their key features, that have been then used as some of the criteria included in an AHP hierarchical model, in order to decompose the complex problem of choosing the best scenario of intervention to improve the functioning of the analysed transport system. The main involved stakeholders, explicitly included in a specific level of the evaluation model, have been subjected to some structured interviews to determine their level of influence with respect to the principal goal, the priorities of the considered criteria and the ranking of the considered alternatives. A similar evaluation approach is reported in Caramuta et al. (2018).

3. Case study

The suggested methodology has been applied to the case study of the Port of Trieste, Italy, whose railway network is interested by an increasing traffic volume thanks not only to its strategic position in the center of Europe and its great water depth, but also to its favorable regime of Free Port. Despite these benefits, the inadequacy of the current railway infrastructure and the limited residual capacity certainly hinder a growth in train flows. Thus, firstly BPMN flowcharts have been created to model the operations of a single train at two different levels of detail, i.e. displaying both the necessary documentary procedures to perform the transfer service (macroscopic level) and the rail maneuvers (microscopic level). Secondly, only this last aspect has been considered to represent the simultaneous movement of different trains on the same infrastructure. A detailed description of a train departure process is contained in Campagna et al. (2020). The analysis of the BPMN models has enabled the individuation of parameters related specifically to the deployment of resources, the smoothness of the administrative procedure and capacity, which have been included in the AHP hierarchical model along with other criteria, like financial investments, technological innovation, safety and environmental sustainability. Key stakeholders belonging to the transport and institutional sector have been engaged to evaluate, according to these features, different alternatives considering the implementation of either infrastructure modifications and/or a change in the organizational framework.

4. Conclusion

A methodology integrating BPMN modeling and a multi-actor AHP-aided evaluation procedure has been developed in order to cope with the selection of the best alternative to improve rail port operations and, thus, to increase the capacity of the whole intermodal system. The application of the proposed approach to an Italian port has proved its validity in capturing the socio-technical complexity characterizing the examined context, suggesting the realization of a scenario of intervention that has been shared among all the actors involved in the assessment process.

References

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