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Logistics process improvement using simulation and stochastic multiple criteria decision aiding

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Abstract

The paper is concentrated on improvement of a delivery process of parts and components for a vehicle production company based on just-in-time system. The authors have proposed a four-stage solution procedure. In the first stage the logistics process has been analysed and modelled using EPC notation in ARIS Business Architect. The major activities in the process, cause and effect relationships, key resources (personal and technical) and their assignment to the activities have been identified. In the second stage, multicriteria mathematical model has been constructed to evaluate the process performance. In the third stage, the simulation model has been built with an application of simulation tool ARIS Business Simulator, and the computational experiments have been carried out. Next, in the fourth stage the set of variants representing changes in the current logistics process have been created, equivalent changes have been introduced to the simulation model and computational experiments have been carried out. Based on the nondeterministic simulation results, in the next stage the variants have been ranked with an application of stochastic decision aiding method – stochastic ELECTRE III. Finally, the compromise variant of the logistics process improvement has been recommended.

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Keywords: Process improvement; Process modelling; Multiple criteria stochastic modelling; Simulation; Stochastic decision making

1. Introduction

1.1. Process definition and improvement

Business process improvement is one of the key area of the competitive advantage in the market. Process quality and its efficiency is therefore a field of interest for many researchers dealing with business process management - BPM. Business process is defined in the literature in a very different way. Davenport and Short

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(1990) state that it is a set of logically related tasks performed to achieve a defined business outcome. Tiwari *et al.*, (2010), Vergidis and Tiwari (2008) define process as a set of actions or activities which, if properly connected and organized, allow to achieve business goals.

Many works divide business processes due to their role in the organization into the following groups: the main - operational (or primary), secondary (support) and managerial (e.g. Arlbjørn and Haug, 2010; van der Aalst and van Hee, 2004). Based on the concept of value chain developed in the 90s by Porter, Leymann and Roller (2000) present 3 criteria of the process classification, i.e.: business value of the final result, the frequency of process repetition and level of process automation.

One of the key business process in almost every market oriented organization is a logistics process. In a common sense, it is a sequence of activities and different resources (incl. technological, informational, financial and personal) involved in the implementation of these activities in order to achieve the defined objectives, i.e. efficient placement and movement of goods. Most of logistics processes are classified as operational one, creating value for customers, with high rate of repetition and with a relatively high degree of automation (mainly in the warehousing processes). Having such a perception of the logistics processes it is very crucial to guarantee the highest efficiency of all the activities as well as appropriate utilization of all resources.

1.2. Related works

There are many research devoted to quantitative improvement, redesign or optimisation of business processes. Those methods are mostly based on complex and interdependent methods or calculation procedures and there are very little research related to individual and independent methods. In the latter, the evolutionary algorithms are very often applied to this end (e.g. Vergidis *et al.*, 2005; Tiwari *et al.*, 2007). In the former, several different approaches exists, including:

- process modelling using graph combined with mathematical modelling and solving the model using approximate methods, including: genetic algorithms (e.g. Hofacker and Vetschera, 2001; Huang *et al.*, 2012; Zhou and Chen, 2002; Salomie *et al.*, 2012) and evolutionary algorithms (Vergidis and Tiwari, 2008; Vergidis *et al.*, 2012; Tiwari *et al.*, 2007; 2010) or alternatively using exact methods, including: branch and bound (e.g. Hofacker and Vetschera, 2001) or PERT method (Dewan *et al.*, 1998);
- process modelling using BPMN language combined with problem modelling and solving by genetic algorithms (Stelling *et al.,* 2009) or a combination of specialised heuristics, Hungarian algorithm and simulation (Kamrani *et al.*, 2012);
- construction of alternative redesign scenarios based on decision rules combined with a choice of the most desirable scenario (e.g. Aghdasi and Malihi, 2010);
- multicriteria mathematical modelling combined with multicriteria decision making method AHP (Kwak and Lee, 2002).

1.3. Objective and content of the research

Due to the fact that duration of the most of activities in any process is based on non-deterministic phenomena, i.e. based on stochastic distribution, it is necessary to take it into account in process evaluation, its improvement or redesign. In practice, most of the research assume that considered phenomena are deterministic type, which leads to significant simplifications. Thus, the authors have proposed the procedure of process improvement based on sequence of related steps, including identification and modeling of process activities and utilized resources (both technical and personal), multiple criteria stochastic modeling of the evaluation criteria, process simulation of its different variants (scenarios) and selection of the most favorable scenario of process redesign, using multiple criteria stochastic decision making. The authors verify a proposed procedure and its efficiency on the example of logistics process of supply of parts and components to the production line.