Available online at www.sciencedirect.com

ScienceDirect

Procedia CIRP 57 (2016) 104 – 109

www.elsevier.com/locate/procedia

49th CIRP Conference on Manufacturing Systems (CIRP-CMS 2016)

Risk efficient migration strategies for global production networks

E. Moser[a]*, Nicole Stricker[a], G. Lanza[a]

[a]wbk Institute of Production Science, Karlsruhe Institute of Technology (KIT), Germany

* Corresponding author. Tel.: +49 -721-608-46939; fax: +49 -721-608-45005. E-mail address: Emanuel.Moser@kit.edu

Abstract

The global competitive environment forces companies to increase their production efficiency. In recent years, companies attempted to increase efficiency by operating in globally distributed production networks. But these networks often grew historically neglecting a future-oriented strategy. Hence, nowadays investments in the adaptation of the network configurations are a promising lever to increase the efficiency. Since multiple influencing factors affect the efficiency of a network configuration and interdependencies of the factors have to be considered as well, the decision-making process has become very complex. Furthermore, due to the short-term cyclical nature of these factors, the adjustment time of the network configuration is even more important within this complex decision-making problem. Combining a stochastic, dynamic optimization model with a portfolio theory approach, a method for risk-efficient migration strategies for global production networks is presented in this article. The method considers both, financial and time expenses for the adaptation of the network configuration. Using the proposed method strategies for proactive adaptations of the network configuration considering the risk aversion of the decision maker can be recommended.

Peer-review under responsibility of the scientific committee of the 49th CIRP Conference on Manufacturing Systems

Keywords: Global production networks, migration planning, optimization, changeability

1. Introduction

Companies of all sizes established globally distributed production networks during the last decades [1],[27],[31]. The main reasons for the global expansion of the manufacturing sector were the development of new sales markets and the efforts to increase efficiency by using regional advantages of locations and concentrating on core competencies [1],[16],[27],[31]. However, these networks often grew historically or opportunistically neglecting a future-oriented strategy [23],[24]. As a result of these relocations, acquisitions and disposals, complex network structures with heterogeneous locations are widespread [6],[24].

In addition to globally distributed production networks, the competitive and turbulent business environment characterizes modern globalization. Nowadays, companies are faced with global competitors, shortened product life cycles, an increasing product variety and a volatile demand [31]. Hence, multiple influencing factors as well as their interdependencies challenge globally distributed production networks [12],[20],[27],[31]. The use of modern technologies (e.g. ICT) also reveals the short-term cyclical nature of these changing factors [14]. Not least because of this, experts claim that the business environment is discontinuously and hardly predictable [29],[30].

In the context described above, further increases in efficiency and reduction of complexity require adaptations of grown network structures [24]. Among others, the integration of new supplier from developing economies (e.g. BRIC) but also relocations of value-added activities and investment in production resources (e.g. replacement of outdated production technology) are promising levers [24]. Simultaneously, today's discontinuous business environment forces companies to adapt their production network more and more frequently [14],[26],[29]. Hence, it is obvious that the so-called migration planning of production networks is considered vital for operating efficient production networks. Beside migration costs, the time required for an adaptation of the network configuration must also be considered when generating efficient migration strategies.

Peer-review under responsibility of the scientific committee of the 49th CIRP Conference on Manufacturing Systems
doi:10.1016/j.procir.2016.11.019

2. Objective

The objective of this paper is to present a methodology for migration planning for globally distributed production networks. By using a stochastic, dynamic optimization model robust migration paths can be identified as reaction to changes of crucial influencing factors and lever to increase the efficiency of the network. Simultaneously, considering multiple future developments of these factors, it is possible to avoid potential misinvestments by generating migration strategies for a multiperiodic planning horizon. In addition, a portfolio theory approach helps finding risk-efficient bundles of change enabler for proactive implementation. Using this information, concrete migration processes for each decision point including an implementation plan for these enablers can be derived.

The methodology provides migration strategies for a globally distributed production network on both, single and multiperiodic considerations. It allows to find the right compromise between a reactive and proactive behavior towards changes of crucial influencing factors.

3. Literature review

Due to the complexity of decision making processes regarding production networks and the number of potential solutions, optimization models have been acknowledged to be a powerful method to support decision making. Recent research approaches provided significant contribution to the strategic planning of production networks. However, a variety of them neglects any multistage adaptation of the production network (cf. [4],[5],[9],[10]). Other approaches integrate efforts for the continuous adaptation (cf. [16],[21],[25]). Although uncertain future developments of multiple influencing factors are included (cf. [16],[25]), stochastic effects cannot be considered adequately as the approaches base on scenario technique [1]. A few approaches take stochastic effects into account, but they only concentrate on customer demand as crucial influencing factor (cf. [15],[18],[26]) Furthermore, approaches particularly for migration planning for production networks barely exist. And if so (cf. [23],[25]) they are still subject to the restrictions mentioned above.

In general, migration planning and especially identifying change enablers as well as the generation of change processes are also a subject of discussion in research approaches in the field of changeability. Existing approaches mainly focus on the design and evaluation of changeable production systems (cf. [7],[8]). Several approaches address the selection of change enablers and the generation of migration processes (cf. [11],[28]). But a risk evaluation of change enablers for proactive implementation is not included in these approaches.

4. Methodology

The underlying approach of this work consists of a combination by linking a stochastic, dynamic optimization to a portfolio selection approach for migration planning for global production networks. The approach enables the identification of risk-efficient migration strategies for global production networks. Essentially, the methodology consists of three modules (Fig. 1).

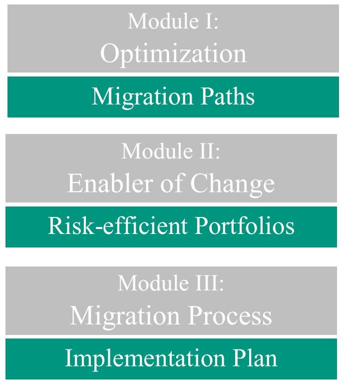

Fig. 1. Structure of the presented approach.

The optimization modules identify robust migration paths for a defined planning horizon and consequently provide the basis for the subsequent modules. For every decision point of the planning horizon, robust migration paths will be identified by applying a stochastic, dynamic optimization model. As a result, this module provides a system of contingency plans for the migration of the production network and consequently the migration strategy for the complete planning horizon. Within the subsequent module, each decision point in the planning horizon will be analyzed in detail. First, the demand for change will be identified followed by the derivation of change enablers for the relevant network objects. Eventually, these enablers are bundled. Applying the idea of risk diversification according to the portfolio theory of Markowitz [19], risk efficient portfolios can then be generated. Based on these analyzes, concrete migration processes will be derived considering the preferences and available resources of the decision maker. These migration processes include an implementation plan for the identified change enablers.

The modules are described in more detail in the following sections.

4.1. Module I: Optimization

The optimization module allows the identification of robust migration paths of the production network. They include both, adaptations of the structural and capacitive network configuration.

For this reason, an integrated network model is developed by applying the graph theory. Within this modelling approach, the integrated (structural and capacitive) network configuration is modelled via rated nodes (n) and edges (e) and comprises the following network objects: customer (modelled as node n) who are demanding products, production stages (n) and technologies (n) which are localized at sites, suppliers (n) who supply materials or semi-finished products and outsource partners (n) who handle single production stages of the value adding process. The connections between sites, suppliers and customers are modelled as transportation routes, and represented as the object transport (e). The capacitive network