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Resource-Based Cost Modeling – a New Perspective on Evaluating Global Production Networks

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Abstract

Production networks need to be constantly adapted so companies can handle the introduction of new products, tap the opportunities of new markets or significantly save costs. Especially cost reductions require an adequate way to predict the cost effects of network adaptions such as product allocations or location decisions. However, studies show that a high amount of network adaptions have been reversed after a short period of time because expected cost savings could not be realized. One reason for this is that simplistic cost estimations are still common in industrial practice since literature approaches are often too complex or require too much effort to apply them.

The approach presented in this paper tackles the problem of the low applicability of existing cost models. It is based on a set of three guiding principles: source-specific, objective-oriented and valid. The approach is source-specific because it includes a resource-based cost modeling method that is used to evaluate the operational costs for each product within the network. Objective orientation is achieved by a flexible aggregation method that enables to define the level of detail necessary for a given decision situation. The validity of the cost model, a crucial element for decision makers, is created through a method that allows for calibrating and adjusting the model with standardized cost information. The result of the presented approach is a comparison of unit costs as well as a net present value calculation for a given decision situation.

An exemplary application shows how the approach can be used as a support for designing the future production network of a company.

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Keywords: Cost Evaluation; Production Network; Global Networking

1. Introduction

Markets for the majority of companies are spread around the world. Therefore, to follow their markets, companies produce more and more internationally. About 40% of the production capacities of all German companies with foreign production are located abroad [1]. This trend is emphasized by growing worldwide foreign direct investments (FDI) that have increased to about US$1.8 trillion by 2015 [2].

The main advantages of an internationalization of production and, hence, the creation of production networks, can be seen in strengthening a company's position towards the competitors in terms of costs, gaining access to new markets and resources as well as reducing the distance to existing customers [3]. In the past, production networks have been redesigned and optimized individually. Nowadays, companies realize that a network is a complex system whose performance can be enhanced by a systematic configuration [4].

A certain configuration or network alternative has effects on key performance indicators such as lead times, responsiveness, flexibility, financial performance or the cost structure [5]. The last indicator, the cost structure, is the focus of this paper.

2. Challenges in cost modeling of production networks

Even though companies produce more and more abroad, the backshoring rate for production remains high. One key issue are expectations about possible cost savings that could not be realized [1]. Some of the main challenges are discussed in the following paragraphs.

Cost-based Operations Research (OR) methods for designing and optimizing production networks have existed since the 1970s, but have not been introduced in producing

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companies to a high extent. Instead, simple investment appraisals are used [6,7]. A missing establishment of OR methods in industrial practice can be explained by low relevance, missing transparency and high efforts [8]. These deficits can be found in most advanced cost models.

The allocation of costs has a high impact on the cost evaluation of production networks. Some costs such as overhead costs for indirect staff do not immediately depend on the production volume, but are caused by the product and/or process complexity [9]. A main deficiency of current cost models is the missing source-specific assignment of costs which leads to incorrect evaluations [10].

Many cost models for production networks do not include a systematic validation in order to reduce modeling efforts. This missing validation results in inadequate cost estimations for adapted network structures that cannot be achieved. To avoid this problem, validation by systematically calibrating and adjusting a cost model is necessary [11].

In summary, three categories of challenges for cost modeling of production networks can be described:

- Low applicability due to high efforts and low transparency of existing cost models
- Unsuitable source-specific assignment of costs
- Missing validity due to unsuitable calibration and adjustment

3. State of the art

In research, a number of approaches has been developed over time to improve cost modeling of production networks. Two main research fields can be distinguished that deal with the cost evaluation of production networks: OR-based network design and cost accounting for production networks. Approaches from both fields will be presented in the following paragraphs.

Huebner develops an approach for strategic network design in the process industry. The planning process consists of three different phases: problem description, optimization of production networks and site selection. Regarding the above described three categories of challenges, the optimization approach of Huebner addresses mainly the process industry and has therefore a low applicability in other industries. It is not focused on source-specific assignment of costs. Validation is regarded, but not in a systematic way [7].

Schilling develops a planning and decision support for the management of production networks that is designed for the consumer goods industry and based on an optimization model. The approach includes the evaluation of the existing network including data validation as well as the generation of a objective configuration. It targets some aspects of the challenges since activity-based costing for overhead costs and a structured validation of the cost model is incorporated. Nevertheless, the general applicability of the approach can be considered low since it causes high efforts and is specifically designed for the consumer goods industry [9].

Schuh et al. develop a software tool for the configuration of production networks that includes an optimization model minimizing the total landed costs. The approach is filled with all necessary data for the application of the optimization model. This includes data regarding products, processes, location, as well as costs. The software tool allows for a detailed analysis of the optimized network structure. The approach of Schuh et al. can be applied to various industries but involves high efforts for data generation. A source-specific assignment of costs is addressed only to a low degree by integrating different characteristics of cost functions. Validation of data is not integrated in a systematic manner [12].

Further approaches for OR-based network design have been developed by e.g. Melo et al., Tsiakis and Papageorgiou or Yuan et al. but do not tackle the challenges more profoundly than the described examples [13,14,15].

LaLonde and Pohlen develop an activity-based cost accounting approach for performance measurement in supply chains. Their approach consists of six steps: First, key processes are identified. Second, the processes are broken down into activities. The next step is the identification of resources required to perform an activity. Step four comprises costing the activities by summing up the resource costs linked to an activity. The fifth step covers the definition of connections between activity costs and supply chain outputs. In the last step, the effects of cost drivers towards the costs of a supply chain are analyzed. The applicability and transparency of the approach of LaLonde and Pohlen are high, even though some efforts are necessary. The assignment of costs can be considered source-specific due to the implementation of an activity-based costing method. A validation of the approach is mentioned by the authors, but not described in detail [16].

The cost accounting model of Schulze et al. also evaluates the costs of supply chains based on activities (activity-based costing). The authors introduce a two-step methodology: the first step deals with the product design, the second addresses production and logistics. The core of the first step is a description of business activities. For those processes and activities, cost drivers are defined. By determining and varying the cost driver quantity, the cost effects of processes and activities can be analyzed. This is used for a selection of cost suppliers and a cost-efficient product design. In the second step, the design and optimization of the production network and the supply chain is targeted. By determining the standard time per activity as well as the cost per time unit, cost rates are determined which are used for the process cost calculation. The process costs are then utilized to evaluate relocations of activities or optimizations within the supply chain, e.g. by introducing a higher degree of automation. The approach of Schulze et al. is transparent and highly applicable. A source-specific assignment of costs is possible, even though different types of costs and their specifics are not regarded. A systematic way for validating the model is not included [17].

Further cost accounting approaches for production networks exist that have not been presented in detail. Examples are the approaches of Dekker and van Goor, as well as Pohlen and