Available online at www.sciencedirect.com
ScienceDirect
IFAC-PapersOnLine 49-30 (2016) 186–191

Master Model for Integrating Inventory, Transport and Service Personnel Capacity Planning

Ann-Kristin Cordes*. Bernd Hellingrath*

** Chair for Information Systems and SCM, Westfälische Wilhelms-Universität Münster Münster, Germany, (e-mail: {cordes; bernd.hellingrath} @ercis.uni-muenster.de)*

Abstract: In industrial production operations, avoiding breakdowns of technical systems is of prime importance. Anticipatory replacement of defective components is one option to reduce breakdowns. Therefore, spare parts are required in the adequate amount, at the requested time and place of repair. In order to fulfill this objective, the planning tasks of a spare parts supply chain have to be aligned and planned simultaneously. In this article an integrated planning model is presented for the most important planning tasks of a spare parts supply chain: inventory, transport, and service personnel capacity planning.

© 2016, IFAC (International Federation of Automatic Control) Hosting by Elsevier Ltd. All rights reserved.

Keywords: Spare parts management, integrated planning, inventory management, transport planning, service personnel capacity planning, optimization, control of networks, condition monitoring information.

1. INTRODUCTION

As spare parts demand sporadically arises, it is difficult to plan activities along a spare parts supply chain in advance (Huiskonen 2001). Primarily, these activities include the allocative planning of inventory, transport, and maintenance services in a spare parts supply chain (Cordes and Hellingrath 2014). All three planning tasks are crucial to provide spare parts in an adequate amount, at the requested time, and to the place of repair, which are the main objectives of a spare parts supply chain (Martin et al. 2010). In order to fulfil these objectives and to avoid stock-outs, the actors of a spare parts supply chain adopt measures such as accumulating inventories and sending emergency shipments. Both measures imply high costs for all actors of a spare parts supply chain (Cordes and Hellingrath 2014). These unfavourable phenomena along a spare parts supply chain occur if capacities are not aligned. Aligning the planning activities for instance by planning inventory, transport, and service personnel capacity simultaneously would greatly reduce the amount of emergency shipments needed, the high volume of spare parts in stock, and the surplus in service personnel. If unaligned capacities are known to be costly, why has this issue not yet been addressed? Two principal reasons impede industry from tackling this problem. First, the existing information systems, which are utilized in industry are not able to provide a solution to plan spare parts supply chain tasks simultaneously (Cordes and Hellingrath 2014). Second, none of the existing theoretical planning methods provides an adequate solution to integrate the planning of inventories, transports and service personnel capacity in order to determine them simultaneously.

Since no planning model exists which integrates all three kinds of planning tasks, the objective of this paper is to develop a model for integrating inventory, transport, and service personnel capacity planning of a spare parts supply chain. The planning model is developed based on the conceptual approach of Cordes and Hellingrath (2014). The main contribution of this article is to find as a first step a theoretical solution how the three different kinds of capacities can be planned simultaneously in order to provide in a in the future as a second step a planning model with which in industry the capacities can be aligned. In addition, it might also be used to analyse and utilize provided data from telematics solutions to further improve planning results.

The remainder of this article is structured as follows: To set up a suchlike integrated planning model, the state of the art (section 2) and the underlying research method (section 3) are described. In section 4, the master model is set up based on the problem previously described. Thus, the assumptions and requirements are deduced from the real-world problem and authoritative theory. Then, the integrated planning model is formulated and explained. Section 5 highlights the procedure of the evaluation and the first step of the evaluation is carried out. Section 6 concludes the article by reflecting on the results, then states an agenda for future research.

2. STATE OF THE ART ANALYSIS

Prior research in spare parts management focuses on the development and improvement of inventory planning methods. Several of these methods were developed or adapted for spare parts supply chains. For instance, Kranenburg and van Houtum (2007) as well as Dekker et al. (1998) focused on a single-echelon system. To tackle a multi-echelon inventory system for a spare parts supply chain, Sherbrooke (1968), Muckstadt (1973), and Kutanoglu and Mahajan (2009) developed and extended specific planning methods for spare parts supply chains. For further details about the various inventory planning models in spare parts management, refer to the literature review provided by Thormann (2015).

In the current literature, simultaneous planning—so-called integrated planning—of spare parts supply chain tasks is rarely considered. Graves (1985) and Lee (1987) developed the first integrated planning models for inventory and transport planning. In addition, Kutanoglu and Lohiya (2008) as well as Thormann (2015) have also set up models for integrating spare

2405-8963 © 2016, IFAC (International Federation of Automatic Control) Hosting by Elsevier Ltd. All rights reserved.
Peer review under responsibility of International Federation of Automatic Control.
10.1016/j.ifacol.2016.11.165

parts inventory and transport planning. However, all of these models focus on integrating two planning tasks—planning inventory and transport—with most of them only considering single-echelon systems. A research gap exists, namely for integrating spare parts inventory, transport, and service personnel capacity planning in a multi-echelon system. Consequently, the innovation of this article is on the one hand three planning tasks are integrated in one model by adding service personnel capacity planning and on the other hand the inventories are planned for a multi-echelon system contrary to the existing models which only plan single-echelon system.

In contrast to spare parts management, the integrated planning view of product supply chains has recently come under investigation. However, such planning models cannot be transferred to spare parts supply chains without an adjustment since these models do not consider the specific characteristics of a spare parts supply chain like sporadic demand. For a more detailed literature review about integrated planning in spare parts supply chains and product supply chains refer to Cordes and Hellingrath (2014).

3. RESEARCH METHOD

The intended integrated planning model for spare parts supply chains is developed on the foundations laid by the methodology of Schneeweiß (1992), which structures the development of a planning model. As an integrated planning model is a specific planning model aimed to integrate different autonomous planning models, the methodology of Schneeweiß (1992) has been adjusted accordingly (see Fig. 1).

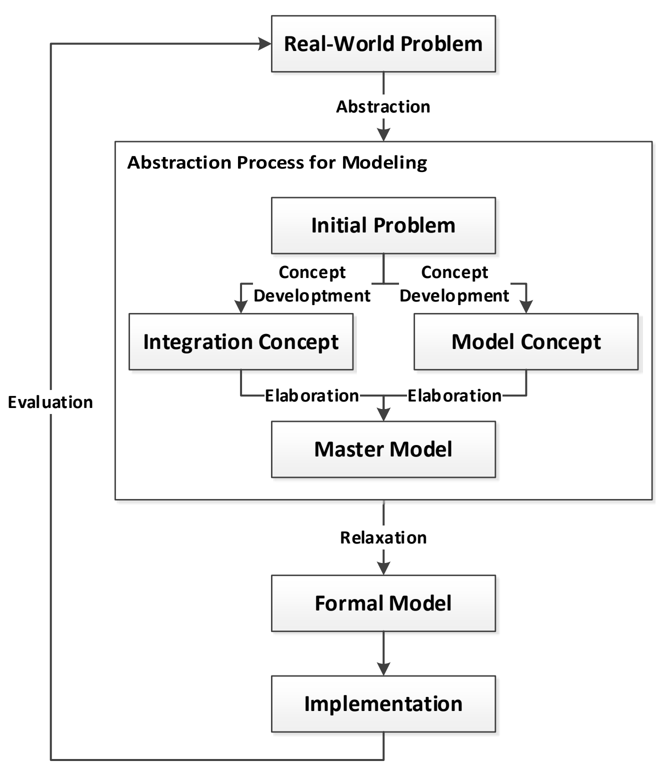

Fig. 1. Overview of the Planning Process according to Schneeweiß (1992).

As a first step, the real-world problem has to be identified and described. As it is usually too complex in order to develop a model for that problem, the second step is to abstract from the real-world problem and specify an initial problem that describes the real-world problem in an abstract form. Then, based on the initial problem, a concept for the model is developed. In contrast to the original procedure, for an integrated planning model two elements are required: a model concept and an integration concept. The former describes the objective, requirements, and assumptions of the model as well as the different autonomous models which can be integrated into it. The later delineates how different planning tasks and the respective autonomous planning model might be integrated in one single, integrated planning model. Both concepts lay the foundation for the subsequent development of the master model. The master model tries to include all aspects of the initial problem. However, the master model is usually not solvable since it is still too complex. Therefore, a relaxation step is needed in order to define a formal model. In this step, further assumptions are defined and only relevant constraints are kept in the model. This formal model is then implemented in order to carry out the evaluation. Ideally this evaluation is based on a data set provided by an industrial partner (Schneeweiß 1992, Suhl and Melloulli 2013).

Based on this methodology, the integrated planning model has been developed. The model concept has already been described in Cordes and Hellingrath (2014). Hence, the focus of this paper lies on developing the master model. In order to understand the purpose of the model, the overall problem is shortly described in the following. Afterwards the development of the master model is described inclusive the definition of all assumptions and requirements.

4. DEVELOPMENT OF THE MASTER MODEL

The foundation for developing the master model is the conceptual approach of Cordes and Hellingrath (2014). This concept solely comprises the integration of inventory and transport planning. The intention is to specify the concept and to transfer it to a mathematical model. Furthermore, with regard to the research goal of this paper, it has to be extended by service personnel capacity planning.

As described in section 3, the real-world problem being modelled is usually too complex. This is why, it is necessary to abstract from the problem. Assumptions are needed in order to reduce the problem scope. The assumptions and requirements for the master model are introduced in the following subsections. This builds the foundation for the master model which is developed and described afterwards.

4.1 Problem description and assumptions

The spare parts supply chain under consideration is a two-echelon system with one single, central warehouse and multiple regional warehouses that stock spare parts. Service personnel are stationed at the regional warehouses. In this case, all service personnel shall be considered to have the same professional skills and capabilities. If any of the regional warehouses are out of stock, the spare parts for that demand are shipped from the central warehouse to the respective regional warehouse. All inventories are controlled by a one-for-one replenishment or also called (S-1, S) policy. Furthermore, it is assumed that the central warehouse has infinite stock, and that service personnel capacity as well as overall transport capacity

Download English Version:

https://daneshyari.com/en/article/5001962

Download Persian Version:

https://daneshyari.com/article/5001962

Daneshyari.com