Developing a Cybernetic Model of Interdepartmental Logistic Interactions in SME

Jonas Mayer, Kai-Frederic Seitz, Thorben Kuprat

Abstract—In today's competitive environment production's logistic objectives such as 'delivery reliability' and 'delivery time' and distribution's logistic objectives such as 'service level' and 'delivery delay' are attributed great importance. Especially for small and mid-sized enterprises (SME) attaining these objectives pose a key challenge. Within this context, one of the difficulties is that interactions between departments within the enterprise and their specific objectives are insufficiently taken into account and aligned. Interdepartmental independencies along with contradicting targets set within the different departments result in enterprises having sub-optimal logistic performance capability. This paper presents a research project which will systematically describe the interactions between departments and convert them into a quantifiable form.

Keywords—Department-specific actuating and control variables, interdepartmental interactions, cybernetic model, logistic objectives.

I. INTRODUCTION

IN view of an increasingly globalized and networked market, the logistic performance capabilities of today's enterprises are attributed great importance. In addition to the price and quality of the product, logistic performance features pose a significant opportunity for enterprises to distinguish themselves within the market. A high logistic performance capability is characterized, for example, by the production's high delivery reliability and short delivery times along with the distribution's minimal delivery delay and high service level [1], [2]. SMEs in particular attach extreme importance to logistic performance capability [3]. However, due to limited availability of resources and competitive disadvantages in the market, realizing a high logistic performance often poses a significant challenge for them [4].

II. MOTIVATION

In order to optimize the logistic performance capability in SME, the interactions between departments and their objectives have to be identified and department-specific objectives have to be harmonized in relation to the enterprises corporate goals. Intersections in the form of interdependencies between departments lead to a loss of efficiency compared to the realizable potential of an overall optimal solution developed through holistically planning [5]. Interdepartmental dependencies cause actions and measures in individual departments to have impacts on other departments in addition

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to their desired influence on department-specific objectives. Consequently, these intersections decrease the logistic performance capability [6]. The root of this can be found in the department-specific logistic targets and the resulting diverging possibilities for optimization in the departments [5], [7] (see Fig. 1).
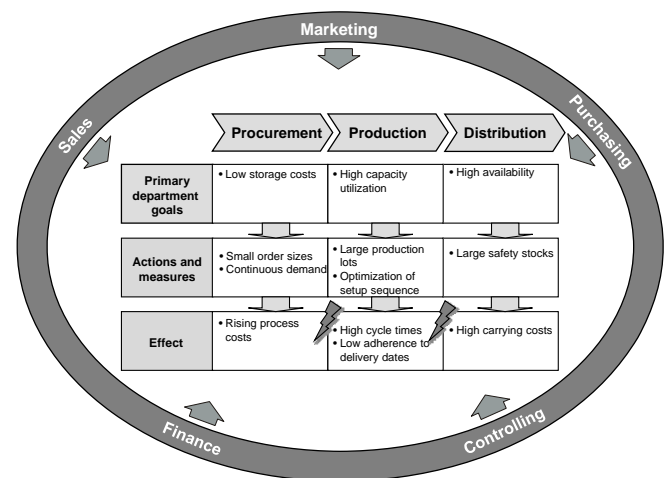

Fig. 1 Contradicting department goals and their impact [8]

An example which clarifies the interdepartmental dependencies is the lot size planning. Optimal lot sizes are independently determined in both the procurement department (order lot sizes) and the production (manufacturing lot sizes). Usually, the models for calculating the lot sizes assume incompatible premises [5], which lead to differently dimensioned lots. As a result logistic inefficiencies can be observed e.g., the uncoordinated accumulation of stock.

Even IT based planning and control activities such as aligning capacities frequently focus on the objectives of one specific department (e.g., production) and in many cases ignore objectives that are relevant for adjacent departments (e.g., due date compliance for customers) [9]. These interactions between departments correspondingly result in decreased logistic performance capability since these objectives are not coordinated across the departments in a vast number of cases. In accordance with the preceding observations, a model is to be first developed which depicts the interactions between the objectives of different departments. Once the interactions between the objectives are made transparent, it will then be possible to orient departmental targets on the enterprise's goals.

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III. MODEL INTRODUCTION

Against the background of growing demands on the logistic performance capability of SMEs, a procedure for identifying and depicting interdepartmental logistical interactions in SMEs will be introduced in this paper. Based on the identification and depiction of these logistical interactions, the target conflicts between the departments within the value-adding chain can be ascertained. Knowledge about these interdepartmental target conflicts is a prerequisite for being able to align the department-specific objectives with the enterprise's overall corporate goals.

Existing research examines the difficulty of coordination between enterprise departments, concentrating on aspects of organizational learning, interdepartmental integration as well as corporate capability management [10]-[13]. These approaches analyze interdepartmental relations based on interviews, workshops and surveys. In addition there is also a pure qualitative development of decision-supporting scenarios for determining the interdepartmental integration of logistic functions [14].

What is common among all of these approaches is that they take into consideration the department specific interactions. However, a holistic research approach to all of the logistics related interactions between departments is not yet existent. Moreover, a quantitative description of these interactions based on logistic parameters is completely lacking.

In order to resolve this deficit, this paper will focus on developing a holistic model for depicting the interdepartmental logistical interactions. This first requires the relevant departments in an enterprise be determined along with their objectives and the measures and actions the departments implement to influence these objectives (see Section III *A*). Subsequent to that in a second step, all existing interactions in SMEs are to be identified and described with regard to their company-wide scope (see Section III *B*). For this purpose, research will focus both on the dependencies between the departments as well as on the interactions between the logistic objectives. Beyond that, the identified interactions are to be described both qualitatively and quantitatively so that dependencies between the objectives and the associated dependencies between the departments can be accounted for within a cybernetic model (see Section III *C*). In the following, the steps required to develop this model will be presented.

A. Identification of Relevant Enterprise Departments and Objectives

In the first step of developing the model, all of the operationally active departments in production SMEs are to be identified and described based on their functions, tasks and responsibilities. In order to holistically model the interactions between departments, not only are the departments that directly participate in rendering the service considered, but also those departments, which as higher authorities, make strategic business decisions (e.g., marketing). This procedure ensures that all of the interactions that arise in SMEs are integrated into the model, even when at first glance they do not appear to be compellingly relevant to the logistic performance. In addition to identifying relevant departments, additional department-specific objectives are to be determined. Here, both logistic and economic objectives are significant since there are also interactions and dependencies between these. In order to establish a holistic alignment of department-specific objectives, central enterprise goals of SME have to be identified.

The root of interdepartmental interactions is found in the department-specific measures and actions that help the respective departments attain their targets. Measures and actions in one department lead to influences not only on its objectives but also on objectives in other departments. Thus in addition to the relevant departments and their specific objectives, measures and actions that influence the departments' objectives have to be identified in order to describe the interdepartmental dependencies. The constellations detected between departments, objectives, measures and actions are then to be systematically categorized in consideration of various operational conditions or enterprise structures (e.g. type of production, industry branch) (see Fig. 2).
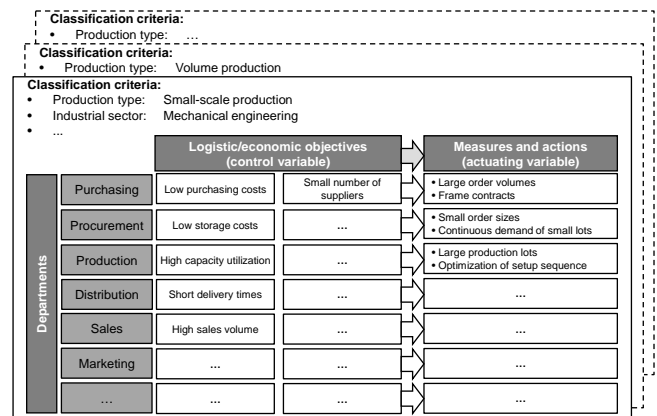

Fig. 2 Categorization of enterprise departments along with their objectives and actuating variables

B. Determining Interactions between Departments and Their Objectives

In a further step towards building a model, the interactions between departments are to be described qualitatively and quantitatively based on the introduced categorization. By analyzing the ascertained department-specific measures and actions, their possible impact both on their own department objectives as well as on those of other departments and the overall logistic performance capability of the enterprise is to be examined.

In direct analogy to a cybernetic control loop, the mentioned measures and actions represent actuating variables. By changing the actuating variable objectives can be influenced in the respective department. Consequently, there is a direct dependency between the actuating variables and objectives. In this context, the department's objectives are to be seen as control variables, since they in turn influence the overall corporate goals (see Fig. 3). Because of

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interdepartmental interactions, changes to actuating variables in one department have effects on the objectives of other departments. Through analyzing the main goal of the entire enterprise, which is influenced by the department-specific control and actuating variables, the orientation of these variables in the department can be optimized. Identified interactions between departments are to be described qualitatively and quantitatively with the aid of an impact model, which depicts cause and effect relationships.
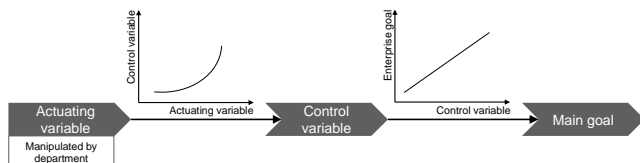

Fig. 3 Interactions between actuating, control variables and objectives

As one example, the influence of the distribution department on the change in sales is described here and specified with the aid of two impact models. Distribution departments in make-to-stock productions influence the sales of an enterprise (as a company-wide key objective) through the control variable 'product availability' [15]. By considering the finished goods store product availability can be described via the logistic variable "service level". This variable can in turn be influenced by the finished goods inventory [2]. Therefore, the stock in the finished goods store represents the actuating variable in distribution with which the department-specific control variable 'service level' can be influenced with respect to the product availability.

As a component of the logistic performance capability in storages, the service level is highly valued by customers and serves as a criterion when making purchasing decisions. As a result, it can be expected that changing the service level will influence sales. Generally, no proportional correlation can be assumed between the realizable service level on the enterprises side, the customer benefit resulting from it and the related sales changes on the market side.

Changes in service levels are evaluated by customers and compared with what competitors offer. If a company's product is the same as their competitors, but their service level is below the average of their rival's, sales can hardly be expected (see Fig. 4). Increasing the service level is related to a growing logistic performance capability. Since the enterprise's attainable logistic performance capability leads to added-value from the customers' perspective, a gradual climb in sales can be assumed when a service level threshold is surpassed. In this context, the service level threshold is dependent on the logistic positioning of rivals. If the average service levels of rival companies climb, it is to be expected that the service level threshold also increases.
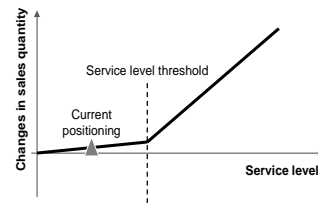

Fig. 4 Interactions between changes in sales and the service level in the outgoing goods store

In contrast to the prior example, distribution departments in make-to-order productions control the sales of an enterprise via the control variable 'desired delivery time' [8]. Within this context a disproportional relationship between sales and 'desired delivery time' can be assumed. The reduction of the control variable 'desired delivery time' is only valuable for an industrial customer in the case of possible changes of its production planning and control processes. One example for these possible changes is the switch of a forecast-based disposition method to an order-related method [8]. Based on this change a possible reduction in inventory is imaginable.

In direct analogy to the prior example desired delivery time thresholds can be assumed (see Fig. 5). Only if certain levels of the desired delivery time are exceeded or go below a certain value significant changes in the number of sales are expected [8]. The development of the sales is directly dependent on the added value through changes in the customers' production planning and control processes.
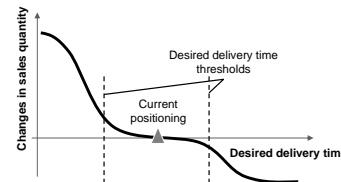

Fig. 5 Interactions between changes in sales and the desired delivery time controlled by the distribution department [8]

The presented examples show that dependent on the general structure of an enterprise departments optimize according to different objectives. Different objectives lead to differing measures for optimization, which have diverse effects on other departments' objectives.

C. Deriving a Cybernetic Model

Similar to the example introduced here, further causal relationships are to be identified for all of the relevant departments, control and actuating variables and then described qualitatively and quantitatively. Moreover, interdepartmental connections between the control and actuating variables are to be revealed. In analogy to a cybernetic control loop, an interdepartmental cybernetic model is to be derived from the determined causal relations (see Fig. 6). This model will depict all of the influences and effects the departments' actuating variables have on the departmental control variables as well as on key enterprise goals. This model can be used to holistically evaluate the impact of

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department-specific measures on the logistic performance capability and economic success of enterprises.
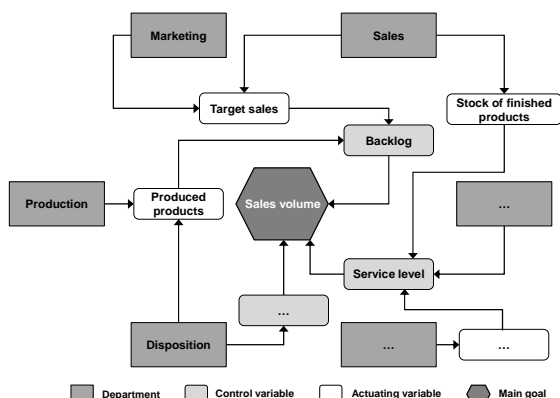

Fig. 6 Cybernetic Model of Interdepartmental Interactions [8]

Since the interactions between the variables and the overall corporate goals are transparently and quantitatively depicted it is possible to align the department-specific control variables with the aid of the cybernetic model presented here. Contradicting department objectives can be balanced. Furthermore, by aligning the control variables with the corporate goals, measures can be derived for implementing this alignment in the form of department-specific actuating variables.

IV. SUMMARY

Within the frame of the developed model, the interactions of departmental key processes within an enterprise can be comprehensively depicted in view of the logistic objectives. This allows possible target conflicts and competing interests between departments to be made transparent. This transparency is necessary to reduce functional 'departmental thinking' and department-specific target optimizations and to instead optimize the entire enterprise.

In many cases, contradicting departmental goals and a lack of knowledge about existing interactions between departments leads to a sub-optimal alignment of operational activities and as a direct consequence to insufficient logistic performance capability [8]. In view of the continually growing role that logistic performance capability plays in a customer's decision to make purchases, this paper offers an approach to increase transparency of interdepartmental logistic performance and for sensitization of interdepartmental interactions.

V. OUTLOOK

In the next step identified interactions between actuating and control variables, such as those illustrated in Figs. 4 and 5, have to be linked to other departments in order to identify interdepartmental interactions.

Future research activities will focus extensively on possibilities to integrate knowledge about interdepartmental interactions in enterprises. One possibility is to incorporate identified interdepartmental interactions into a simulation game that can be used for advanced employee training. With this measure, knowledge about the existence of these interactions can be integrated within enterprises allowing a holistic orientation of departments' objectives on the enterprise's goals.

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