3rd Conference on Production Systems and Logistics

PPC Task Plan Sourcing - Synchronization Of Procurement And Production. A Model-based Observation

Simon Hillnhagen[1], Selim-Hendrik Koller[1], Alexander Mütze[2], Peter Nyhuis[2], Matthias Schmidt[1]
[1]*Leuphana University of Lüneburg, Institute of Product and Process Innovation (PPI), Lüneburg, Germany*
[2]*Leibniz University Hannover, Institute of Production Systems and Logistics (IFA), Hanover, Germany*

Abstract

As companies continue to globalise, manufacturers face the challenge of strategically adjusting their vertical integration and restructuring production and supply chains. This leads manufacturers to increasingly pursue two strategies of restructuring. On the one hand, in the form of outsourcing value-adding activities, the focus is being placed on the core competencies of the company's own production. As a result, the vertical range of manufacture within the company is decreasing, while outsourcing is becoming more and more important. On the other hand, companies are also pursuing the strategy of least possible dependency to secure production through regional procurement of resources and expansion of the necessary competencies by means of increased vertical integration. In order to understand the consequences and effects of these changes at the level of production planning and control (PPC), a model-based view is necessary for an expanded understanding of the processual context of these changes. The PPC is the essential steering instance of production. It combines long-term tasks, e.g. Plan Sales or Roughly Plan Resources, with short-term tasks, e.g. Schedule Throughput or Plan Resources in detail. The main PPC task, Plan Sourcing, is an essential link with its tasks and procedures between the core processes of procurement and production in the company's internal supply chain.

In the context of this paper, the PPC main task Plan Sourcing is to be considered in a model-based manner, which focuses on the selection and connection of suppliers as well as the general view of the supplier management of manufacturers. For this purpose, the effect on the PPC and the production logistic objectives variables is presented by means of the consideration of the tasks and possible procedures for the fulfilment of these PPC tasks. Utilising collected findings, a process-related derivation for the synchronisation of the affected areas of procurement and production is presented.

Keywords

Procurement; Synchronization; Modelling; Production Planning and Control; PPC; Sourcing

1. Introduction

Globalisation has strongly changed the competition for manufacturing companies. In addition to rising cost pressure, companies are confronted with increasing individualisation requirements and shorter product life cycles [1,2]. In order to compete in this environment, it was a global trend, especially before the pandemic, for companies to focus on their core competencies in their production and outsource large sections of the value chain. During the pandemic, this trend has changed from a strongly global perspective to a locally oriented procurement in the area of particularly vulnerable supply chains. This is why it is currently called

the "glocal / glocalisation" mega-trend, i.e. global and local procurement. [3,4] The reasons for outsourcing are that in many cases specialised suppliers can produce and deliver certain components much more cost-effectively than manufacturing these specific products in-house [5]. In addition, the suppliers, for their part, can drive forward the technical development of certain components in a more targeted manner and thus increase the quality of the final product [6]. For this reason, besides optimising the own production, procurement is becoming increasingly important, especially in complex supply chains [7].

In general, the task of procurement is to cover the demand for raw materials, semi-finished products and primary products that cannot be produced economically by the company's own production or cannot be produced at all [8]. Therefore, externally sourced items must reach production at the right time, in the right quantity and quality, in order to fulfil internal processes and specifications and to ensure the logistical efficiency of production [9]. Procurement is particularly significant for companies with multi-variant product portfolios and strong individualisation by customers, as they often carry out order-specific procurement for little-used articles and thus do not have any safety stocks in the warehouse. This can be observed more frequently especially with contract manufacturers (engineer-to-order (ETO) and make-to-order (MTO) manufacturers). In such cases, procurement is on the lead-time-critical path, which is why procurement processes and production processes should be synchronised as much as possible in order to improve the lead time and thus the response time of the company. [8,10] This paper will therefore analyse the interface between procurement and production in more detail. For this purpose, the process crossovers will be identified and examined in the wider context in relation to PPC.

2. Research Question and Research Methodology

In today's business structures, different departments often have overlapping subtasks where different objectives are always in the focus, leading to difficulties in coordination. In addition, the optimisation of corporate coordination is necessary, as this improves not only vertical but also horizontal cooperation with the supplier network. [2] The focus of this paper is the analysis of the interface between procurement and production. The contribution follows the research question: "How can procurement be optimised and synchronised based on control via production logistics objectives?"

In addition, the preconditions for this type of minimisation of interdepartmental conflicts are to be considered. Here, the focus is on procurement, since another interface exists here as a communication channel outside the company. Through a model-based approach, it is to be found out to what extent the production planning and control of the Hanoverian Supply Chain Model (HaSupMo) can make a target-oriented contribution in order to control logistics performance and logistics costs individually and to adapt them to the company-specific needs. Therefore, the main PPC task of “Plan Sourcing” of the HaSupMo will be presented later in chapter 4.1 and its characteristics will be shown as well as the resulting logistical objectives will be dealt with. In terms of the research question, a possible answer will be given with a qualitative approach based on the Hanoverian Supply Chain Model.

3. General Interface of Procurement and Production

The operational design of a company's supply chain involves overlapping cross-sectional tasks in which the respective decisions have a direct impact on objectives [8]. However, their influence on the logistical objectives in a company is not comprehensively known in industrial practice. This mutual, mostly unintentional, influence must be avoided through efficient and effective interface management. Joint coordination of the departments on necessary measures is indispensable to reduce internal barriers [11]. Departments such as procurement and production are essential constituents of every company. Therefore, these departments are required to engage in extensive exchange through transparent communication and

coordination [12]. The reduction of interfaces is therefore an important approach to optimising internal processes [11,13].

3.1 Interface analysis

Companies have a large number of interfaces in connection with procurement, which can be found either externally, e.g. with suppliers, or internally, e.g. in relation to the supply chain between the warehouse and production. The primary objective of the company's internal supply chain should therefore be to optimally integrate procurement as a higher-level link in order to avoid supply interruptions in production. Especially for order-based producers with individual customer requirements, the lead time and adherence to delivery dates for the completion of the products is an important competitive factor [14]. To ensure that these sometimes sensitive process chains function in a resilient way, a comprehensive analysis is required as the basis for designing a target-oriented PPC. In order to systematically work out the characteristics of supplier activities as well as the necessary information flows, the value stream analysis and the SIPOC method (Supplier, Inputs, Process, Outputs, Customer), for example, which are anchored in the Six Sigma toolbox of methods, are valuable tools. These proven and clearly structured overview methods not only enable transparency of the essential interfaces in terms of content and process, but also show the data-driven input and output through the value creation process.

A closer look at processes and their interfaces always highlights the fact that the results usually relate to different levels of consideration and interact with each other. For the best corporate strategy is difficult to implement if workflows and processes are not clearly structured up to the operational level. On the other hand, corporate process analyses, such as value stream mapping, always start from the current production processes via coordination points such as planning and IT interfaces. This knowledge is essential in order to be able to make well-founded strategic management decisions.

3.2 Approach of the interfaces at four levels

The levels of the realization win for interfaces with production analyses, addressed in chapter 3.1, are to be pointed out now in this approach, at the example of production and procurement. In this approach, four levels can be identified, which build on each other and are interdependent (see figure 1). In addition, two procedural directions are presented. The analysis procedure from level 1 to level 4 (bottom to top) and the hierarchical control direction from level 4 to level 1 (top to bottom).

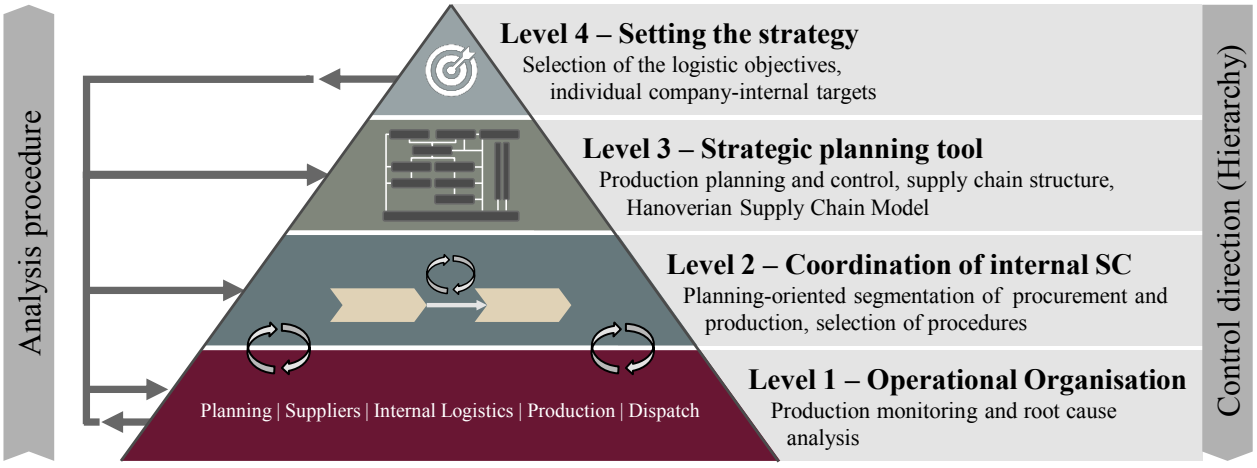

Figure 1: Four levels of interfaces (inspired by [15])

Level 1 forms the foundation for the production-related analysis of processes and interfaces. This level 1 "Operational Organization" is thus the starting point for the analysis direction. Level 4, on the other hand, is a strategic control instance and is to be regarded as the starting point for the direction of control (hierarchy).

After considering the processes at the production level, it is necessary to carry out segmentation at the product level and to categorize these products according to a defined value, for example. Based on this, a classification of components must be carried out in level 2. This classification of components can basically be divided into three categories. Parts that have to be procured externally due to the fact that there is a limited vertical range of manufacture. Parts that are manufactured in-house in any case due to the existing vertical range of manufacture. A third category consists of parts that can be sourced externally as well as manufactured in-house. On the one hand, products in the third category in particular bring the necessary flexibility to production in relation to the objective of capacity utilization. Depending on the allocation of these products to in-house production or external procurement, this is also accompanied by increased planning effort in procurement. This is because either raw materials or finished assemblies have to be procured.

In the next level 3, production planning and control is reviewed. Here, for example, the PPC of HaSupMo can be seen as a strategic tool. At this level, the planning stage is reached. Planning is based on data and assumptions of the past and also the future. The examination of the already configured PPC thus shows helpful clues for an alignment of the strategy of a company based on objectives. These clues are made visible and measurable by means of the PPC the objectives of the production logistics.

The fourth level now has the goal of defining a strategic orientation for the company. Here, the logistical objectives can be defined individually within the company. For example, companies with high quality requirements, such as aircraft manufacturers, should not necessarily pursue the objectives of short lead times or adherence to deadlines as a top priority. On the other hand, companies from the consumer goods segment pursue logistical objectives such as a high finished goods inventory and a short delivery time. This strategic objective orientation forms the framework and thus indicates the corresponding scope for decision-making for the departments with a focus on the interfaces.

In this way, using functioning process flows from Level 1, the classification of components from Level 2 and reduced interfaces by means of PPC tools from Level 3, production logistics objectives can be set by strategic business decisions. Based on the management's specification of the target values, the production programme can now be adjusted again and again by the three lower levels via iteration loops, and the type of procurement and production can be regularly reviewed and adjusted. At Level 1, processes and procedures in the operational organisation can also be changed and adapted to the procedures for optimising the specified objectives.

4. Integration of PPC

Production planning and control is an instrument that regulates the processes in the internal supply chain of manufacturing companies [16]. Their tasks include the entire planning and flow of production. From processing and clarifying orders to dispatching the finished products. It plans and controls orders taking into account the available resources and in compliance with overriding corporate objectives such as delivery time, punctuality and cost minimisation. [1,16] In addition to the planning and control of processes along the company's internal supply chain, production controlling, i.e. monitoring and intervening in the event of disruptions in the production process, is also part of the PPC's tasks [17]. Because PPC includes all areas of operational production management such as procurement, production, assembly and dispatch, it forms the organisational core of manufacturing companies [1,6,16].

Due to the complexity, scope and high importance of these interrelations, there are various approaches and concepts that model the tasks and processes within PPC. These range from more technical concepts, such as MRP-I and MRP-II logic, to various frameworks, such as the Aachen PPC model [16], and specialized modelling approaches for individual PPC tasks, such as the Manufacturing Control Model of Lödding [18]. An overview of the evolution of PPC can be found in [8], [18] and [19].

A model for describing the PPC, which integrates approaches from the Aachen PPC model and the modelling of LÖDDING, is presented in the framework "Hanoverian Supply Chain Model". This approach models for the first time the link between the eleven different main tasks of the PPC and the related objectives of the entire internal supply chain (see figure 2, right-hand side) [8]. The model shows the interrelationships between the PPC tasks and the control, regulating and objective variables. The target, planned and actual variables in the material flow as well as the effects on the logistical objectives in the individual core processes of the company's internal supply chain are placed in a causal relationship [8].

4.1 Plan Sourcing in HaSupMo

Focusing on managing the supplier network not only vertically but also horizontally, the share of external sourcing is becoming higher and higher, which is why the importance of procurement is steadily increasing [20]. In the PPC of HaSupMo, the central procurement tasks are controlled in the PPC main task “Plan Sourcing”. As the main task of the PPC, it is the central interface between procurement and the company's internal production and therefore of great importance for the company's success [16]. The PPC main task “Plan Sourcing” is divided into five sub-tasks that cover the entire procurement process (see figure 2, left-hand side).

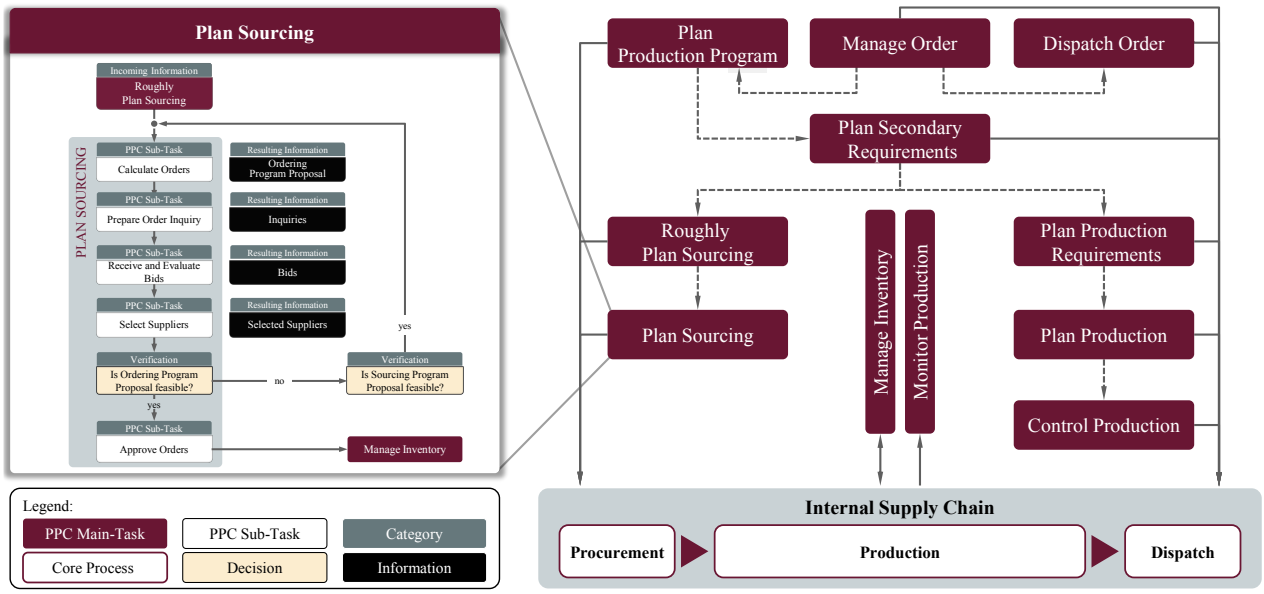

Figure 2: PPC-Main Task Plan Souring and the Hanoverian Supply Chain Model according to SCHMIDT AND SCHÄFERS [24] and SCHMIDT AND NYHUIS [8]

The first sub-task is "Calculate Orders". Here, an order programme proposal with the optimal order quantities and times for requirements to be procured is created from the determined primary and secondary requirements. From the order programme proposal, which contains the determined order quantities and times, in the following sub-task “Prepare Order Inquiry” concrete inquiries can then be made to the already selected suppliers. In the sub-task “Receive and Evaluate Bids”, based on the inquiries, the suppliers can in turn create offers from which the company can subsequently select the most optimal offer according to the target premises. The "Select Suppliers" task is carried out from the analysis of the offers, taking into account the price, quality and logistical performance of the suppliers. [21,22,23] After the suppliers have been selected, the "Approve Orders" are placed. If no "Approve Orders" are placed, the system then checks whether the external procurement programme is feasible so that it can be carried out again from the "Calculate Orders". If the external procurement programme cannot be carried out, a message is sent to the PPC main task "Plan Production Requirements", which then checks the consequences for in-house

production. As a result, the rescheduling of individual orders or in-house production of outstanding requirements can be initiated. [8]

4.2 Influence of logistical Objectives for Procurement

According to the PPC definition of HaSupMo, “Plan Sourcing” influences the objectives of inventory, due date Compliance and service level, or expressed the other way round, delivery delay, in the core process of procurement, the first core process in the company's internal supply chain [8]. As already mentioned, the task in procurement is to cover the needs that are not covered by the company's own production [1]. The inventory is formed from the stored articles [25]. Inventory results in inventory-induced costs, e.g. through capital commitment or inventory costs. Therefore, inventory should be kept as low as possible in order to keep inventory costs low from an economic point of view [1]. The service level is an important indicator of a company's logistics performance. It indicates what percentage of the demands from the inventory could be served in the right quantities and at the right time without a delivery delay or failure (see figure 3) [25,26].

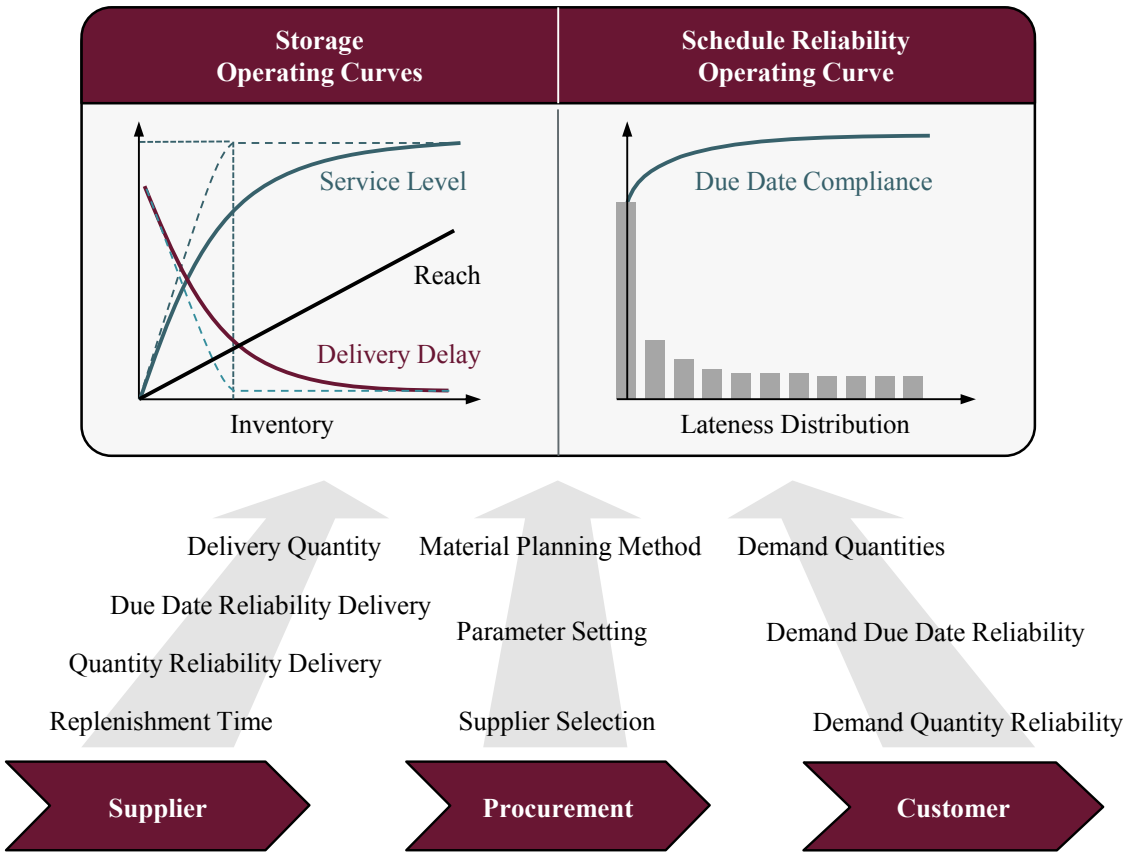

Figure 3: Influencing Factors of Storage and Schedule Reliability Operating Curves according to LUTZ [25] and NYHUIS AND WIENDAHL [27] and NYHUIS AND MAYER [28]

For this reason, the target is to achieve the highest possible level of service, as this demonstrates a high level of logistics performance and is synonymous with low delays in delivery from the warehouse compared to production [8]. The "due date compliance" results for order-specific procurement and shows the share of orders that are available in terms of quantity and on time [18]. Similar to the "service level", the aim is to achieve the highest possible "due date compliance". As the average inventory of stock items and directly procured items increases, the logistics performance in the form of the logistics objectives "service level" and delivery delay is positively influenced. In addition, this is accompanied by an increasing range, while at the same time logistics costs rise. This demonstrated influence of logistical objectives illustrates that a clear strategic orientation is of high importance for the configuration of the PPC. A clear positioning between the logistical objectives can only be achieved in this way.

4.3 Conflict of Objectives

In logistics target achievement, it is often necessary to position the company between logistics costs and logistics performance as shown in figure 4 [25]. In order to be able to achieve a high "service degree" in the procurement, the stock (high) is largely dependent on the access lot size and the performance of the supplier or the safety stock. By a transparent communication with the supplier and a purposeful production planning the performance can be besides substantially affected. If this is not the case, there is a risk of failures or delays if warehouse demands cannot be met. As a result, the objective "service level" cannot be sufficiently fulfilled. [8] The same situation exists for the objective "due date compliance". To ensure availability at the time of need and to avoid interruptions in production, safety times are included as buffers for procurement, which subsequently result in higher inventories and thus higher logistics costs. [1] In order to guarantee these conflicting objectives of high logistical efficiency and high logistics performance with low or optimal logistics costs, these differences must be minimised and optimally positioned to meet the company's internal needs.

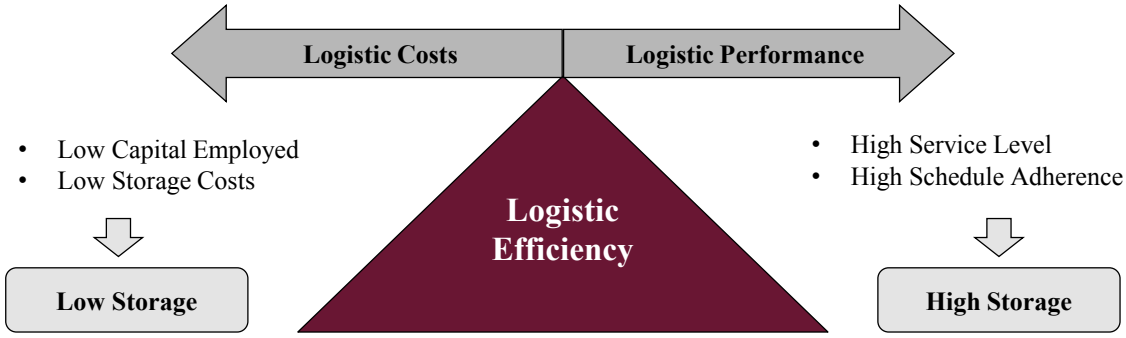

Figure 4: Logistical target system and conflicting objectives of procurement according to LUTZ [25]

For a holistic view of the conflicting objectives, an exact process-related localisation of the problem area is therefore important for a later synchronisation. The interaction of different areas of the company-internal supply chain often forms the area of tension, since procurement and production often pursue different interests and do not submit to the superordinate objectives through company specifications.

In order to obtain a standardised view of this interface between procurement and production, the production logistics objectives, as described in the HaSupMo, form a standard basis for evaluating and assessing these conflicting objectives. This is because direct conflicts are usually visible and can be made measurable. Indirect impacts, on the other hand, such as the influence on objectives, which is difficult to measure, can only be tracked via a strategic determination of defined objectives.

The approach presented in chapter 3.2 of using the PPC as a tool for checking the strategic alignment in controlling production for the production logistics objectives makes it possible to optimally match the required capacities with the order situation. Early information from production can be checked and adjusted with the interface to the supplier. With a lead time, determined capacities can be expanded or reduced within a certain framework at an early stage via external procurement. On the other hand, in-house production serves as a further balancing instrument that can cushion possible fluctuations. This type of general make-or-buy decision of dependent requirements makes it possible to achieve optimal values for production logistics goals and can thus be evaluated as an important mainstay. However, it must be taken into account that the framework for capacity adjustment of this kind is always tied to the flexibility of the products of the dependent requirements and the company's own vertical range of manufacture.

The order situation is often subject to predictable and unpredictable fluctuations in the course of a fiscal year. This is due to a variety of different factors. For a manufacturing company, however, capacity-adjusted utilization of the available resources in defined planning periods is necessary in order to avoid transferring

fluctuations in incoming orders directly to production. As shown in chapter 3, the use of a PPC offers the possibility to detect any changes at an early stage and to react to them proactively. In order to optimally supply a production with the planned demand, not only a good and dense supplier network is necessary, but also a suitable configuration of the PPC, as this already provides a lot of information for the interface observation.

5. Conclusion and Outlook

In the context of this paper, a model-based analysis for the interface of procurement and production was conducted. Based on the challenges in the production-related environment, the necessary prerequisites and structures were pointed out that are required for a sensible integration and configuration of a PPC.

The approach to the interface analysis presented in chapter 3.2 points out in the first step that interfaces from the operational level up to the strategy definition should be regarded holistic. This approach offers the advantage of being able to control the defined corporate strategies hierarchically in the further development. Especially the question of the make-or-buy decision for affected components significantly influenced the capacities in defined time periods. However, these affected components have the positive side effect of being able to compensate for fluctuations that occur by means of targeted control of the PPC deficits or capacities. Based on the HaSupMo, the interface of the dependent requirements planning was localised as the interface between production and procurement. Depending on the allocation of products, the main PPC task of Plan Sourcing presented in chapter 4.1 is significantly influenced. These effects also represent an influence on the production logistics objectives, which serve as a control option.

Nevertheless, the results presented are characterised by basic theory that still needs to be transformed for practical use in the future. Further research activities are to be carried out in the validation of the presented results in the production environment. Despite this, it can be stated that the entrepreneurial focus should be on a sophisticated PPC and its influence on logistical objectives to be able to react successfully and proactively to dynamic market movements.

Acknowledgements

The project “Systematic analysis of the effect of production planning and control processes on logistical objectives” leading to this paper is funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – 434659386.

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Biography

Simon Hillnhagen (*1989) studied industrial engineering at the Leuphana University of Lüneburg and has been working as a research assistant at the Institute for Product and Process Innovation (PPI) since 2020 in the field of production management with a focus on production planning and control.

Selim-Hendrik Koller (*1998) studied Business Administration at Leuphana University of Lüneburg. Since 2021 he is studying European Management at the Eberhard-Karls-University of Tübingen and the EM Strasbourg Business School.

Alexander Mütze (*1994) studied industrial engineering at Leibniz University Hannover and has been working as a research assistant at the Institute of Production Systems and Logistics (IFA) since 2018 in the field of production management with a focus on production planning and control.

Peter Nyhuis (*1957) studied mechanical engineering at the Leibniz University Hannover and subsequently worked as a research associate at the Institute of Production Systems and Logistics (IFA). After obtaining his Dr.-Ing. doctorate, he was habilitated before working as an executive in the field of supply chain management in the electronics and mechanical engineering industry. He has been head of IFA since 2003.

Matthias Schmidt (*1978) studied industrial engineering at the Leibniz University Hannover and subsequently worked as a research associate at the Institute of Production Systems and Logistics (IFA). After completing his doctorate in engineering, he became head of Research and Industry of the IFA and received his habilitation. Since 2018, he holds the chair of production management at the Institute for Product and Process Innovation (PPI) at the Leuphana University of Lüneburg. In addition, he became the head of the PPI in 2019.