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Overall commissioning effectiveness: systematic identification of value-added shares in material supply

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Abstract

The increase of customized products and the associated decrease in batch size as well as a rising variance of required parts lead to more complex material supply processes. Additionally, the customer places an increasing emphasis on meeting delivery dates as well as on shorter delivery times which both require especially reliable and efficient logistics processes. One approach to increase the efficiency is the transfer of lean thinking to logistics processes, which implies a reduction of waste. Currently, only basic approaches to apply lean production methods to logistics exist. Literature review shows that they are insufficient as they don't detect reasons for waste systematically and give advices to reduce it.

The focus of this article is therefore the development of a tool for quantifying value-added shares in material supply as a main task of logistics. First, it is examined to what extent logistics activities can generally be classified as value-adding. Subsequently, the Overall Equipment Effectiveness (OEE) analysis, which is so far used to evaluate the efficiency of production systems, is transferred to commissioning as one part of the material supply process. The value-added shares of commissioning are identified and reasons for losses are discussed. Finally, a case study in the Process Learning Factory CiP validates the approach. Through the application of this tool, it is possible to identify losses and thus increase the efficiency of logistics processes.

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1. Introduction

Driven by the increasing diversification of product ranges, the product variety rises constantly, whereas lot sizes decline simultaneously [1]. Smaller batches have to be delivered directly to the assembly location, which in turn implies higher frequencies of material supply. Sequenced subsets and supply in lot size one are frequently required, which increases complexity of upstream logistics processes [2]. Associated by this development, customers demand shorter delivery times and reliable delivery dates [3], which calls for efficient logistics processes [4]. Additionally, production processes are relieved constantly from material handling processes while the effort in logistics increases. Hence, the aim is to improve both areas, production and logistics. Methods of lean production, which aim at the prevention of waste, represent a promising approach [5]. Nevertheless, their application in the fields of

logistics is still limited [6]. Until now, there is no consistent understanding, which KPI to use for the evaluation of leanness in logistics processes [7]. In the following chapters an instrument is developed in order to identify waste in production logistics and evaluate the system regarding the share of waste activities.

2. Literature Review

2.1. Evaluation of logistics performance

Material supply as a part of production logistics covers the whole process from goods reception to the storage at the point of use [8]. Its task is to provide material for the utilization during the execution of tasks in the demanded quality and quantity in the correct time slot at the right place [9]. The execution of material supply comprises the physical activities

of storing, commissioning, transporting and handling at the workplace [9]. In order to evaluate logistics processes regarding their performance, a number of approaches exist [10 - 20]. Approaches to transfer the methods of lean production to logistics are available, for example in the sense of a logistics oriented value stream analysis [21] or in several KPI systems [7], maturity models [22] or recommendations for the implementation of lean logistics systems [4,23- 25]). Nevertheless, none of the mentioned approaches allows the detailed analysis of the several functions of material supply regarding waste and value-added shares. Hence, an analysis instrument needs to be developed, to point out value-added parts of material supply and causes for waste, so that leanness and efficiency of this area can be evaluated. An instrument, which seems appropriate, is the Overall Equipment Effectiveness (OEE), which traditionally is applied in the fields of production system efficiency.

2.2. Overall Equipment Effectiveness (OEE)

OEE is a common approach for the measurement of production equipment efficiency and originated in the frame of lean management with the introduction of Total Productive Maintenance [26]. It is a quantitative approach, which aims at the improved utilization of production equipment. Apart from preventive avoidance of downtimes, it also aims at the continuous improvement of equipment availability. The objective is to rise output and reliability of production equipment through identification of relevant types of waste. Types of waste are losses in availability (downtime losses, setup and adjustment losses), losses in output (speed losses, idling and minor stoppage losses) and losses in quality (defect and yield losses) [27,28]. The calculation of the OEE is carried out by multiplying the three dimensions availability rate, performance rate and quality rate, which are influenced by the losses. Alternatively, the performance indicator can be calculated by subtracting all losses from the planned operating time and dividing this result by the planned operating time. The advantage of this instrument is that apart from the mere calculation of the KPI the analysis of losses during line operation is also possible. By considering these dimensions it is feasible to recognize optimization potentials in the three areas to improve those factors and subsequently the OEE. In recent years, it was observed that the concept can be transferred to other production related areas and serves as a measure for process efficiency [31,32,30,29]. From this point of view the transfer of the concept to material supply seems promising to differentiate waste from value-adding tasks and hence make losses and optimization potentials visible. Beforehand it has to be discussed, to which extent logistics can be seen as a value creating process.

2.3. Understanding of added value in logistics

Added value describes activities during the product creation process, which lead to an increased product value for the customer. Auxiliary processes, this means non value-adding but necessary activities are non-preventable activities during the product creation process. Waste describes activities

Logistics as a...	Dickmann (2007)	Durchholz (2013)	Faust (2009)	Gorecki/Pautsch (2013)	Ohno (2013)	Pfohl (2010)	Richter (2006)	Zollondz (2013)
non value-adding activity	●			●	●			
necessary, but non value-adding activity			●				●	
potential value-adding activity		●				●		○

● Explicitly mentioned ○ Implicitly mentioned

Fig. 1. Understanding of value creation in logistics (referring to: [5, 34, 35, 36, 37, 38, 39, 40])

during the product creation process, which do not contribute immediately or indirectly to a rising product value [33]. Figure 1 gives an overview on the literature on the understanding of value-added in logistics.

According to the literature, the product value is not only a result of the product's functions and shape, which are determined in the production process. Moreover, the satisfaction of needs arises from benefits of a product in the customer's point of view. Correspondingly, next to the technical gain of a product, other benefits e.g. from access rights, time and place and also informational benefits can be identified [38]. Time and place benefits and partly informational value can be created in the logistics system. Hence, the value, which is demanded by the customer, consists of goods (the physical object) and services (point of time and place). While production processes influence the good's value, efficient logistics rise the services' value. As all other processes in the organization, logistics processes compose of value and waste. Consequently, value-added shares have to be increased [35].

For the classification of logistics activities, the differentiation into multiple types of output like effective output, supporting output, idle output and failure output referring to [41] seems to be suitable. Effective output are all activities, which raise the product value from the customer's perspective, e.g. construction and assembly tasks. Supporting output are activities, which enhance the effective output significantly. Hence, they contribute indirectly to the increase of value and have to be planned explicitly [42]. They are not perceived by the customer, but nevertheless need resources. For this reason they have to be designed as economical as possible. Zollondz counts logistics as a part of this category [40]. In contrast to effective or supporting output, idle outputs (e.g. interruptions of production process, repeated work, waiting times [42]) exert no positive influence on the product value. They increase manufacturing costs, but don't help to achieve higher prices due to their lack of added value. Failure outputs are planned as effective or supporting output, but are executed with errors [42]. For the categorization of material supply activities into value and waste, this presented approach is used. However, in the frame of effective output, the five types of benefit referring to Pfohl are used [38]. Hence, the effective output comprises activities, which increase the technical, informational, place or time benefit or the benefit of access rights of the product.

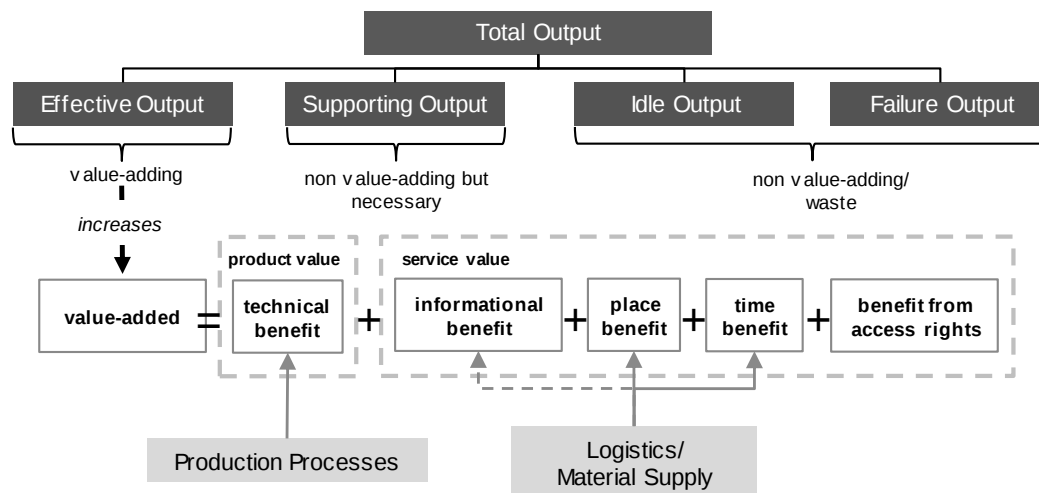


Fig. 2. Logistics in the concept of value creation (referring to [35,38,41])

The value of goods creates the technical benefit, whereas the other types of benefit emerge from the service value (see figure 2). Thus, logistics can have a positive influence on the customer's benefit and activities of material supply are part of the effective output. While effective output is value-adding, support output is not value-adding but necessary and idle outputs and failure outputs are waste.

Consequently, it has to be investigated, how activities of material supply can be classified regarding the concept of value-add.

3. Transfer of Overall Equipment Effectiveness to material supply

3.1. Overall Commissioning Effectiveness

It is conceivable that OEE, which has been transferred to other fields already, can be applied in material supply. In fact, OEE doesn't take into account the human factor, but Homuth and Künzel [43] show in the shape of process OEE, that this is feasible and reasonable. The objective is to identify the essential types of waste in material supply in order to locate starting points for the optimization of valued-added share in material supply. For the deduction of conclusions about waste in material supply, KPIs for each function of material supply have to be developed and linked to each other. For the development of the approach, losses have to be identified and classified for every department. This article focuses on commissioning, which is the task to create subsets (products) of a total set of goods (assortment) based on requirements (orders) [44]. Hence, the term Overall Commissioning Effectiveness (OCE) analog to OEE is defined.

By combining the approach of OEE and the concept of value creation in logistics (see figure 3), total commissioning time can be divided in the constituents depicted in figure 3. The picking time comprises the activities from withdrawal of parts from provision stock until deposition in a commissioning container. Picking processes are carried out without a change of place of the commissioner in the

provision stock area. Organizational time is the time, which is spent on activities, which enable the execution of picking activities. They include activities, which take place both before or after the actual picking process, for example identification of the storage yard, reading the picking list or acknowledging the withdrawal.

Table 1. Examples for types of losses of the OCE

Type of loss	Example
Repairs/ Maintenance	- IT-System - conveyer - cleaning up
Waiting time	- for materials at the stock - for commissioning container - until storage for terminated orders is free - until PC-Terminal is available - for new order
Speed losses	employee works slower than expected (e.g. due to incorrect planning of standard times or because employee is new and still in development stage)
Downtime losses	- walking time - personal time losses, as coffee breaks, idle work, unplanned pauses
Defect losses	- picking of wrong parts - picking of wrong amount
Yield losses	damages of parts during commissioning process

The time, in which no work is done, consequently is denominated by ineffective time (for examples see table 1).

Regarding the process of commissioning, arising losses can be defined according to the production equipment OEE and the concept of Zollondz [40] (see table 1 and figure 3).

Planned work time is calculated by subtracting planned breaks and shift meetings from the theoretical work time. From this time, shares, in which the system is not available (availability losses) have to be subtracted.

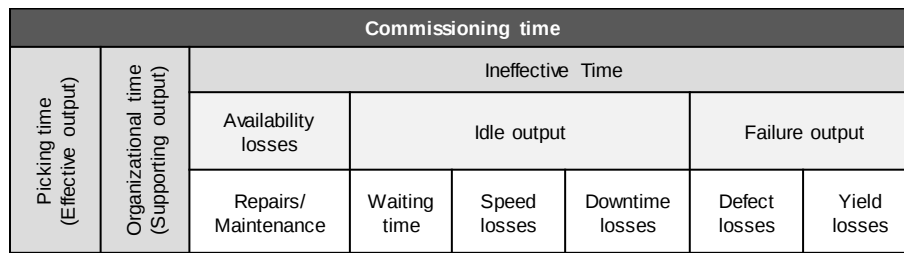


Fig. 3. Composition of commissioning time (referring to [45,46])

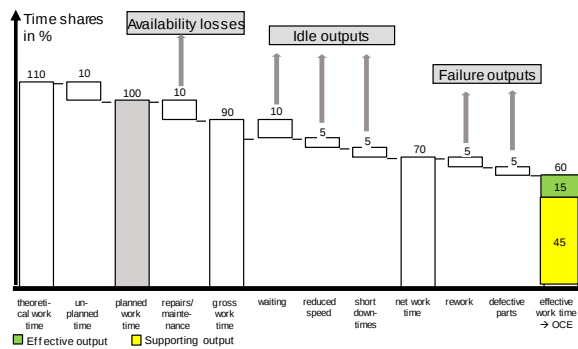


Fig. 4. Exemplary Diagram of Overall Commissioning Effectiveness

For further classification of losses types of output of the value-added concept are taken into account. If idle outputs, which arise due to suboptimal planning (speed losses, short downtimes and waiting time) are subtracted from the planned work time, the net work time is obtained. Effective work time (and hence OCE) results from subtracting the failure output in the shape of defective parts and rework. Effective work time can be divided in supporting (organizational time) and effective (picking time) output. By analysing the task of commissioning, qualitatively the following diagram (see figure 4) according to the types of output from Zollondz with the resulting OCE can be obtained.

3.2. Validation in the Process Learning Factory CiP

A commissioning process for transmission motors serves as a basis for validating the method. The product can be assembled in 2000 different variants. For supplying the material a commissioning process is needed which selects the parts. Afterwards the commissioned material is delivered to the assembly line. There are five types of orders with different planned times for commissioning which result from time studies. The commissioning process starts with checking the list and searching for the parts needed. Afterwards the parts for the motor and the gearbox are picked and placed in a container. The process ends with placing the picking list to the parts and provide the container to a shelf. This process is analyzed by the developed approach.

The default cycle time comprises of picking time (effective output) and organizational time (supporting output). Thus, the type of waste “reduced speed” is calculated by the expression:

$$\text{Reduced speed} = \sum_{k=1}^n (\text{cycle time}_{\text{real}_k} - \text{cycle time}_{\text{plan}}) \quad (1)$$

k: number of orders

Hence, the difference of actual commissioning time, consisting of actual picking and organizational time, and of the planned commissioning time is calculated. The planned commissioning time is obtained by multiplying the cycle time, consisting of planned picking and organizational time, with the number of (successfully) completed orders. Effective work time is calculated by subtracting of all types of waste from the theoretical work time.

3.3. Discussion of the results

The results can be transformed to a diagram by data analysis and the KPI OCE (29.6%) can be calculated (see figure 5). The largest type of waste is reduced speed of the commissioner (20.4%), that is the time, which differs from the specified time. Walking time (short downtimes) of 17.2%, waiting times (14.81 %) and cleaning times (10.9%) also form part of the relatively low OCE. In contrast there are only few failure outputs. The biggest lever for correction measure to increase the OCE lies in the availability losses and idle output.

In order to distinguish between effective output (picking time) and supporting output (organizational time) separated scheduled times for organizational time and picking time must be provided and not only an overall scheduled time for both parts as in the given example.

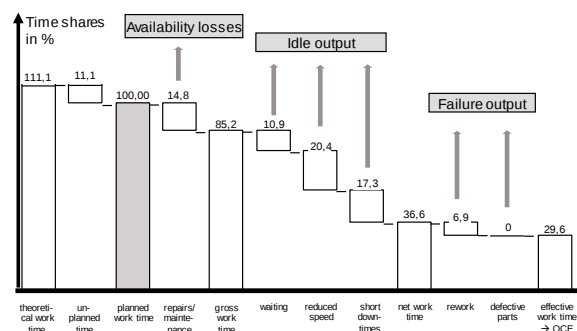


Fig. 5. Evaluation of OCE in the Process Learning Factory CiP

Based on this diagram, it is possible, to take and prioritize measures for the reduction of losses and waste of the commissioning process in order to raise the value of this KPI and improve the commissioning process. In this example the next step is the further analysis of the most important loss, the reduced speed of the commissioner. A detailed recording of the commissioner's sequence can provide reasons for this type of loss and measures can be initiated and evaluated, e.g. using picking technologies (pick-by-light, pick-by-voice) in order to accelerate the process. Because of the possibility of false cycle times as the cause for reduced speed they have to be reviewed.

4. Conclusion and outlook

The goal of the presented article was the development of an approach, which supports help to identify and eliminate waste during material supply. Therefore a concept is presented, which analyses the understanding of value-added in the context of material supply. Partially, the concept differs significantly from the widespread perception that only production processes increase customer's benefit and hence are value-adding. In the framework of this model, five dimensions of customer's benefit are distinguished and potential influences of material supply on these types of benefit are examined. It is shown, that also logistics exert an influence on the product value and value-adding components. Subsequently an instrument to reveal waste of production equipment, which is known from the fields of production was transferred to material supply and a KPI for the value-added share of the process was developed. Additionally, the term Overall Commissioning Effectiveness has been introduced.

By applying the method to commissioning process serving the transmission motor assembly the general practicable implementation was shown. The visualization of the results by the diagram allows a quick and intuitive analysis of the types of waste. Besides the utilization to identify potentials of waste reduction the method can be used for internal and external benchmarks. During the application it has to be considered that problems can arise at the exact measurement of particular time shares. Organizational times, for example the identification of a stock place of an item, are not only executed before the actual picking process, but to some extent occur between the picking processes. Nevertheless it is not evident from the KPI if the organization of material supply may be completely restructured. Improvements on that basis can be undertaken only in existing logistics systems. Recommendations, which type of material supply (e.g. commissioning, sorted supply at place of use) is suitable, cannot be drawn.

Further need for investigation is identified in the following areas:

- Broader development of the method by inclusion of adjacent departments, as for example production, with the object to display effects of optimization measures of material supply on the value-adding process in assembly.
- Elaboration and validation of the method in the areas of internal transports and storage and combination to an overall KPI.

- Analysis of potential opportunities for optimization, which can be identified with the developed method.
- Examination, if electronic collection of the KPI can be facilitated, without the user being dependent on manually entered data.

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