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SELECTED TOPICS OF THE SUPPLY CHAIN MATRIX UNDER CUSTOMER AND PROCESS UNCERTAINTIES

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ABSTRACT

This work has investigated four selected topics of the Supply Chain Planning (SCP) Matrix to deal with uncertainties (customer and process) in production planning. The topics are focusing mainly on intra-company planning tasks such as Master Planning, Demand Planning, Production Planning and Scheduling. Moreover, the associated hierarchical planning structure of such planning tasks has also been highlighted.

1 INTRODUCTION

The focus of the Supply Chain Planning matrix (Rohde et al. 2000, Stadtler 2005) is on supporting the material flow across the supply chain and its related business functions: (I) purchase (procurement), (II) production, (III) distribution and (IV) sales (x-axis). On the y-axis the associated hierarchical planning tasks, from aggregated long term to detailed short term, are considered. Analytic methods such as basics of queuing theory and discrete event simulation framework presented in (Hübl et al. 2011) are applied to solve the problems in this work.

2 RESULTS

Part one focuses on the hierarchical planning structure by investigating the optimal treatment of the metrics utilization on each hierarchical planning level. It has been identified that controversial objectives in long term, medium term and short term planning results in the following advices. For long term planning tasks high utilization due to accounting leads to a high Just-In-Time (JIT)-intensity. Medium term planning, however, focuses on the flexibility of the workforce to compensate customer fluctuations which again results in a maximization of utilization. It is shown that the short term decisions avoiding waste based on the seven zero philosophy leads to minimizing the metric utilization. This results in the main finding that if a high JIT-intensity is reached, it is possible to reduce excess capacity or sales can be increased with no additional investments. In further research, an empirical study to confirm the presented relationship between JIT-intensity, utilization and profit/revenue should be carried out.

In stochastic environments, where practitioners have to deal with customer and process uncertainties, information processing is an important issue to ensure a competitive environment for the manufacturing companies. In part two (Altendorfer et al. 2014) a decision support system for setting the capacity provided based on the capacity demanded is developed. Based on the information available due to enterprise resource planning systems, production data acquisition systems and/ or manufacturing execution systems the decision maker can add or neglect information for processing time uncertainties or customer uncertainties to determine the capacity demanded. Depending on capacity demanded some methods supporting the Master Planning for calculating the capacity provided are developed. The main finding in this chapter is that methods, which use both processing time distribution and the customer required lead time distribution, are most efficient. It is shown, however, that too much capacity flexibility can lead to overreactions and the performance measured by service level and tardiness decreases. In this part also a simplified production system consisting of a m/m/1 queuing system. This system is extend, so that the system can switch from a low production rate to a high production rate whenever the WIP exceeds a certain level. Since the transient behavior at the switching point is neglected the error of this assumption is analyzed. Again, too much flexibility in capacity provided leads to a worse performance of the logistical key performance indicators. Moreover, based on the density function of production lead time a optimization problem for identifying the optimal switching point for the m/m/1 is suggested for further research.

Part three is dedicated to the module Production Planning of the SCP matrix by focusing on Conwip. The classical Conwip system where the WIP is contrained by the Wipcap is compared to a Conwip system where the Wipcap constrains WIP+FGI. Moreover, a safety stock for finished items is implemented for both scenarios. The main finding is that the tested Conwip systems where only the WIP is constrained outperforms a system where WIP and FGI are constrained. The safety stock is not needed in the current setting of the production system. It is shown that the work-ahead window is almost independent of the customer required lead time distribution for the minimum cost scenarios. Further studies where different configurations of production systems in terms of complexity (e.g. stochastic parameters, amount of machines) are suggested for further research since due to computational power a limit set of scenarios could have only been test.

The Scheduling module of the SCP matrix is focused in part 4 (Hübl et al. 2013). Since most real-world application are NP-hard problems dispatching rules are applied in practice very often. A theorem for multi-stage production system for calculating the average production lead time based on the covariance of processing and queuing time and the "processing time weighted average production lead time" is formulated. For single-stage production system the influence of different dispatching rules on average production lead time is proven analytically, whereby insights for multi-stage production system are gained by discrete event simulation. One of the main findings is that the "processing time weighted average production lead time" for multi-stage production systems is not invariant of the applied dispatching rule. The reason for that is that the dispatching rules reorder the input stream in the next subsystem. A managerial insight is that the "processing time weighted average production lead time" serves as a dispatching independent indicator for single-stage production systems for identifying the behavior when applying a certain dispatching rule. The analytical proof of Theorem 2 for multi-stage production systems needs to be postponed to further research.

3 REFERENCES

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