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Hybrid Production Strategy Between Make-to-Order and Make-to-Stock – A Case Study at a Manufacturer of Agricultural Machinery with Volatile and Seasonal Demand

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Abstract

Manufacturing companies want to implement the make-to-order (MTO) strategy to be more flexible and responsive to the volatility of demand and product variability. However, the make-to-stock (MTS) approach is an appealing concept due to its desirable performance properties: high capacity utilization, high availability and short lead times. This paper aims to define a methodology that combines the advantages of MTO and MTS. The evaluation of the production strategies is based on an industrial case of a global manufacturer of agricultural machinery and is accomplished with the help of System Dynamics.

Keywords: Hybrid Production Strategy; Customer Order Decoupling Point; System Dynamics; Industrial Case Study

1. Introduction

In the evolution of production systems, mass customization is playing a major role because markets have changed from supplier to buyer markets. Hence, manufacturing companies want to implement the strategy of make-to-order (MTO) supply chains to be more flexible and responsive to demand volatility while also providing higher product variability [1, 2]. The increasing interest in product customization is explained by the fact that customers are demanding highly customized products and services [3]. Furthermore, customization is also driven by marketing since it provides manufacturing firms with an approach that is claimed to improve its competitive position [4]. Especially, the market performance measures like high service rate and short lead times of customized products are unique selling proposition [5]. Generally, in an deterministic MTO supply chain the processes can respond to the actual customer demand when it occurs. However, firms suffer from increased vulnerability due to variations (e.g. demand fluctuations) and disturbances (e.g. material supply issues) that lead to unpredictable effects and destabilize the equilibrium of MTO supply chain. The required adaptability (e.g. flexibility) of spare production capacities to variations (e.g. seasonal or volatile demand) is limited due to the associated costs. Hence, the production concept of MTS is appealing due to its desirable performance properties: high capacity utilization and short lead times. As a result, the desired market performance of a MTO supply chain can be achieved only at the costs of the operational performance to meet seasonal and volatile demand. Accordingly, the success of the MTO strategy does not entirely reach expectations.

Consequently, the focus of this contribution lies on an evaluation of a *hybrid production strategy* between MTO and MTS to achieve market and operational performance. In the academic literature, the topic of choosing the right product delivery strategy (PDS) and the design of downstream (agile approaches) and

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upstream (lean approaches) processes from the customer order decoupling point (CODP) are widely discussed [2]. However, these discussions insufficiently cover the implications of the right production strategy for companies that operate in seasonal markets with volatile demand. This contribution addresses this gap through a methodology that defines a *hybrid production strategy*.

2. Related Literature

2.1. Customer Order Decoupling Point (CODP)

The PDS is defined by the position of the CODP in a supply chain. The CODP defines the stage in the manufacturing value chain, where a particular product is linked to a specific customer order [6]. Sharman [7] defines the CODP as the point where product specifications are typically frozen. As a rule, the CODP also coincides with an important stock point from which the customer is supplied [8]. On the downstream side of the CODP the finished goods are pulled by customer orders. On the upstream side, the production is driven (pushed) by forecasts. The MTS approach is characterised by high customer anonymity in the supply chain, short order-to-delivery time, high importance of forecast accuracy, high inventory costs and high capacity utilization in the supply chain. Many manufacturers follow the vision of a CODP that allows MTO production. However, the decision of the CODP, which also implies the PDS, has to consider the variations, disturbances and capacity limits in the supply chain. In general, these aspects get too little attention in the design of supply chains and the choice for a production strategy. As a result, the dynamics of crucial parameters and the limits of adaptability have to be respected when choosing the right PDS.

2.2. Approaches to Define a PDS

This subsection illustrates three approaches for defining a PDS by considering selective criteria. First, the model from Olhager [6] defines the PDS based on two criteria: relative demand volatility (coefficient of variation, CV) and the ratio between production lead time (P) and delivery lead time (D). The CV is an indicator for the predictability of demand. Thus, in order to ensure high operational and market performance, a low CV favours a MTS strategy while a high CV leads to a MTO strategy. On the other hand, the ratio of production lead time (P) and delivery lead time (D) indicates that a product could be produced in less time than the customer desired delivery time. If the ratio is less than one, then the PDS is driven by customer orders. If not, then the PDS follows a MTS approach. Figure 1 shows that Olhagers's framework essentially defines whether a product will be MTS or MTO. In-between those two strategies products can also follow the strategy of ATO, which means to hold inventory of components and to assemble the final product once a customer order arrives.

The second classification approach for choosing a PDS is based on the Pareto Law, which states that 20% of the products make 80% of the total demand. The way in which these 20% of products are managed differs considerably from the remaining 80% [9]. Those 20% of products generally show high and stable volumes that makes them more predictable and, hence, more adequate for the MTS principle. The other 80% of products are more exotic with intermittent and erratic demand that caused by highly volatile demand behaviour [10]. In this case, these products are more suitable for a MTO production.

Third, a *hybrid production strategy* based upon separating demand patterns into “base” and “surge” elements has been proposed [9, 11]. Base demand can be forecasted, whereby surge demand is typically characterised by unpredictable, volatile demand behaviour. The advantage of this separation is to produce base demand on stock during slack periods to achieve a robust scheduling of production capacities, reducing the need for flexibilities. It has been shown that MTO is an adequate principle for surge demand [11]. As a result, the approach of base-surge-demand can balance the target set of production controlling, high capacity utilization, low inventory, short lead times and high service rates. In a nutshell, this approach combines the advantages of MTO and MTS production.

However, there are still gaps in regard to the applicability of the approaches i) in case of seasonal and volatile demand and ii) when considering capacity constraints while defining the production strategy. In summary, the model of Olhager, the Pareto Law and the base-surge-demand approach together create the base framework for this contribution. The following Section 3 illustrates the practicability of the approaches by applying them to an industrial case. The goal is to determine their suitability and demonstrate the necessity for a *hybrid production strategy* between MTO and MTS, which considers also the utilization of production capacities in cases of seasonal and volatile demand.

3. Case Study

The case study is based on data from the supply chain of a global manufacturer of agricultural machinery that produces combine harvesters, forage harvesters, balers, forage harvesting machinery and tractors. These markets are characterized by a series production, low and seasonal demand volume, increasing product variety and globalization of operations. Due to the competitive