

PRODUCTION PLANNING AND ACTUAL DECISIONS: AN EMPIRICAL STUDY

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Abstract

Production planning decisions are usually made by human planners that are assisted by decision support systems. While it is widely argued in the literature that current decision support systems for production planning are generally inadequate, it is not clear to what extent human planners actually disregard the planning decisions proposed by the system. In this study, we investigate this question. In a setting in which the planning system's model has an adequate representation of reality, we collect data on actual planning decisions and compare them to the planning decisions proposed by the system. We conclude that planners systematically and largely neglect the system's recommendations and that the extent of neglect is larger if the planning problem is more complex.

Keywords:

production planning, human decision making, ERP systems.

1 INTRODUCTION

Production planning systems have been deployed widely in the last three decades, with extensive presence of ERP systems. Although the presence and use of the system has been accepted in industry, the academic literature generally argues that the basic replenishment, lot sizing and production planning logic in ERP systems is incorrect and insufficiently represents the stochastic characteristics of the manufacturing system. The actual usage of the planning logic in ERP systems has not been investigated empirically, and in this study we intend to provide some initial and tentative insights into this phenomenon. We study a chemical company with a very simple material and resource structure that can be fully represented in a resource constrained single level MRP system. Data have been collected during a period of three months. During this period, both the planned orders proposed by the ERP system and the actual orders planned by the production planners are recorded and compared. Our results support the general notion that planners largely disregard the planned orders proposed by the ERP system, and that this effect is further enhanced if the complexity of the planning problem is increased..

2 PREVIOUS STUDIES

Den Boer (1992, 1994) conducted a quantitative field study on the decision behavior of material requirements planners. The model was based on the paramorphic representation of judgment (Hoffman, 1960) and contained four elements: performance, actions, disturbances and environment. Based on this study, Den Boer concluded that planners suffer from a lack of feedback in setting parameters such as safety time and safety stock. A similar study was carried out by Wiers (1996), where the decision behavior of four production schedulers in a truck manufacturing company was investigated, using a quantitative model. This model consisted of three parts: performance variables, action variables and disturbance variables. The experiences with quantitative descriptive field studies is that a wide variety of interesting conclusions can be drawn from the results, which however are not very suited to confirm or reject theories about the decision behavior of the planners. It can be expected that these studies, had there been an explicit normative behavioral model to guide the data gathering and analysis, could have contributed to behavioral theory on the human factor in planning.

Several interesting and novel results have been reported in the qualitative studies, such as the heuristics used by schedulers to avoid future problems, or the temporal aspect and the role of resource aging (McKay, 1992). A major contribution of these studies has been to move the field of study from the laboratory to the factory, with extensive qualitative empirical studies having been conducted, mostly based on ethnographic or case methodologies.

In a recent study by Fransoo and Wiers (2004), they investigated the variety of actions that planners apply to cope with the complexity of the planning problem. The methodology applied in their study is identical to the methodology we apply here.

3 PLANNING ENVIRONMENT

In this study, we are considering one business unit of a large chemical company. The business unit operates seven plants across Europe. Each of the plants consists of a number of manufacturing units (reactors). The manufacturing units produce a variety of products. The manufacturing units that are part of our study produce a chemical product which is mostly delivered in bulk (trucks or containers) to industrial customers. Although theoretically the variety of products is extremely large (due to the possibility of blending in specific additions), in reality the number of products on each of the resources is fairly limited (typically around one dozen, with a few resources producing up to around three dozen products).

The planning of the reactors has been centralized in a European Central Planning Office. All customer orders are received at the European Customer Service Center that is located in the same building. The order handlers are located in the office adjacent to the office where the planners are located. There are four planners involved with planning the reactors, and one additional planner is responsible for planning the shipments from the plants to the customers. For each of the plants, one primary planner has been allocated. Also, for each of the plants, one of the other planners acts as a secondary planner, who can replace the primary planner in case of absence. Each of the planners has primary responsibility for one or two

plants, and also carries secondary responsibility for one or two plants. Planners differ in their experience.

The production process and the role of the planner is depicted in Figure 1. We consider the planning process to the extent to which the planner influences it. The planners use an ERP system (deploying Material Requirement Planning logic, see, e.g. Silver et al., 1998, for an explanation on MRP logic) that generates planned orders. Production planning as carried out by MRP is the process of converting customer orders with a specific due date and quantity into production orders with a specific manufacturing time and quantity. A planned order can be viewed as an advise of the planning system which product to manufacture on which date and in which quantity. These planned orders are generated based on actual information regarding customer orders (actual orders placed by customers), demand forecasts (expectations of future orders made by someone else in the planning office), current inventory levels, required safety stock levels, and lot sizing rules. Customer orders and demand forecasts cannot be influenced by the planner and should be considered exogenous. Safety-stock levels and lot sizing rules are system parameters that can be set by the planner. Hence, the planner is able to change the parameters that drive the generation of planned orders. However, the planner can also choose to change every planned order individually. Note that the implementation of MRP logic in this ERP system is capacity constrained by forward loading, and that the bill-of-material consists of one level.

Every night, a new set of planned orders are generated by the system, based on the current inventory levels, the parameter settings for safety stocks and lot sizes, new customer orders that have arrived on the preceding day, and the available production capacity. New demand forecasts can be supplied every week, but in practice are only updated into the system once a month.

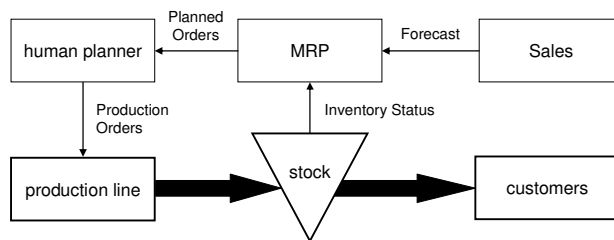


Figure 1: planning and production structure

Each morning, when the planner arrives, he sees a new list of planned orders, as well as all realized (produced) production orders on the previous day, and any manufacturing orders that have already been scheduled by him on previous days, but which have not yet been completed (either due to delay – which rarely happens – or due to the fact that the order is scheduled to be executed at a later date). The planner then needs to decide on the manufacturing orders. Using the planned orders as a suggestion, but using additional information such as inventory levels and available capacity, he needs to determine which orders actually to produce. All planning actions are considered as modifications to the originally suggested plan by the MRP algorithm.

In doing so, he can either:

- convert a planned order directly into a manufacturing order
- modify the planned order, and then convert it into a manufacturing order
- create a new manufacturing order without a planned order being present
- delete a planned order

The planner will work through the planned orders until he has processed all of them with a specific time horizon (which he can determine himself). When he has allocated all manufacturing orders to a specific time slot, his work for this specific plant is finished for the day. He may also modify any manufacturing orders that had been created on previous days. This may include moving the order backward in time (postponing the execution), bringing the order forward in time, changing the order duration (and hence the lot size), and by changing production start times the planner may change the sequence of two or more orders.

For a number of days, varying between roughly 2 and 12, manufacturing orders have been assigned by the planner to a particular reactor for a particular period. This is called the manufacturing schedule. Overnight, all manufacturing orders that are scheduled for the following day only, are released to the specific plant. The people in the plant execute the schedule according to specification.

The information flow for the planner that is supported by information systems is depicted in Figure 2. Both the input and results of the manual planning task are captured by the information system, making it possible to retrieve the data. Every day, the following information is available from the ERP system:

- complete list of planned orders
- complete manufacturing schedule (list of manufacturing orders assigned to a specific reactor in a specific time slot)
- complete list of production orders that have actually been executed

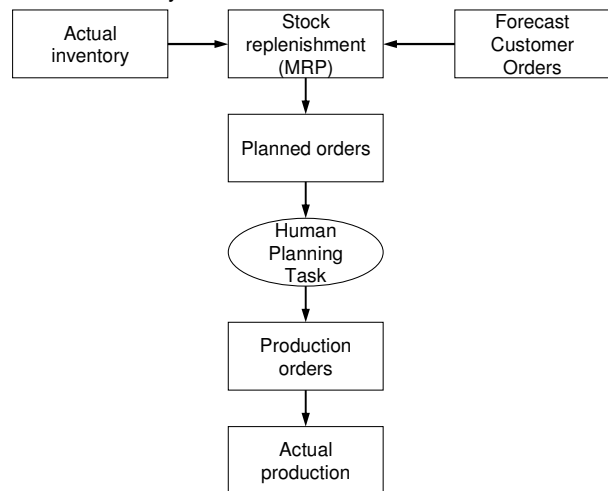


Figure 2: Information flow MRP and human planner

4 RESEARCH QUESTION AND SETUP

We are interested in the difference between the orders as proposed by the ERP system and the orders that are generated by the planners. As stated in the previous section, production orders can be either generated from

planned (proposed) orders, or they can be created by themselves. As described in Section 2, we expect production planners to anticipate required production by planning production orders before planned orders are generated. We expect that increasing complexity of the planning problem will increase this anticipatory behavior of the planner. Namely, if the planner anticipates further in advance, he will be faced with less rescheduling requirements at a later stage. Based on this reasoning, we define the following hypotheses:

H1: Planners anticipate the future by planning more orders than the ERP system suggests

H2: The number of orders independently planned by the planner increases when the complexity of the planning problem increases.

5 ANALYSIS AND RESULTS

A list has been generated with all planned orders and production orders that were planned during the measurement period. This resulted in a list of 6224 planning entries, of which 3284 are unique orders. Every entry in the production plan is either of the following cases:

- I. A production order that has been created from a planned order
- II. A planned order that has not been used to create a production order
- III. A production order that has been created without a planned order

Table 1 below shows the number of plan entries for every case.

Table 1: Plan entries

| | | | |
|------------------|-----|---------------|-------------|
| | | Planned order | |
| | | Yes | No |
| Production order | Yes | I 359 | III 1532 |
| | No | II 1393 | |

As discussed above, we expect that a planner that anticipates future events will avoid planned orders to be generated by the MRP algorithm. Table 1 clearly shows that most production orders are created by the planner without a planned order. Moreover, most planned orders are not transferred to a production order. This means that most of the output of the MRP algorithm is ignored by the planner and the bulk of the production is specified by the planner. Therefore, we cannot reject H1.

It has also been investigated if the extent to which the planner anticipates demand before the system generates a planned order depends on the complexity of the planning situation. In other words, if the number of article codes for a specific production line is higher, would there be less anticipation of production orders. The number of orders per category is visualized in Figure 3.

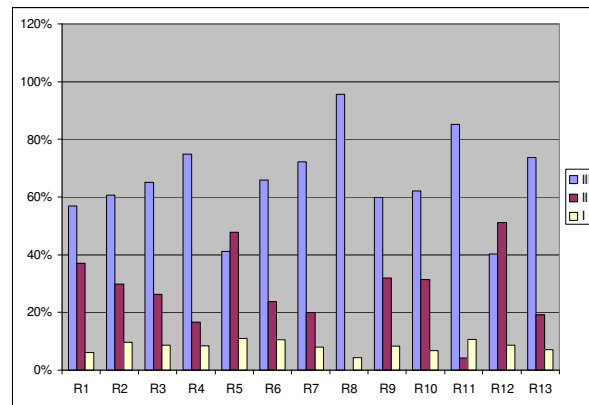


Figure 3: Number of orders per category by work center

Figure 4 shows the number of products per work center. The correlation coefficient of the category III orders and the number of unique article codes sorted by work center is .856 (< .0005). Therefore, we also cannot reject H2.

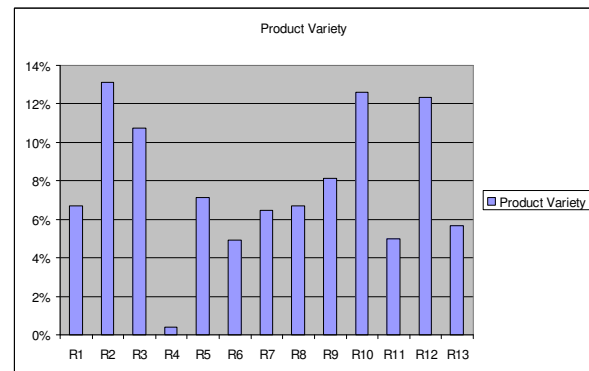


Figure 4: Product variety per work center

6 CONCLUSION AND DISCUSSION

In this paper, we have made an analysis of the decisions of a number of production planners. We were specifically interested in the extent to which they accept the suggested production orders by the ERP system in place. Based on our analysis, we have strong suggestions that planners largely disregard suggestions from the ERP system, and anticipate themselves on future orders. Obviously, the planners could avoid this by adjusting the parameter settings of the system.

Our analysis is very basic and unfortunately does not allow us to draw more advanced conclusions at this stage. The anticipatory behavior of planners is discussed in the hierarchical planning literature (e.g., Schneeweiss, 1999), but has not been investigated empirically or experimentally. We encourage further research in this area, since it is very important for the development of more effective decision support systems.

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