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Determining the changes in the Master Production Schedule (MPS) at the company with Make to Stock (MTS) and Make to Order (MTO) strategies

R Amaranti*, C R Muhammad and M V Septandri

Departement of Industrial Engineering, Universitas Islam Bandung, Indonesia

*reniamaranti2709@yahoo.com

Abstract. The master production schedule (MPS) planning is influenced by the manufacturing environment. Therefore, the process of MPS planning with make to stock (MTS) strategy will be different from make to order (MTO) strategy. The MPS is based on production capacity, changes in inventory of finished products, fluctuations in demand, efficiency and utility of production factors, and lot size. Companies with MTS strategies make production schedules based on estimated demand so that customer demand can be met from stock products. While companies with an MTO strategy make a production schedule after the order is received. This paper discusses how the time fence approach is used to change MPS for companies with the MTS and MTO strategies simultaneously. With the time fences approach, companies can determine when orders can be received or rejected by looking at the position of the order on the existing MPS. This paper describes a case of applying the time fences approach to determine the MPS changes in a garment company that produces bed covers sets as the MTS products and other products as MTO products. This paper also explains the procedures to determine changes in the MPS based on predetermined time fences.

1. Introduction

Production activities are carried out based on production plans that have been made with various considerations. Production planning involves top management decisions related to manufacturing, marketing, and financial decisions. Therefore, production scheduling becomes a very important activity in manufacturing planning and control [1]. The production plan is a plan made with the aim of minimizing costs [2]. The production plan also describes plans for the level of output based on needs within a certain timeframe [3], capacity requirements, and capacity adjustments that must be made.

The master production schedule (MPS) is a schedule created for the manufacture of finished products [4,5]. Changes to operational conditions encourage re-planning on the master production schedule. Basically, there are two conditions that lead to re-planning. First, there is a rolling effect due to the extension of the planning period. Second, when the demand is uncertain or there is a forecast error, so the plan must be modified to adjust to new information. The change was made to reduce production costs and maintain service levels. The MPS is very important to maintain customer service levels and stabilize production plans in the Material Requirements Planning (MRP) environment. When MPS is further used for material requirements planning, frequent changes to the MPS will cause adjustments to the detailed MRP schedule. Adjustment to the plan also caused additional effects on the assembly system, increased production and inventory costs, and decreased customer service levels



[6,7]. Therefore, reducing the instability of the production schedule is an important goal in MPS planning.

Production planning is a preparatory process carried out within a certain time horizon to adjust the demand with the capacity. Therefore, production planning will also be influenced by how companies manage their internal operations. Companies that operate on the make-to-order (MTO) principle tend to have more difficulty because of schedule instability than companies that operate on the make-to-stock (MTS) principle [8]. For companies with MTS strategy, the master schedule serves as the final assembly schedule and can be considered as the inventory filling schedule for finished goods. Companies with MTS strategy will have finished product inventories as a result of production plans based on the estimated product demand. Meanwhile, companies with MTO strategy allow customers to determine the desired design of the final product or service, as long as they use the appropriate raw materials and standard components. They make production plans in accordance with orders so that the production depends on the capacity requirements of each order. Manufacturing companies with two strategies simultaneously, namely MTO and MTS necessitate greater consideration in making production schedules. This is related to how the company's techniques in conducting production planning for MTS products as well as how the decision plan will be made if it faced with the arrival of an order for MTO products.

Most manufacturing companies have a time frame to determine when changes in the MPS can be made and when approval from a higher authority in the organization is needed before changes can be made [9]. This time frame is usually known as a 'time fence' system. Companies can use this time fence frame as consideration for making rescheduling decisions, especially if changes are initiated by marketing as a result of their negotiations with customers. Time fences can be used by companies to help maintain the flexibility of production schedules in the condition of companies that are facing changing demands due to impromptu orders or other production offers when the company has set up a master production schedule. Therefore, companies with MTO and MTS strategies must be able to make production plans well to avoid delays in fulfilling customer orders. Related to this problem, this paper will discuss the use of the time fence approach to determine MPS changes in companies that are simultaneously implementing MTS and MTO strategies.

2. Literature review

2.1. Master Production Schedule (MPS)

The master production schedule (MPS) provides formal details of production plans and converts them into plans for the needs of raw materials, labour, and work equipment/production machinery. Therefore, the MPS is an appropriate statement in production including product, time, and quantity for more mature planning in the system [10]. The main functions of MPS are 1) to translate aggregate planning into specific end products; 2) evaluating alternative schedules; 3) determine the production materials needed; 4) determine production capacity; 5) facilitate information processing; and 6) use capacity effectively.

Basically, the MPS is a feasible production plan that states the amount and time of production of the final product [10]. Reference Garpersz [11] outlines five main inputs of MPS, namely 1) total demand data (sales and order forecasts); 2) inventory status (on-hand inventory, allocated stock, released production and purchase orders, and planned orders); 3) production plans; 4) planning data (lot-sizing, shrinkage factor, safety stock, lead time, item master file); and 5) rough cut capacity planning information. The MPS is then used to determine the capacity requirements to meet the planned production schedule. In its implementation, checking requirements capacity can be seen from the results of the analysis of rough-cut capacity planning (RCCP). Generally, the MPS has 2 functions, specifically 1) in the short term, the MPS serves as the basis for planning material needs, component production, priority orders, and short-term capacity needs; 2) in the longer term, the MPS serves as the basis for estimating long-term demands on company resources such as human resources, factories, equipment, warehousing, and capital [10].

2.2. Time fence of MPS

Time fence is made based on MPS and is known as a tool to maintain the level of stability needed at the planned MPS. Time fences can be used to maintain the flexibility of production schedules, especially if the company is facing a changing demand situation due to sudden orders or other production offers (such as additional order for MTO products). MPS can be divided into zones to maintain schedule stability and to ensure that changes have been properly considered before they are approved [9]. Changes that can be made in each of these zones are regulated by different procedures. Changes to MPS will be easy to do if they can be achieved outside the cumulative lead time, but it will be even more difficult if they are in the cumulative lead time to the point where changes cannot be made [10]. The planning horizon and the freezing proportion significantly influence schedule instability [1].

The most important thing in establishing a time fence is to determine the exact position of demand deadline or Demand Time Fence (DTF) and the time limit of planning or Planning Time Fence (PTF) along the MPS planning time horizon. The position of DTF and PTF in the planning time horizon is illustrated in Figure 1. When additional orders fall in the period before the request deadline, the company can accept additional orders, but the order must be completed in the period zone after DTF or PTF. If it forced to be settled in the zone before DTF, it will require a large cost.

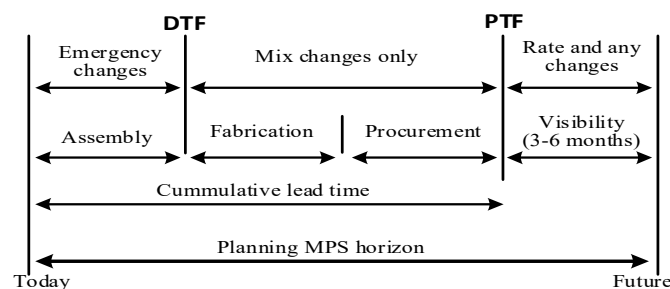


Figure 1. The position of DTF and PTF on the planning time horizon [9].

The DTF and PTF are determined based on the remaining capacity necessities in each period. The planning period can be a frozen zone if the available capacity is less than 30%. Furthermore, several periods can be regarded as slushy zones if both production capacity and availability of raw materials are available between 30% to 50%. Whereas for the period that is said to be a liquid zone is a period where production activities have not yet been carried out so that production plans can be changed.

- The left zone of the DTF is called the frozen zone. In this zone, it is very difficult to change production plans because orders placed in this zone are not based on predictions, but actual requests that must be completed immediately [12]. Schedule changes in the frozen zone can only be made by top management [13] or emergency changes with the approval of the production manager [9,10].
- The zone between the DTF and PTF is called the slushy zone. In this zone, planners cannot change the number of products without ensuring the availability of capacity and other resources. If additional orders must be completed in the slushy zone, changes to the production plan can be made with management approval [12]. If the change in the production plan is considered to increase costs, the company can reduce production for other products [9, 10].
- The right zone of the PTF is called the liquid zone. Production plans in this zone can be changed freely to handle additional orders [9], although they still need supervision. According to [10], PTF is the cumulative lead-time for most products. Therefore, if the demand is in a period that exceeds the PTF boundary, the MPS is only placed in two usage functions namely provides input for rough capacity planning and provides the best estimate for preparing components.

3. Method

This research was conducted to design flexible production planning by applying the time fences of MPS. For this reason, this research takes the case of a manufacturing company with MTS and MTO strategies simultaneously.

The steps undertaken in this study are as follows: 1) preparing a production plan based on data available at the company (for MTS products); 2) determine the time fence for the production schedule; 3) formulating a scenario of changing the production plan by applying the time fences of MPS. This research produced a flexible production plan as an effort to minimize delays in fulfilling orders while optimizing the utilization of production capacity.

The data used in this study were obtained from data recorded at the company. The results of this research can be used as a basis for making decisions on whether orders from customers can be accepted or not as well as decisions regarding changes that must be made to the MPS that have been made if the company receives additional orders for MTO products.

4. Result and discussion

This research was conducted in companies with MTS and MTO strategies. The company produces bed cover sets as MTS products and accepts orders for other products that are manufactured to order (MTO products). The company has 3 production lines namely line 1 is for MTS modern market products while the 2nd and 3rd lines are for MTS traditional market products. In this study, traditional market products are defined as the family I and modern market products as family II.

The current MPS is obtained from a production plan determined by an intuitive approach. Current production planning does not consider the possibility of additional orders, so it is often difficult to decide whether an order is received or not. This additional order is not only for MTO products but also changes in the number of products ordered for MTS products both family 1 and family 2. Additional orders for MTS products are obtained from the central company. The company may not refuse additional orders for this MTS product.

Based on the results of the calculation of rough capacity requirements, it can be seen that the total available regular capacity can meet the capacity requirements for production every month. Therefore, production can be carried out without using overtime. Changes to the production schedule are made if additional orders occur both for MTS products and for MTO products. Additional orders are grouped into two namely orders for MTS or MTO products with fabrics provided by the company and orders for MTO products with fabrics provided by consumers.

The production schedule is separated for family 1 and family 2 because the two families use different production lines. The next step is to determine DTF and PTF and divide the planning time horizon into three zones, namely frozen, slushy, and liquid zones. The results of the determination of DTF and PTF, as well as the determination of zones in the planning time horizon, are explained in Figure 2 and Figure 3. In this figure, it can be seen that the monthly production plan for the two families is broken down into weekly production plans so that the remaining production capacity is clearly visible. This capacity can be used to produce MTO product orders. From the production plan for production line 1, the production plan every month can be completed in 2 weeks so that there is remaining production capacity for 2 weeks. If additional orders occur during the planning period, the criteria for acceptance or not are described as in Table 1. The same method is used for production line 2. Decision making regarding additional orders for production line 2 is determined as in Table 2.

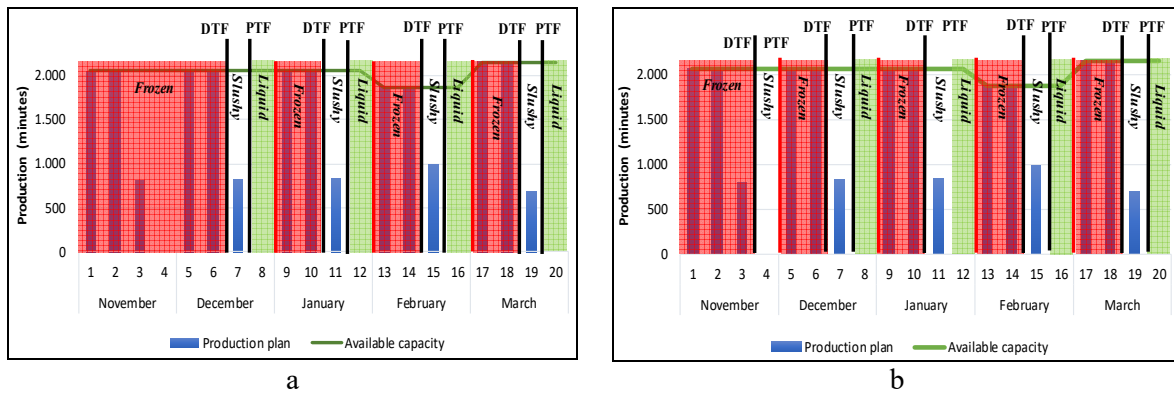


Figure 2. Time fences for MTS product family 1: a) order condition 1; b) order condition 2.

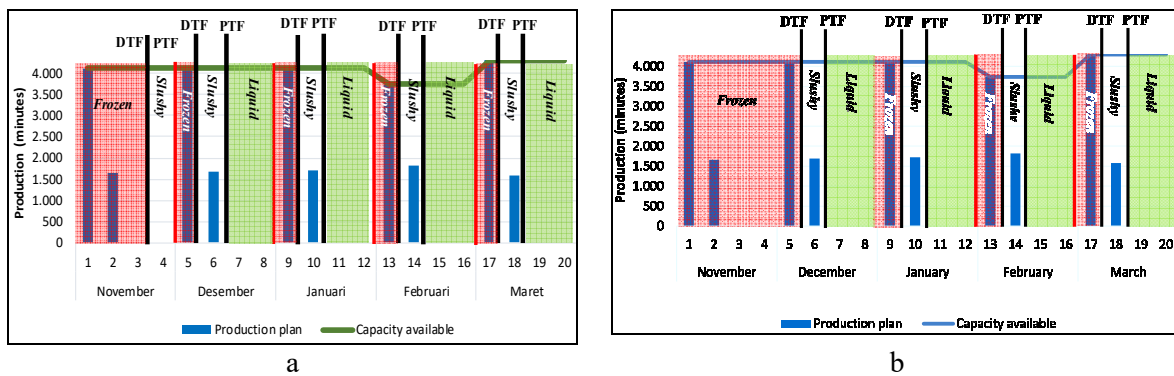


Figure 3. Time fences for MTS product family 2: a) order condition 2; b) order condition 1.

Table 1. Acceptance criteria for additional orders on production plan family 1 (production line 1).

Due date	Condition	Zone	Criteria
Week 3	1 Orders placed in week 1	Frozen	Rejected
	2 Orders placed in week 1	Frozen	Rejected
Week 4	1 Orders placed in week 1	Frozen	Rejected
	2 Orders are placed no later than week 2 and the available capacity is smaller than demand	Slushy	Rejected
	2 Orders are placed no later than week 2 and the available capacity is more than demand	Slushy	Accepted
Week 6	1 Orders are placed no later than week 2 and the available capacity is less than demand	Slushy	Rejected
	1 Orders are placed no later than week 1 and available capacity more than demand	Slushy	Accepted
	2 Orders are placed no later than week 4 and available capacity less than demand	Slushy	Rejected
	2 Orders are placed no later than week 3 and available capacity more than demand	Slushy	Accepted

Table 2. Acceptance criteria for additional orders on production plan family 2 (production line 2).

Due date	Condition	Zone	Criteria
Week 3	1 Orders placed in week 1	Frozen	Rejected
	2 Orders placed in week 1	Frozen	Rejected
Week 4	1 Orders placed in week 1	Frozen	Rejected
	Orders are placed no later than week 2 and the available capacity is smaller than demand	Slushy	Rejected
	2 Orders are placed no later than week 1 and the available capacity is more than demand	Slushy	Accepted
Week 7	Orders are placed no later than week 3 and the available capacity is less than demand	Slushy	Rejected
	1 Orders are placed no later than week 2 and the available capacity more than demand	Slushy	Accepted
	Orders are placed no later than week 5 and the available capacity less than demand	Slushy	Rejected
	2 Orders are placed no later than week 4 and the available capacity more than demand	Slushy	Accepted
Week 8	Orders are placed no later than week 4 and the available capacity is less than demand	Liquid	Rejected
	1 Orders are placed no later than week 3 and the available capacity more than demand	Liquid	Accepted
	Orders are placed no later than week 6 and the available capacity less than demand	Liquid	Rejected
	2 Orders are placed no later than week 5 and the available capacity more than demand	Liquid	Accepted

5. Conclusion

Production schedules for companies with MTS and MTO strategies are more complicated than those with one strategy. Companies with MTS and MTO strategies need to consider the possibility of additional orders and determine clear criteria for making decisions on receiving additional orders, especially when a master production schedule has been made. The determination of the time fence of MPS along the planning time horizon provides a clearer picture of when additional orders can be received and when they should be rejected. Thus, changes made to the MPS will not interfere with the MRP process and the service level can be maintained. Future research should be directed at determining alternative strategies for changing production schedules by considering the costs involved.

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