Demand Forecasting and Material Requirements Planning to Improve Production Planning of Small Apparel Enterprise

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Abstract

Aggregate planning has been widely used by apparel manufacturers to gain maximum profit by finding the optimal solution between maximizing sales and minimizing production cost. Commonly, small apparel companies use chase strategy, where production rates are varied for each time period to meet changes in demand. However, without an appropriate demand forecast and well-calculated production planning, this strategy might not accommodate the fluctuating demand. It can cause recurring product stock outs which increases the number of unmet customer demands. To improve the company's production planning, the number of demands is forecasted using single moving average (SMA) method for each week of the upcoming month. The forecasted demand is then used to plan the production quantity using Material Requirement Planning which helps ensure that all the demands are met while avoiding over-production by taking on-hand inventory into account. Comparison between the former and the improved production planning method shows an increase in the company's sales, increasing profit by 37,33% or equal to Rp3.360.000. This concludes that the method proposed in this paper can be used as a simple yet effective way to improve the apparel company's production planning, hence increasing the company's profit.

Keywords

Forecasting, production planning, fashion, and apparel.

1. Introduction

Fashion is a term that is familiar in daily life. Fashion is generally identified as clothing, in fact what is said to be fashion is everything that is trending in society. It includes clothing, appetite, entertainment, consumer goods, and others. Related to the trend in society that changes through time, the fashion industry seems an opportunity that never ends. According to Alex Thio in his book, Sociology, "fashion is a great though brief enthusiasm among a relatively large number of people for a particular innovation". The phenomenon of huge fashion demand has created consumptive behavior and the thirst of ready-to-wear apparel. It is translated by garment producers into producing the large scale of fashion products which then created a similarity of fashion on most people. This similarity of fashion encourages some people to stand out and distinguish themselves from the others, especially the younger generations, on the basis of their courage and interest in innovations (Law et al. 2014).

In order to determine the production rate to balance the customer's order, forecasting and planning play a huge role. Good forecasting and planning will lead to on-time delivery, minimum waste, and minimum production cost. To optimize the strategy, the company needs to have a well planned production as well as raw material stock schedule. Delay in the supply of materials and inappropriate storage of materials can result in delays in the completion of a project or even stopping the project, resulting in complaints and customer dissatisfaction that will decrease the competitiveness of the company (Rahmat et al.

2020). Material Requirement Planning (MRP) is a time phased-priority planning technique that calculates material requirement and schedule supply to meet demand of a product (Moustakis 2000). This technique has so many benefits including better response to customer orders as the result of improved adherence to schedules, faster response to market change, improved utilization of facilities and labor, and reduced inventory levels (Heizer & Render 2011). Therefore this research attempts to narrow the scope by implementing demand forecasting and material requirement planning for production planning management for small apparel companies.

One example of a MSME business performer which runs in the field of apparel companies is PT. X. PT. X is a small apparel company that sells warm clothes based in South Jakarta, Indonesia. The company uses a simple forecasting technique to determine their production for the upcoming week. However, since the forecast was based on a short time period (1 week), this method often causes out-of-stock (OOS) occurrences. Due to the ever-changing and competitive nature of the fashion industry, this condition can lead to opportunity loss. This method can result in stagnant or even worst case if applied in the long period time. Hence, this paper attempts to undertake demand forecasting and material requirement planning to a small apparel company to prevent product stock outs.

1.1 Objective

The objective of this research is to improve small enterprise's production planning by preventing out-of-stock occurrences using demand forecasting and material requirement planning. The results of this study are expected to increase the company's projected sales and profit in order to provide a better quality system in the production process.

2. Literature Review

2.1 Aggregate Planning

Aggregate planning is a method for analyzing, developing and maintaining a manufacturing plan with an emphasis on uninterrupted, consistent production. Aggregate planning is most often focused on targeted sales forecasts, inventory management and production levels in the mid-term future. the goal of aggregate planning is figuring out the level of production, inventory and workforce required to respond to fluctuating demand in the medium term.

2.1.1 Chase Strategy

The first type of aggregate planning strategy is chase strategy. Chase strategy or also called demand matching strategy means chasing market demand. The production matches demand, and inventories can be kept to a minimum. Goods are made when demand occurs and are not stockpiled. This is part of a larger lean production strategy, which saves money by waiting until an order is placed. However, productivity and quality can be reduced, and it can negatively impact the morale of the workforce.

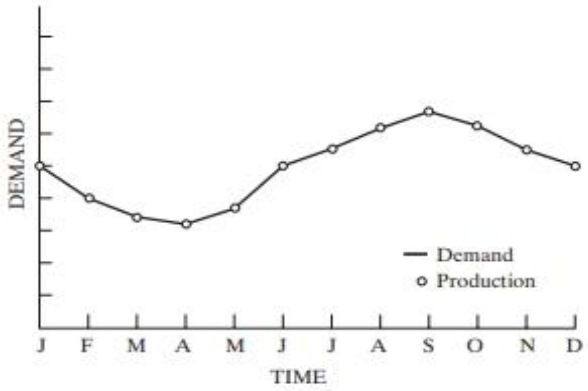


Figure 1. Demand Matching Strategy

2.1.2 Level Strategy

Defined as a production planning method that has an even distribution in production. Production planning method level, will maintain a stable level of production temporarily using varying inventory levels to accumulate output in case of excess total demand (Glendy et al. 2021). The strategy taken by maintaining the level of output, production and labor constant work. The characteristics of level strategy are to maintain a high level of production, fixed and fluctuating inventory levels, order backlogs and lost sales (Fristha 2019). Production leveling or level workforce strategy is producing the amount of products equal to the average demand continually in purpose to maintain the level of products, production process and labor constant work.

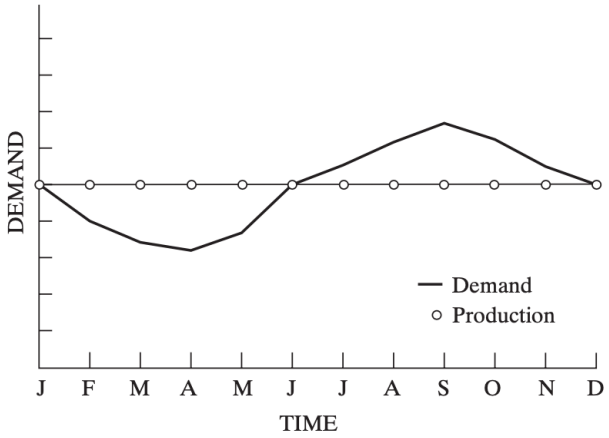


Figure 2. Production Leveling Plan

Figure 2 indicates the stable production at the level rate that the company has decided. Company will use its resources to reach the level rate. The advantage is that it results in a smooth level of operation that produces stable costs of production levels. The company does not need to have excess capacity to meet peak demand. Moreover, it can build a stable workforce in which companies do not need to hire and train workers and lay them off in slack periods. On the other hand, the disadvantage is that inventory will build up in low-demand periods that causes additional cost.

2.1.3 Hybrid Strategy

This strategy is a combination of level strategy and chase strategy. Characteristic features Mixed Strategy is to combine the level of production with a fixed level of demand and combine the two methods inventory level and chase levels, order backlogs and lost sales (Fristha 2019). In determining the hybrid strategy, production management is responsible for finding the combination of strategies that minimizes the sum of all costs involved, providing the level of service required, and meeting the objectives of the financial and marketing plans. Figure 3 visualizes possible hybrid strategy plan.

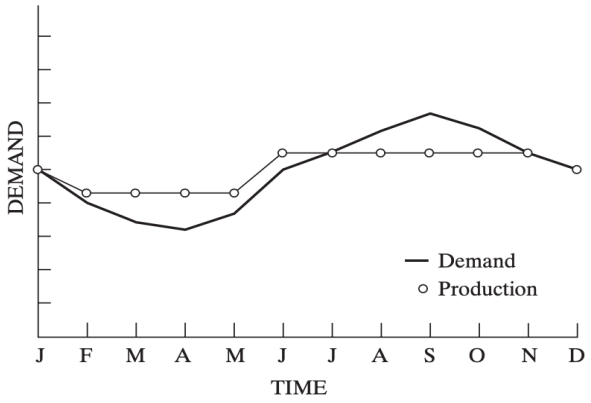


Figure 3. Hybrid Strategy Plan

2.2 Master Production Schedule

Every company or enterprise certainly produces goods to be consumed by the market. Therefore, a structured plan is required to balance the needs of the market and the capacity of manufacturers to be able to produce goods. The focus of optimization in production scheduling is to determine an effective scheduling production based on demand (Rahmat et al. 2020). Master production schedule is a specific plan of the quantities to be produced of individual models within each product line (Afriansyah et al. 2019) The production quantities of major product lines from aggregate plan must be converted into master production schedule (MPS) to make possible valid order promises. The master production schedule (MPS) is a plan for the production of individual end items. Inputs to the MPS are the production plan, the forecast for individual end items, sales orders, inventories, and existing capacity.

The master production schedule (MPS) provides formal details of production plans and converts them into plans for the needs of raw materials, labor, and work equipment/production machinery. Therefore, MPS is an appropriate statement in production including product, time, and quantity for more mature planning in the system (Amaranti et al., 2020). The main objectives in developing an MPS are 1) to maintain the desired level of customer service by maintaining finished-goods inventory levels or by scheduling to meet customer delivery requirements, 2) to make the best use of material, labor, and equipment, and 3) to maintain inventory investment at the required levels (Arnold et al. 2022).

2.3 Material Requirements Planning

The improvement of progressively modern innovation, the more exacting competition within the fabricating industry. This progressively furious competition requires companies to be able to win the competition and pick up a wider showcase. In today's promoting environment, showcase share, performance can be accomplished by giving items and administrations delivered by company in time, least taken a toll, ideal arrange amount, conditions the best benefit and within the most fitting period of time (Torunogluet al. 2017) The amount of inventory on hand has an impact on the manufacturing process, which in turn has an impact on each company's efficiency and effectiveness. Raw materials or materials, product components, semi-finished items, and completed goods are all examples of inventory in manufacturing organizations.

To minimize different raw material difficulties and assist the coordination of production operations, a planning system is required in material planning and control activities. Material Requirements System Planning is one of several concepts in planning and inventory control. Management Requirements Planning (MRP) could be a generation arranging and stock management system used to oversee coordinations forms and planned to help generation supervisors in scheduling and setting orders for things of subordinate request.

2.4 Jersey Dri-Fit Manufacturing Process

First of all, the material will come from the factory, then quality control will be carried out first if there is a material defect. For the design process, the jersey printing design will be made using a computer with design software. If the jersey printing design is complex, this setting stage will take a lot of time. In addition, at this stage, a pattern will also be made according to the player size data. The process will be leading to the printing process. It is to print with the full printing method so that the jersey printing designs will be clearly visible. At this stage, PT. X uses the best special type of sublime ink, so that it produces bright colors and the printing jersey will look good.

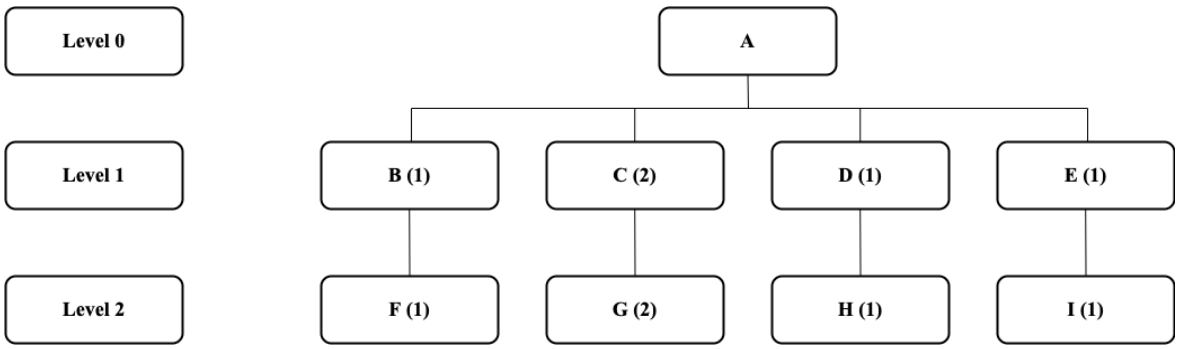
3. Methods

Simple Moving Average (SMA) is used to find out means of past production capacity as well as means of past sales and use it as the forecast value of PT. X's projected demand and production capacity in March 2022. To forecast the demand and the production capacity, SMA is one of the technical indicators which is widely used to predict future data in time series analysis. SMA is appropriate when there is no noticeable trend or seasonality. Since the object of this paper is a small apparel company which sells long jersey t-shirts, their demand and production pattern is not considered as seasonal. Formula that is applied in the SMA method is:

$$SMA = \frac{Xt-1 + Xt-2 + \ldots + Xt-n}{n}$$

With $Xt-1 = Actual\ occurrence\ in\ the\ past\ period\ for\ up\ to\ n\ periods$

$n = Numbers\ of\ period\ to\ be\ averaged$



A: Jersey T-shirt
B: Collar
C: Sleeves
D: Front body
E: Back body
F: 0,03 kg of rib cloth
G: 0,035 of dri-fit cotton modal
H: 0,08 of dri-fit cotton modal

Figure 4. Bill of Materials (BOM) of Jersey T-Shirt

Table 1. Raw Materials Requirement for One Jersey T-Shirt

Material		Part	Quantity	Mass (kg)	Total Mass (kg)
Dri-fit cotton modal		Sleeves	2	0,035	0,07
		Front body	1	0,08	0,08
		Back body	1	0,08	0,08
Rib cloth		Collar	1	0,03	0,03

To anticipate customer demands for the following week, the company has always referred to the sales data from the previous week and added 40 - 50% more pieces from last week's sales. However, from the data of number of sales and volume of production in March 2022, it can be seen that the demand still exceeded the production capacity (see Table 2 and Table 3). This proves that the company's strategy in planning and deciding the production quantity is still inadequate. It causes a recurring out-of-stock situation.

Table 2. Data of Jersey T-Shirt Sales in March 2022

Time Period	Sales (pcs)
Week 1	85
Week 2	45
Week 3	110
Week 4	60

Table 3. Data of Jersey T-Shirt Production in March 2022

Time Period	Production Capacity (pcs)
Week 1	45
Week 2	37
Week 3	58
Week 4	43

5. Results and Discussion

5.1 Numerical Results

The simple moving average method is used to forecast the demand and production capacity (see Table 4 and Table 5) to know whether the production capacity can satisfy the demand needs in April 2022. From the table, Week 1 - Week 4 refers to weeks in March 2022 and Week 5 - Week 8 refers to weeks in April 2022. The forecast is done in weeks-period because the company produces jersey t-shirts every week. Furthermore, the forecast is based on the data in March 2022 due to lack of the data availability.

Table 4. Data of Jersey T-Shirt Production in March - April 2022

No.	Week	Sales (Pcs)	Demand Forecast (Pcs)
1.	1	85	-
2.	2	45	-
3.	3	110	-
4.	4	60	-
5.	5	-	72
6.	6	-	81
7.	7	-	71
8.	8	-	74

Table 5. Data of Jersey T-Shirt Production in March - April 2022

No.	Week	Production Capacity (Pcs)	Demand Forecast (Pcs)
1.	1	45	-
2.	2	37	-
3.	3	58	-
4.	4	43	-
5.	5	-	46
6.	6	-	49
7.	7	-	46

8.	8	-	47

5.2 Graphical Results

Histogram below shows the comparison between forecasted number of demand and quantity of production that indicates the number of demand still exceeds the number of production in three out of four weeks in April 2022 (see Figure 5). This imbalance means that a significant amount of customer demands went unfulfilled, implying an inadequateness in satisfying customer demand. It can be concluded that the current production planning and inventory management adopted by the company is ineffective, urging an adoption of a better planning system.

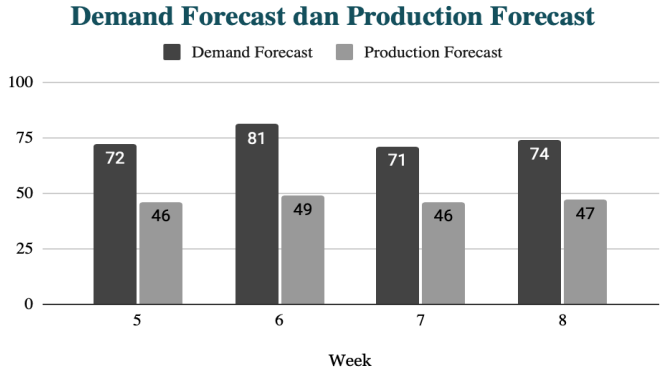


Figure 5. Histogram of Demand Forecast vs. Production Capacity Forecast

5.3 Proposed Improvements

The Table 6 below shows the material requirement planning of cotton modal to satisfy the demand in April 2022. This material is needed to make the sleeves, the front body, and the back body of the t-shirt produced. The quantity needed to produce one Jersey is 0.195 kg of dri-fit cotton modal (0.08 for the front body, 0.08 kg for the back body, and 0.035 kg for the sleeves) and 0.03 of rib cloth (0.03 for the collar).

Table 6. Material Requirement Planning (MRP) of Jersey April 2022

Jersey T-Shirt		5	6	7	8
Gross Requirement (pcs)		72	81	71	74
Schedule Receipt		100			
Projected On Hand Inventory (pcs)	78	6	26	0	0
Net Requirement (pcs)				45	74
Planned Order Receipt				45	74
Planned Order Release			45	74	

The implementation of Material Requirement Planning (MRP) in determining the production quantity and inventory level is a form of improvement strategy to prevent the out-of-stock situation in April 2022. The company can better determine the production quantity because the production quantity is based on the forecasted demand while taking on-hand inventory and net requirement into account. Using empirical calculation, the company can prevent the occurrences in which the quantity of materials exceeds or unfulfill the amount needed. The acknowledgement of raw materials' lead time will also help in ensuring that the materials needed are always available on time, which will decrease the chance of product stock outs. Decrease in the number of unmet demands will increase the amount of goods sold, which will result in an increase in the company's overall profit.

5.4 Validation

Based on the comparison below, the cost calculation that the company obtained by using MRP is increasing about 37,33% or equal to adding Rp3.360.000 more profit than without obtaining the MRP, which is

Rp5.640.000. This validates the hypothesis mentioned in the objective of this paper which stated that by applying inventory planning, profit of the company will increase.

Table 7. Profit obtained without applying MRP

T-Shirt	Revenue	Production Cost	Profit
46	Rp3.312.000	Rp1.932.000	Rp1.380.000
49	Rp3.528.000	Rp2.058.000	Rp1.470.000
46	Rp3.312.000	Rp1.932.000	Rp1.380.000
47	Rp3.384.000	Rp1.974.000	Rp1.410.000
Total			Rp5.640.000

0.23 kg of cotton modal and 0.03 kg of rib cloth (1 jersey t-shirt) = Rp37.000

Cutting and sewing cost (1 t-shirt) = Rp5.000

*Total cost for 1 jersey t-shirt = Rp42.000

Table 8. Profit obtained with applying MRP

T-Shirt	Revenue	Production Cost	Profit
85	Rp6.120.000	Rp3.570.000	Rp2.550.000
45	Rp3.240.000	Rp1.890.000	Rp1.350.000
110	Rp7.920.000	Rp4.620.000	Rp3.300.000
60	Rp4.320.000	Rp2.520.000	Rp1.800.000
Total			Rp9.000.000

0.23 kg of cotton modal and 0.03 kg of rib cloth (1 jersey t-shirt) = Rp37.000

Cutting and sewing cost (1 jersey t-shirt) = Rp5.000

*Total cost for 1 jersey t-shirt = Rp42.000

Table 9. Total profit comparison of MRP implementation

Profit without Applying MRP	Profit with Applying MRP	Incremental Profit	
		In Price	In Percentage
Rp5.640.000	Rp9.000.000	Rp3.360.000	37,33%

6. Conclusion

PT. X is a small clothing firm that uses the chase approach as a strategy for product development. Due to a lack of well-planned generation scheduling and stock control, this organization frequently experiences out-of-stock situations (OOS). This problem arises due to a missed chance. This problem might cause the firm to stagnate or perhaps fail in the long run.

Using the simple moving average (SMA) forecasting approach, it is discovered that the company's production capacity would be insufficient to fulfill consumer demand in the next month, April 2022, due to limited supply. This, of course, can have an impact on PT. X's profit margins. Material Requirement Planning (MRP) is being

implemented as a recommended improvement strategy to address these issues. This approach was chosen because it generates a schedule of the components required at each stage of assembly and calculates the time when these components will be required based on lead time.

As a comparison of the data it can be seen that in April 2022 demand, PT. X can increase its profit by 37.33% if the company has implemented MRP in its production planning. The result of the incremental calculation is that the profit obtained is relatively small in percentage. However, in its capacity as a small company, the implementation of MRP method in planning the purchase of raw materials, in the company getting a significant amount of profit. Judging from the small size of the company, this increase has a sizable impact.

The addition of this strategy resulted in organizations being able to meet consumer demand schedules on time, in addition to increasing profits. Aside from that, this method's adoption aids the organization in reducing the risk of production capacity not meeting consumer demand, as well as making it easier to determine how much raw material to acquire to fulfill demand.

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Biographies

Abigail Naomi Ariela is an Industrial Engineering undergraduate student from University of Indonesia. She is interested in learning about manufacturing systems and entrepreneurship. She is currently an intern in start-up business as a partnership. She also joined an organization as a head division of entrepreneurship and joined a choir community.

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Mahesti Layla Nursea is a sophomore of Industrial Engineering from University of Indonesia. A highly motivated individual interested in marketing plan, oral and written communication and entrepreneurship. She was working on her business where she eagerly practiced and developed her skill. She also joined plenty of activities such as organizations, competition, and other events in order to channel her capability into the things she is interested in.

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