Production Planning in a Rack Industry Using Moving Average Forecasting Method and Material Requirements Planning

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Abstract

The paper aims to improve the production planning of a rack industry by implementing forecasting and production planning tools. The production strategy used in the manufacturing industry is a make-to-stock production approach. The manufacturing industry often encounters problems mostly about underproduction and overproduction that leads to high cost and poor performance. The problem is highly related to the quality of forecasting and production planning. This paper discusses the implementation of a moving average forecast method and MRP in one product of the observed manufacturing industry to increase production planning efficiency and effectiveness. The results show that the forecast of supply, production, and demand for the present year have the potential to be in condition of overproduction so reducing the production is necessary to get the optimum profit by avoiding unnecessary cost. Moreover, the MRP provides clear information about how much materials are required for production and when to order the materials. The forecasting method and MRP could improve the production planning in the manufacturing industry.

Keywords
Production Planning, Forecasting, Manufacturing Industry, Moving Average, and MRP.

1. Introduction
This research paper addresses the application of production planning and control concepts using a forecasting method and Material Requirements Planning (MRP) to a manufacturing industry that produces various types of household products such as dish rack, shoe rack, tv rack, display rack, multipurpose rack, ironing board, and plastic flour. Many variants of plastic coating racks have been marketed in Indonesia and several countries. With experienced professionals and advanced machines, the products will continue to maintain quality and stability for customer satisfaction. Kapuk Molek Ltd. founded by Mr. Kalim is an integrated company primarily engaged in the manufacture of household products. The company was founded in 1981 in North Jakarta,Indonesia.

The problem faced by the company is how to forecast the production of products in the future based on historical data. There are still a limited number of local factories that are using scientific methods to forecast and planning their production (Almaktoom 2017). This problem mostly affects inventory systems in factories as well as customers because the demand is undefined or inaccurate (Alsaadi et al. 2016). This problem can lead the industry to be in underproduction or overproduction.

The data recording in the company is still using manual methods by handwriting on paper. It makes the data difficult to read and proceed. Forms of manual reporting make it difficult for the owner to see the development of the business related to the addition or reduction of the stock. This research focuses on the forecast and production planning of a product labeled as RK-01, a dish rack product, for the present year by implementing moving average forecasting method and Material Requirements Planning (MRP) in order to increase the efficiency of the production system. The forecasting method by Moving Average (MA) is used to forecast the supply and demand in the future for production planning. In forecasting the estimated level of demand in order to avoid excesses and not less inventory quantities based on past data (Dewi and Chamid 2019). Main purpose of optimization in industry is to increase efficiency in production (Nurcahyo 2016). Optimization in this research is related with the implementation of moving average forecasting method and MRP.

Nurcahyo (2016) researched production efficiency improvement through preventive maintenance and production scheduling optimization. Optimization of personnel scheduling is also necessary to acquire labor schedules precisely and efficiently and finally it can directly reduce the cost of the project. Meanwhile, this paper is trying to improve the production efficiency through forecasting and production planning using material requirements planning.

1.1 Objectives

The objective of the paper is to make the production planning accessible and integrated by scientific method and digitalization. The forecasting of supply, production capacity of industry, and product demand are studied to see whether the company can satisfy the demand in the future. The objective is also to determine whether existing production planning of the company is effective and improve it by determining production priority using MRP.

2. Literature Review

In a Make-To-Stock environment, a limited number of standard items are assembled from many components. Make-to-stock means that the supplier manufactures the goods and sells from finished goods inventory. Delivery lead time is shortest. A make-to-stock production plan determines how much to produce in each period to achieve the forecast and maintain the required inventory levels (Arnold et al. 2007). The MTS strategy focuses on preventing stock shortages at minimum inventory costs (Beemsterboer et al. 2016). Under make-to-stock management, all production is purely forecast driven. The products are manufactured up front without allowing for customer customisation. As these products are stored till ordered, high holding costs are unavoidable. Moreover, one can expect frequent stock-outs when demand fluctuates considerably (Rafiei and Rabbani 2009). In the process industries, production is mainly a make-to-stock (MTS) process and is carried out with reference to forecasting (Sherbrook 2004). Therefore, an efficient inventory management and control method is critical in reducing the inventory costs and improving the accuracy of production planning (Axsa¨ter 2006).

Forecasting is a decision-making tool used by many businesses to help in budgeting, planning, and estimating future growth. Therefore, companies should apply forecasting to have a clear vision for the future (Bashnaini et al. 2018). Forecasting means predicting the future based on past, present data and most commonly by analysis of trends. The more data used for forecasting the more accurate the results. However, there is evidence from the case that the reason lies in environmental uncertainty and volatility and not in internal factors within the control of the company (Rieg 2009). Forecasting by moving average method based on time series is generated by a constant process subject to random error, then the mean is a useful statistic and can be used as a forecast for the next period. Moving averaging methods are suitable for stationary time series data where the series is in equilibrium around a constant value (the underlying mean) with a constant variance over time (Gudagunti and Ali 2018). The accuracy of forecasting is evaluated using Mean Absolute Deviation (MAD). Results show that companies adopting a structured forecasting process have positive impacts on operational performances not only through improved accuracy (Kalchschmidt 2008). With the further development of market economy demands forecasting becomes not only the base of enterprises decision-making, but also the important gist for planning resources (Qu 2005).

An effective production planning method plays a key role in the production management system for the process manufacturing industries (Feng et al. 2011). Material requirements planning (MRP) is a system for calculating the materials and components needed to manufacture a product and avoid missing parts. MRP is a production planning, scheduling, and inventory control system used to manage manufacturing processes (Kasat and Deshmukh 2020). It establishes a schedule (priority plan) showing the components required at each level of the assembly and calculates the time when these components will be needed based on the lead times. MRP has two major objectives: determine requirements and keep priorities current. There are three inputs to MRP systems: master production schedule, inventory records, and bills of material (Arnold et al. 2007).

Method of producing a dish rack (RK-01) in the manufacturing industry consists of six main processes: wire cutting, wire bending, wire heating, powder coating, wire cooling, and wire welding. The supplies are wires and LDPE plastic powder. The first process is to cut the wire into the required shape and size based on the product specification. Wire cutting uses several cutting machines with different output based on the type of wire and the cut size. The next process is bending the wire by using several bending machines. There are three outputs of wire

bending that are grouped as base wire, wave wire, and ring wire. After the wires have a good shape, the next step is the heating process of the wires using the oven machine by tying the wires using an additional hook up wire that will go to the oven by a moving rail going through the automatic door. The LDPE powder vessel is placed after the oven door so the moving rail will stop at the top of the vessel, the machine will bring down the heated wires into the LDPE powder in the vessel and the wires would be coated by the powder. This process is called powder coating. Then, immediately continue to the next process which is the heating process again by a similar oven. After another heating process, the wires will get to the cooling process by hanging on the rail outside the oven. Finally, the wires would be transported to the welding area. Welding is a fabrication process whereby two or more parts are fused together by means of heat, pressure or both forming a joint as the parts cool. This process forms the final product.

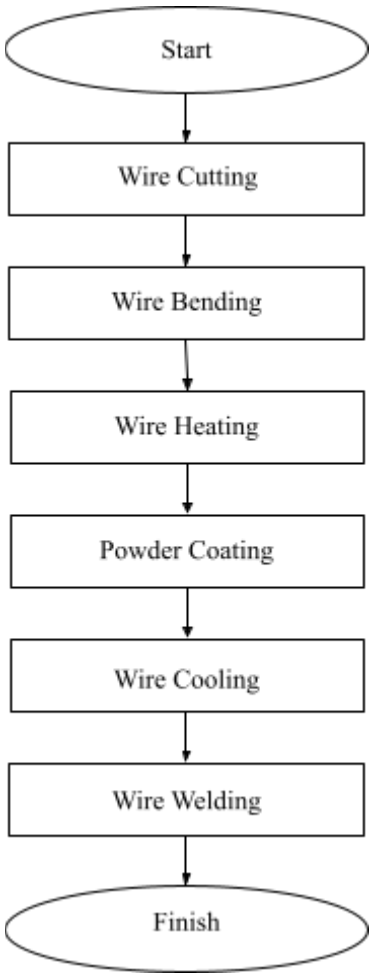

Figure 1. Flowchart of production process

3. Forecasting Dish Rack Supply Using Moving Average Method

Table 1 and Table 3 shows the supply of wire and LDPE powder to the industry from 2016 until 2020 and predicted using a simple moving average method for the present year to obtain the forecast of supply needed for the production. Table 2 and Table 4 shows the summary of Table 1 and Table 3.

Table 1. Forecasting the wire supply

Year	Actual wire supplied (ton)	Forecasting m=3	Forecasting m=4	MAD for m=3	MAD for m=4
2016	32				
2017	33				
2018	35				
2019	36	33.33		2.67	
2020	37	34.67	34	2.33	3
2021		**36**	35.25		
Total				2.5	3

Table 2. Summary of wire supply

Year	2016	2017	2018	2019	2020	2021
Wire Supply (ton)	32	33	35	36	37	**36**

Table 3. Forecasting of LDPE powder supply

Year	Actual LDPE supplied (ton)	Forecasting m=3	Forecasting m=4	MAD for m=3	MAD for m=4
2016	5.28				
2017	5.52				
2018	5.76				
2019	6	5.52		0.48	
2020	6.24	5.76	5.64	0.48	0.60
2021		**6**	6		
Total				0.48	0.60

Table 4. Summary of LDPE powder supply

Year	2016	2017	2018	2019	2020	2021
LDPE powder Supply (ton)	5.28	5.52	5.76	6	6.24	**6**

3.1. Forecasting Dish Rack Production Using Moving Average Method

Table 5 shows the forecast of the production capacity of industry to the industry from 2016 until 2020 and predicted using a simple moving average method for the present year to obtain the forecast of production capacity. Table 6 shows the summary of table 5.

Table 5. Forecasting the production capacity of industry

Year	Actual Rack Produces (unit)	Forecasting m=3	Forecasting m=4	MAD for m=3	MAD for m=4
2016	26400				
2017	27600				
2018	28800				
2019	30000	27600		2400	
2020	31200	28800	28200	2400	3000
2021		**30000**	29400		
Total				2400	3000

Table 6. Summary of production capacity of industry

Year	2016	2017	2018	2019	2020	2021
Dish Rack Production in unit	26400	27600	28800	30000	31200	**30000**

3.2. Forecasting Dish Rack Demands Using Moving Average Method

Table 7 shows the forecast of the demand of the product to the industry from 2016 until 2020 and predicted using a simple moving average method for the present year to obtain the forecast of product demand. Table 8 shows the summary of Table 7.

Table 7. Forecasting the demand of the product

Year	Demands (unit)	Forecasting m=3	Forecasting m=4	MAD for m=3	MAD for m=4
2016	25200				
2017	27000				
2018	28440				
2019	29280	26880		2400	
2020	31680	28240	27480	3440	4200
2021		**29800**	29100		

Total				2920	4200

Table 8. Summary of demand of the product

Year	2016	2017	2018	2019	2020	2021
Dish Rack Demand in unit	25200	27000	28440	29280	31680	**29800**

3.3. Forecasting Analysis

The demand forecast of RK-01 racks in 2021 is 29.800 units whereas the production capacity is 30.000 units. Since the demand is lower than the capacity, it is important to reduce the materials to meet the demand. Reducing non-used materials will reduce the cost of inventory. On the other hand, forecasting shows that in 2021, the company has to supply as much as 36 tons of wire and 6 tons of LDPE Powder. The supply forecasting has to be done in case of the demand reaching the same level as forecast one.

3.4. Bill of Material (BoM)

To make MRP of RK-01, we need to define materials that build up RK-01 itself. Through observation of the production report we found that to make the product we need 2 components, LDPE Powder and wire,then we translate it into Bill of Material, as shown at figure 2. Table 9 is also included in this chapter to inform and clarify Figure 2.

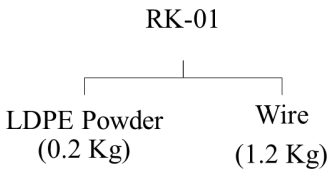

Figure 2. Bill of material RK-01

Table 9. BoM table RK-01

BoM Level	0	1	2	Part Name	Quantity	Unit of Measure	Procurement Type
0	x			RK-01	1	Each	MTS
1		x		LDPE Powder	0.2	Kg	OTS
1		x		Wire	1.2	Kg	OTS

3.5. MRP of Wire

Table 10 shows the material requirement planning of wire. The wires in this manufacturing industry are used to fill the product in the total of 1,2 kg per unit. The production is to be leveled at 2500 units for January-June. So the wires required are 3000 kg monthly. Lead time for the wire is 2 month. Safety stock of wires is 252 kg.

Table 10. Material Requirement Planning of wire

Wire		**Month**					
		1	2	3	4	5	6
Gross Requirements		3000	3000	3000	3000	3000	3000
Schedule Receipts							
On Hand Inventory	0	-3000	-3000	-3000	-3000	-3000	-3000
Net Requirement		3252	3252	3252	3252	3252	3252
Planned Order Receipt		3252	3252	3252	3252	3252	3252
Planned Order Release *6504		3252	3252	3252	3252		

3.6. MRP of LDPE Powder

Table 11 shows the material requirement planning of LDPE powder. The LDPE Powder in this manufacturing industry is used to make the product in the total of 0.2 Kg per product. The production is to be leveled at 2500 units for January-June . So the LDPE Powder required is 500 kg monthly. Lead time for LDPE powder is 2 month. Safety stock of LDPE Powder is 42.

Table 11. Material Requirement Planning of LDPE powder

LDPE Powder		**Month**					
		1	2	3	4	5	6
Gross Requirements		500	500	500	500	500	500
Schedule Receipts							
On Hand Inventory	0	-500	-500	-500	-500	-500	-500
Net Requirement		542	542	542	542	542	542
Planned Order Receipt		542	542	542	542	542	542
Planned Order Release *1084		542	542	542	542		

3.8. MRP Analysis

This paper gives some insight on how we determine stock availability of each component that builds RK-01. We determine how much to be produced using information from Bill of material. From it we know that to make one unit of RK-01 we need 1.2 kg of wire and 0.2 kg of LDPE Powder. Data that is used for MRP is production data from January-June. Each component needs 2 month of lead time and on hand inventory is assumed to be 0. MRP results show that during observation time, with level type of production planning, each month, there will be 3252 kg of Wire and 542 kg of LDPE Powder required.

4. Results and Discussion

In 2016 until 2020, the actual wire supply always rises each year. The actual supply of wire in 2019 and 2020 is higher than the supply forecasting. The wire supply in 2021 is predicted to be 36 tons. In order to increase the cost efficiency, the company needs to drop the wire supply from 37 tons in 2020 to 36 tons in 2021.

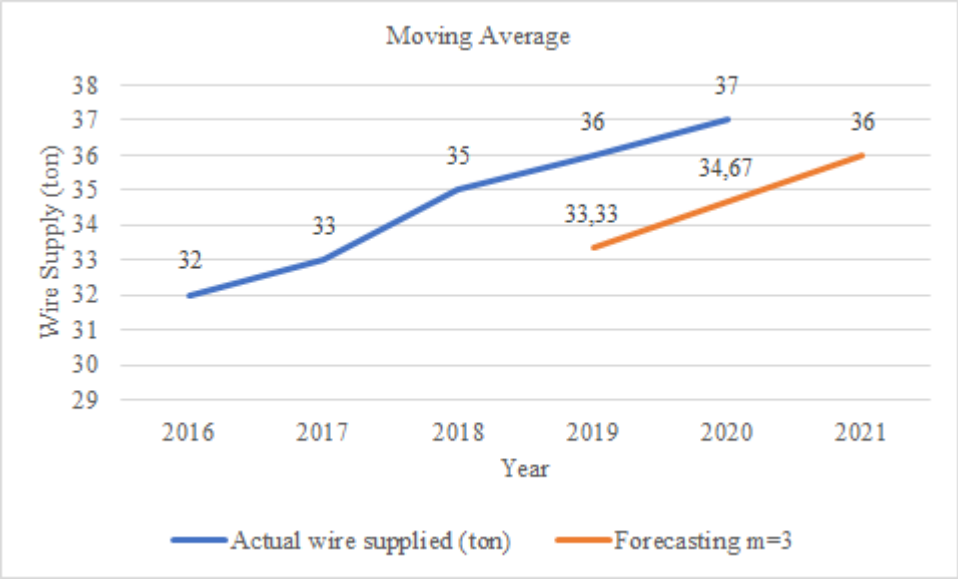

Figure 3. Supply of wire forecast

In 2016 until 2020, the actual supply of LDPE powder always rose gradually in increments of 0,24 ton each year. The LDPE powder supply is predicted to be 6 tons in 2021.

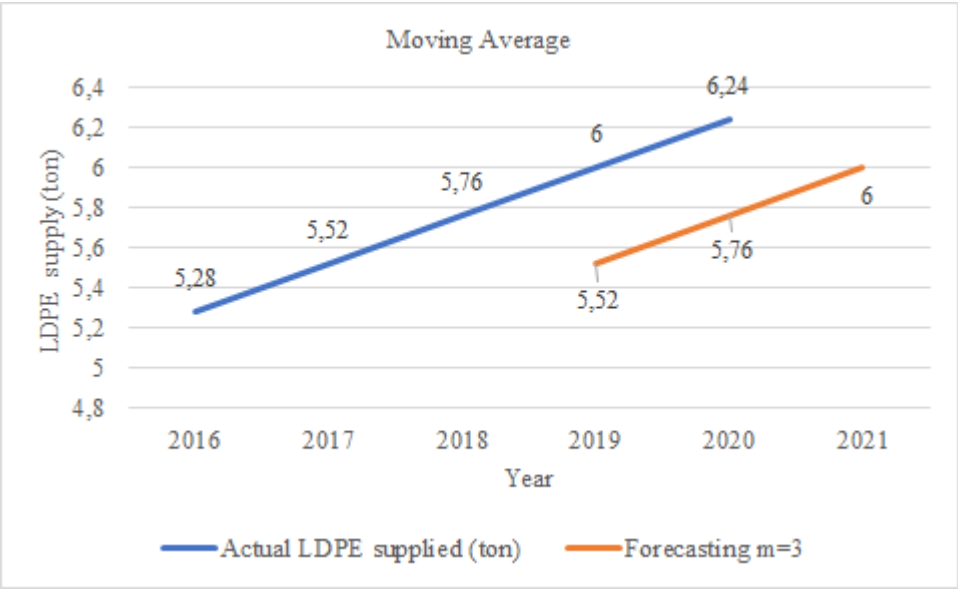

Figure 4. Supply of LDPE powder forecast

In 2016 until 2020, the actual rack production always rose gradually each year in increments of 1200 kg. The production forecast in 2021 is predicted to be 30.000 units.

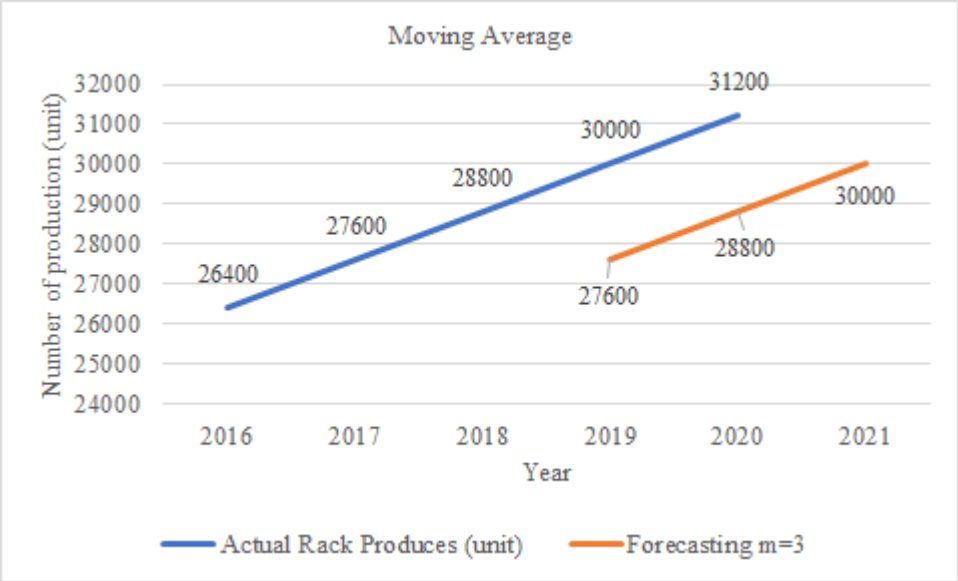

Figure 5. Production forecast

In 2016 until 2020, the actual demand for racks always rose each year. The rack demand for 2021 is predicted to be 29.800 units.

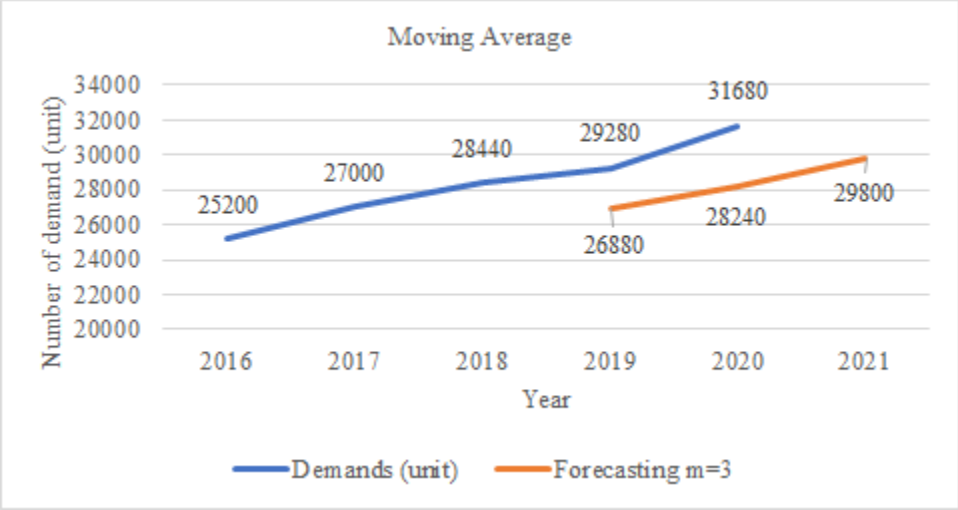

Figure 6. Demand forecast

From Figure 5 and Figure 6, it can be concluded that in 2016 until 2019 there was overproduction. The demand in 2016 until 2019 is lower than the production. In order to meet the racks demand in 2021, the company needs to drop the racks production by 1.200 units. Producing only 30.000 units of rack is the safest plan for 2021. Forecast output for production in 2021 is 30000 units, the effective production capacity is 32400. Therefore, production efficiency from forecasting can be estimated by dividing forecast output with effective production capacity resulting in 92,59% production efficiency. Also, the forecasting result of production can be used to estimate cost reduction by comparing the inventory cost of the production planning with and without the implementation of simple moving average forecasting method and MRP. The production without forecasting is 32400 units, meanwhile production based on forecasting is 30000 units. The difference between forecasting results and without forecasting is 2400 units. The inventory cost of the product is $1 per unit product. So, cost reduction from production is $2400. Wire supply without forecasting is 38,5 ton, meanwhile the forecasting result is 36 ton. The difference between forecasting results and

without forecasting is 2,5 ton. The inventory cost of this material is $1 per 0,01 ton. So, cost reduction from wire supply inventory cost is $250. LDPE powder supply without forecasting is 6,48 ton, meanwhile the forecasting result for this material is 6 ton. The difference between forecasting results and without forecasting is 0,48 ton. So, cost reduction from LDPE powder supply inventory cost is $48. The total cost reduction from the implementation of the forecasting method and MRP is $2698.

This study gets the results from analyzing the production planning of a product in the rack industry with forecasting methods and MRP, estimating the company's production efficiency and inventory cost reduction after implementing forecasting method and MRP. The research shows the implementation of a simple forecasting method for the industry and the use of MRP has a significant impact for production planning in the industry. The industry could use programming code to generate autoplot moving average forecasting methods in any year and computerized MRP to get the results immediately and automatically, also allowing easy adjustment for production planning. Future studies in this area could take research on production planning of other industrial fields & larger scope using another forecasting method.

5. Conclusion

From the result, it can be concluded that the production plan is ineffective and inefficient. There was overproduction in the past years and can be solved by dropping the racks production based on forecasting results. By forecasting the supply, production, and demand helps in making production planning more effective. The production planning using MRP based on the forecast provides detailed information about material requirements for a period of time so it will clarify the needs and prevent the occurence of underproduction and overproduction problems. Using digital applications to build forecasting systems and MRP tools can make the production planning accessible and integrated, resulting in improvement of the production planning system.

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