Production Planning, Inventory and Capacity in PT. WDY and ERP Simulation Open Source

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Abstract

Production planning is an important activity in the company, production planning at PT. WDY experienced several problems, namely the company tended to use intuition or experience in determining lot sizes and sometimes ordered only as needed. This has resulted in several problems such as increased costs, shortage of raw materials, etc. Therefore, it is necessary to improve the lot determination process. The improvement process starts with forecasting, where the forecasting method chosen based on the smallest error rate of 19.46% is the winter method. Then proceed with the manufacture of MPS, checking capacity using the gross capacity method, calculating the number of lots and calculating the capacity of each machine. The results of the calculation of factory capacity show that the factory capacity is larger so that MPS can be implemented. The method of calculating the number of lots selected is the Wagner within the method with a cost reduction of 14.24%. In the calculation of machine capacity, it is found that each machine has a capacity greater than what is needed, which means that each machine can meet consumer demand

Keyword
Production Planning, Forecasting, Capacity Planning, MPS

1. Introduction

PT. WDY is a manufacturing company engaged in printing, this company produces snack food packaging. The main product produced is in the form of box-shaped snack packaging. not only snack packaging but also various other product packaging, such as instant noodle packaging, canned drinks, and mosquito coil packaging. PT. WDY produces tens of thousands of packages in one day from various orders, seeing many orders, the production process carried out by the company requires sophisticated and modern machines and tools (Manahan, 2012). The method of planning and quality control must also be precise, so that it can fulfill a high customer order

Based on information from discussions with the production staff of PT. WDY is known that the company in determining the lot size of raw materials has not used the right method. Generally, companies use intuition or experience and order according to consumer demand.

The absence of the right and optimal method and ordering only based on consumer demand, causes companies to have to order raw materials repeatedly (Kusuma, 2009). Of course, this will cause ordering costs to rise. In addition, the company also often experiences delays in receiving raw materials and shortages of raw materials so that the production process is disrupted. The company also informed that the procurement of raw materials also accounts for 65% of the company's total costs.

Therefore, the company needs a proposed improvement design for the new lot sizing method which is expected to help the company overcome the problems that occur. Thus, the purpose of this study is to determine the right lot sizing method for each material that will be used to make the product,

make the right material requirements planning to reduce delays and determine the right lotting size for each material to meet consumer demand, determine the schedule ordering the right raw materials so that they can be implemented properly.

2. Literature Review

To be able to do research at PT. WDY requires some good knowledge so that it can analyze existing problems and find solutions to the problems.

2.1 Production Planning and Control

Production is the main activity carried out by every company; this activity includes activities that are responsible for creating value-added products which are the output of each industrial organization (Fahmi, 2016).

2.2 Safety Stock

Safety stock is a number of necessary goods provided by the company which serves to prevent a shortage of goods when consumer demand conditions are uncertain. To be able to provide these inventory items, a certain period is needed before the goods can arrive (Lieberty, 2015).

Safety stock or safety stock has a very important role in supply chain management. This system is designed to be able to achieve maximum profit, anticipate changes in market demand and make it easier to schedule the production of goods (Christifan et.al., 2020).

2.3 Forecasting

Forecasting is the science of predicting future events. Forecasting is done by involving taking historical data (previous data) and projecting that data into the future with mathematical models (Agung, 2009).

This demand forecasting activity is an attempt by the company to find out the amount of a product or group of products in the future under certain constraints or conditions and to minimize the risks or uncertainties that will be faced (Lefta et.al., 2020).

2.4 Master Production Schedule

The Master Production Schedule or commonly referred to as the master production schedule is a short-term production planning activity in a company that contains a comprehensive plan and details for producing the final product (Hasan, 2011). In the master production schedule, there is some important information that contains the priority of the product model to be produced, the schedule for purchasing production materials, the schedule for the implementation of the production process and employee work schedules as well as the machine operating schedule (Heizer, 2006). This master production schedule also has benefits in planning production capacity and material requirements for production activities (Putri and Gozali, 2020).

2.5 Rough Cut Capacity Planning

Rough cut capacity planning is an activity in the form of a capacity analysis process from a production facility in a factory to ensure that the production facility can support the master production schedule that has been prepared (Sinulingga, 2009).

2.6 Lot Sizing

Lotting or lot-sizing is the process of calculating how large the optimal order of a material is based on the net needs of the calculation results. The lotting process is closely related to determining the amount of material that must be ordered or provided to make the production process run well and smoothly (Handoko, 2011). The lotting process itself is very important in planning material requirements, so the use and selection of the right method will affect the effectiveness of the material requirements plan.

2.7 Material Requirement Planning

MRP is a material management system created to increase business productivity in managing materials. Usually, MRP is applied to identify the amount of raw material needed to be used in producing an item (Sitompul, 2011)

2.8 Capacity Requirement Planning

capacity requirements planning is the stage to compare the required capacity with the available capacity on the actual production floor to ensure that demand can be met (Indrajit, 2003)

3. Methods

In the process of collecting data, researchers used observation and interview methods and collected data through permitted company documents. In conducting this research, the writer uses various methods in performing calculations and then the results of these calculations are compared with one another. After making a comparison, then an analysis is carried out to choose which method is the best that will be suggested to the company.

The method used in the forecast calculation is the single moving average, double moving average, single exponential smoothing, double exponential smoothing, weighted moving average, quadratic, decomposition and winter methods.The method used in the calculation of capacity is the method of capacity planning using the overall factor, bill of labour and resources profile approach.

The method used in determining the number of lots is the fixed lot method, planned order quantity, lots for lots, economic order quantity, Silver Meal, Wagner Within, Least Total Cost, Least Unit Cost, and Part Period Balancing. The method used in calculating the required engine capacity and available engine capacity is the capacity requirement planning method. The ERP simulation carried out is using an open-source ERP, namely Odoo. The following is a flow chart of the research method which can be seen in Figure 1 below.

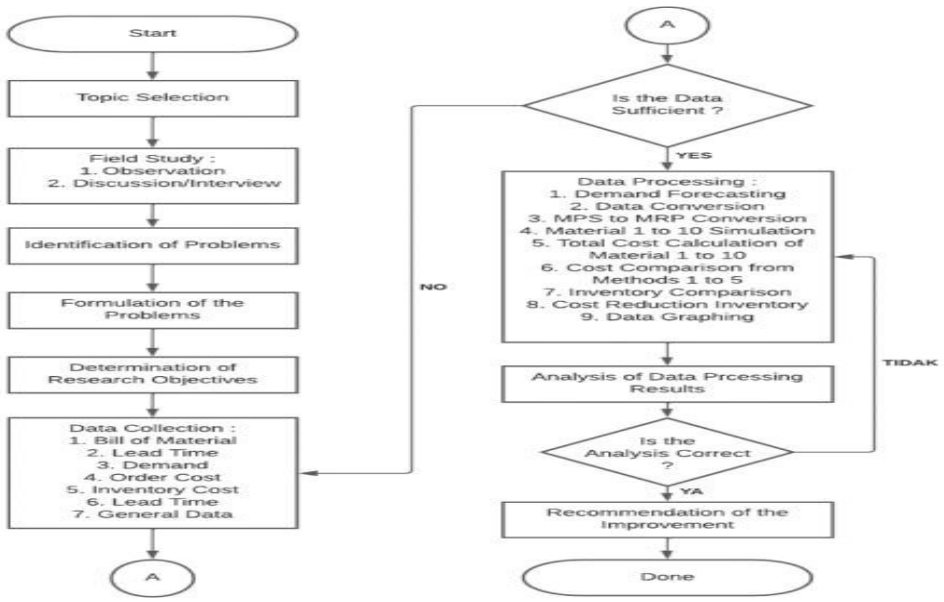

Figure 1. Methods Flow Chart

4. Data Collection and Processing

In this study, a product called Box P25 Siip Keju will be used, the first step that must be done is to forecast demand for the next period, this is intended to estimate how much consumer demand will be in the coming period. Thus, we can find out whether the products we make have decreased or increased.

4.1 Forecasting

In forecasting we will use demand data from the previous period, namely data for the past twelve months. Then, forecasting will be carried out to predict product demand using Minitab software (Santoso, 2009). The following is the result of demand forecasting for the next twelve months which can be seen in Table 1 below.

Table 1. Forecasting Results

Methods	MAD	MSE	MAPE
SMA 2	385350.00	295734100000.00	49.49%
SMA 3	340296.30	272302500000.00	38.55%
SMA 4	435562.50	337006300000.00	45.81%
SMA 6	443944.50	382765800000.00	37.41%
DMA 3	510492.06	473376552028.22	69.50%
WMA 3	409456.80	293792000000.00	50.87%
WMA 4	436152.80	327788400000.00	50.77%
WMA 6	440685.20	322750200000.00	44.95%
WMA 2	399337.50	289588600000.00	52.77%
SES 0,2	350441.36	285126873025.78	35.61%
SES 0,3	340766.1	249639900000.00	37.98%
SES 0,6	354141.3	240402100000.00	46.91%
SES 0,8	379126.5	264008100000.00	53.27%
DES 0,2 0,5	313742.00	197235000000.00	63.82%
DES 0,3 0,6	343612.00	232154000000.00	65.60%
DES 0,6 0,3	3.30E+05	250567000000.00	64.08%
Least Square	280920.4	132682900000.00	64.70%
Quadratic	275789	120705000000.00	75.74%
Decomposition	274480.00	134877000000.00	63.20%
Winter 0,1	361026.00	222145000000.00	48.53%
Winter 0,9	**87576.90**	**11225900000.00**	**19.46%**
Winter 0,3	161702	63090400000	29.41%

The winter method with an alpha value of 0.9 produces the smallest error value. Therefore, the authors suggest the company use the Winter Exponential Smoothing method for forecasting.

After the forecasting results are obtained, the next step is to validate the forecasting results. After the validation of the forecasting results is obtained, then the tracking signal calculation results will then be plotted (Gunawan et.al.,2020). The plotting results can be seen in Figure 2 below.

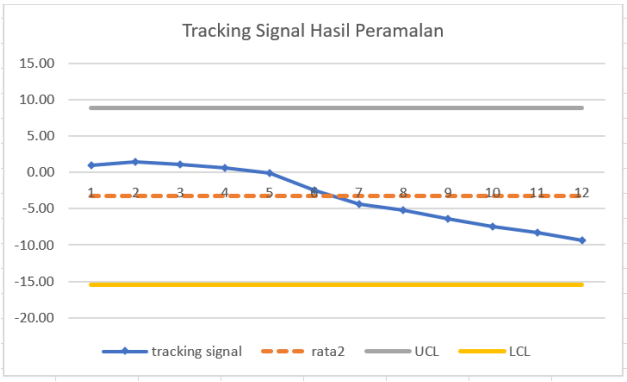

Figure 2. Tracking Signal

Based on the graph above, it can be concluded that the tracking signal value does not cross the upper and lower control limits. So, it can be concluded that the forecasting results are within the control limits and can be used.

4.2 Master Production Schedule

The next step is to determine the master production schedule or commonly referred to as the master production schedule. The master production schedule is obtained from the calculated forecasting results. The following is a master production schedule which can be seen in Table 2 below.

Table 2. Master Production Schedule

Month	Demand (Pieces)
May 2022	204,758
Jun 2022	174,491
Jul 2022	253,132
Aug 2022	228,450
Sept 2022	316,205
Oct 2022	1,636,761
Nov 2022	2,788,945
Dec 2022	783,750
Jan 2023	1,880,620
Feb 2023	2,206,298
Mar 2023	1,319,019
Apr 2023	2,121,194

After the master production schedule has been created, the next step is to validate the master production schedule that has been made using rough capacity planning or commonly called rough-cut capacity planning.

4.3 Rough Cut Capacity Planning

Rough cut capacity planning is capacity planning that aims to find out how big the factory's capacity is to produce a product (Wijaya et.al.,2020). The results of the RCCP calculation can be seen in Table 3 below.

Table 3. Comparison of Available Time and Time Required

Machine	May 2022	Jun 2022	Jul 2022	Aug 2022	Sept 2022	Oct 2022	Nov 2022	Dec 2022	Jan 2023	Feb 2023	Mar 2023	Apr 2023
Cutting	V	V	V	V	V	V	V	V	V	V	V	V
Printing	V	V	V	V	V	V	V	V	V	V	V	V
Coating Water Base	V	V	V	V	V	V	V	V	V	V	V	V
Ponding Matic	V	V	V	V	V	V	V	V	V	V	V	V
Gluing Machine	V	V	V	V	V	V	V	V	V	V	V	V

After the comparison is made, it can be seen that the demand on the master production schedule can be met by the factory capacity which is marked with a check mark (V).

4.4 Material Requirement Planning

In material requirements planning, it is necessary to convert from the master production schedule into material requirements planning. The following is an example of calculating changes from the master production schedule to material requirements planning on the Liquid Ink DM-08 Yellow material which can be seen in Table 4 below.

Table 4. Exploding MPS Liquid Ink DM-08 Yellow

Month	Demand (Pieces)	Needs/Pieces	Results (Kg)
May 2022	204,758	0.000094 Kg	19
Jun 2022	174,491		16
Jul 2022	253,132		24
Aug 2022	228,450		21
Sept 2022	316,205		30
Oct 2022	1,636,761		154
Nov 2022	2,788,945		262
Dec 2022	783,750		74
Jan 2023	1,880,620		177
Feb 2023	2,206,298		207
Mar 2023	1,319,019		124
Apr 2023	2,121,194		199

4.5 Lot Sizing

Lot sizing aims to determine the amount of material to be ordered so that the combination with the lowest cost is obtained. The comparison of the lot method can be seen in Table 5 and Table 6 below.

Table 5. Cost Comparison of Each Method

Material	Methods				
	LFL	Fixed	LUC	LTC	EOQ
Duplex Board 310 GR 610 X 650 mm	Rp21,227,717	Rp22,531,177	Rp19,657,043	Rp16,773,873	Rp17,726,741
Liquid Ink DM-01 Cyan	Rp2,543,984	Rp2,112,193	Rp2,223,700	Rp2,132,217	Rp2,295,343
Liquid Ink DM-04 Magenta	Rp1,872,000	Rp2,012,039	Rp1,596,609	Rp1,523,759	Rp2,430,297
Liquid Ink DM-08 Yellow	Rp2,004,000	Rp2,083,665	Rp2,022,865	Rp1,825,965	Rp2,992,166
Liquid Ink DM-06 Pr-Black	Rp1,320,000	Rp1,463,815	Rp1,224,517	Rp1,081,553	Rp2,787,823
DOOS Packing	Rp20,880,000	Rp21,384,702	Rp17,278,170	Rp12,252,855	Rp21,566,611
Fluid WB Coating	Rp2,232,000	Rp2,607,724	Rp4,129,255	Rp2,815,727	Rp3,350,710
Lem Perekat	Rp1,776,000	Rp1,968,642	Rp2,033,495	Rp2,097,735	Rp2,434,921

Table 6. Cost Comparison of Each Method

Material	Methods			
	PPB	POQ	Silver Meal	Wagner
Duplex Board 310 GR 610 X 650 mm	Rp12,874,580	Rp13,138,578	Rp12,874,914	Rp11,890,806
Liquid Ink DM-01 Cyan	Rp1,813,141	Rp1,857,659	Rp1,930,076	Rp1,522,307
Liquid Ink DM-04 Magenta	Rp1,539,481	Rp1,605,328	Rp1,620,161	Rp1,379,074
Liquid Ink DM-08 Yellow	Rp3,262,479	Rp2,548,034	Rp1,754,206	Rp1,718,543
Liquid Ink DM-06 Pr-Black	Rp1,145,371	Rp1,218,090	Rp1,229,884	Rp1,019,217
DOOS Packing	Rp16,284,875	Rp17,383,237	Rp17,561,380	Rp13,871,928
Fluid WB Coating	Rp2,343,749	Rp2,553,340	Rp3,072,435	Rp1,659,923
Lem Perekat	Rp2,044,383	Rp2,014,274	Rp2,102,524	Rp1,464,462

After looking at the comparison of the costs of each method for each material, the Wagner Withi method produces the lowest cost compared to all other methods of determining the

size of the number of raw materials ordered. Thus, the authors suggest the factory to use the Wagner within the method in determining the number of raw materials to be ordered.

4.6 Capacity Requirement Planning

Capacity Requirement Planning is a capacity calculation to find out whether each machine on the production floor is able to meet consumer demand (Gozali et. al., 2020). The results of the CRP calculation can be seen in Figure 3 to Figure 7 below.

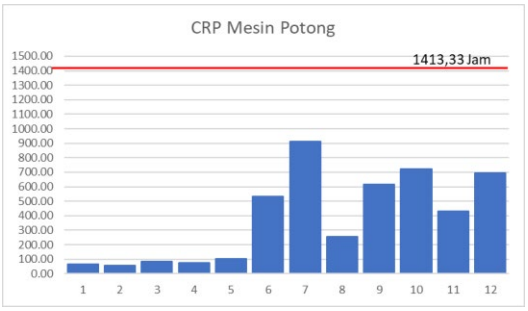

Figure 3. CRP Cutting Machine

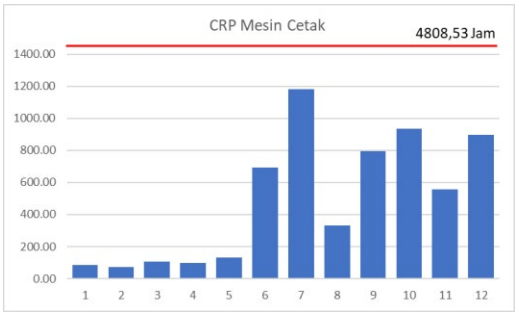

Figure 4. CRP Printing Machine

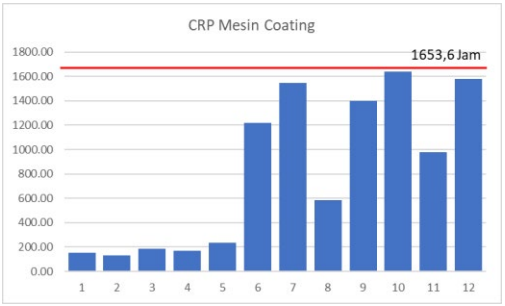

Figure 5. CRP Coating Machine

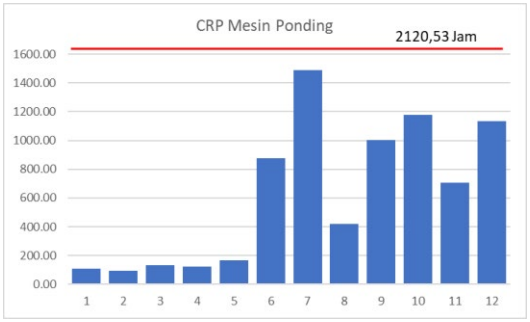

Figure 6. CRP Ponding Machine

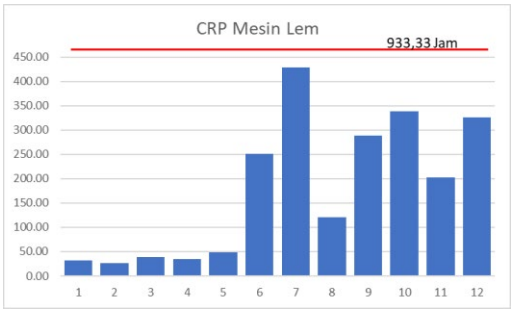

Figure 7. CRP Gluing Machine

Based on the diagram of each machine above, it can be seen that each machine in the factory does not exceed the total available time owned by the factory, thus each machine can meet consumer demand.

4.7 Enterprise Resources Planning

Enterprise resource planning is a set of modules that are combined into an information system that can automatically connect or integrate business processes within the company (Rangkuti, 2007). Odoo is an open-source ERP information system that consists of various modules to integrate business processes within a company. Some of the modules available are sales, manufacturing, human resources, projects, inventory, and accounting. This is an example of implementing odoo ERP which can be seen in Figures 8 to 11 below.

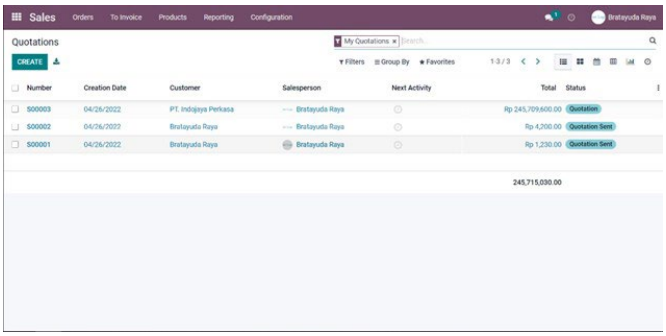

Figure 8. Sales Module

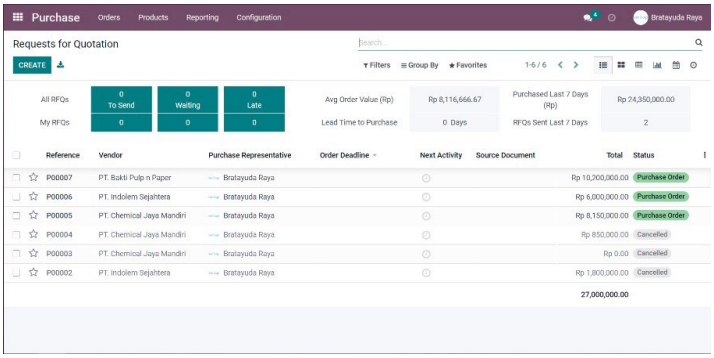

Figure 9. Purchasing Module

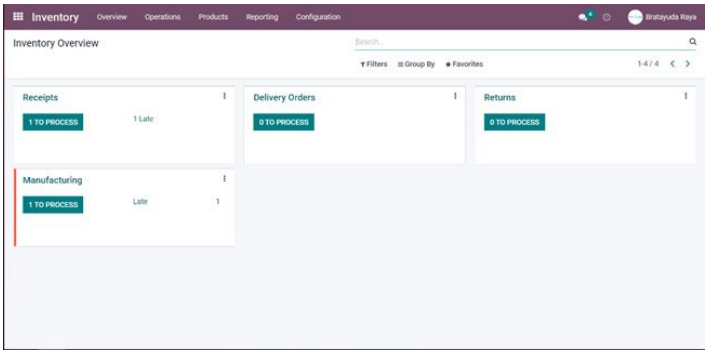

Figure 10. Inventory Module

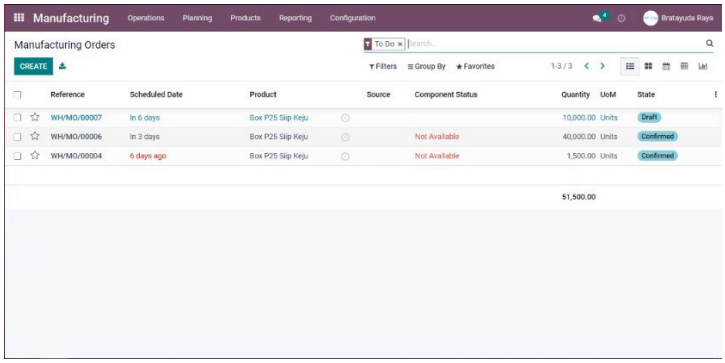

Figure 11. Manufacturing Module

The implementation of ERP certainly makes the processes within the company easier and more effective and of course faster. The following is a comparison after ERP implementation which can be seen in Table 7 below.

Table 7. Comparison After ERP Implementation

Before Implementation	After Implementation
Updating of information regarding the entry and exit of goods from the warehouse is done manually by the operator	Information updates regarding the entry and exit of goods from the warehouse are carried out automatically by the system
The process of calculating whether raw materials are sufficient or not in the production process is carried out manually by the operator	The process of calculating whether or not raw materials are sufficient in the production process is carried out automatically by the system
The making of asales, purchases and production invoice are done manually by operators with different applications	The making of sales, purchases, and production invoice are done automatically by the system and can be sent directly to consumers
The Dissemination of information for each department in the company is still limited because to get information, you must contact the relevant department	The Dissemination of information to every department in the company is very open because to get information, you only need to log into the system
Coordination between each division within the company is still slow due to limited information	Coordination between divisions becomes faster because each division shares information with the other

5. Results and Discussion

Based on the data collection and processing that has been done above, it can be seen that a good method based on the calculation of the smallest error value is the winter method with an alpha value of 0.9. In addition, no forecast validation calculation that crosses the upper and lower limits. Therefore, the authors suggest using this method.

In the calculation of factory capacity, it is found that consumer demand is still below the factory capacity so that consumer demand can be fulfilled, and the master production schedule can be implemented.

In the comparison of lot determination methods, it was found that the method with the lowest cost was the Wagner within the method with a cost reduction percentage of 14.24%.

In the calculation of the capacity of each machine, it can be seen that the production needs for each machine do not exceed the amount of available time owned by the factory, thus each machine is able to meet consumer needs.

The application of enterprise resource planning can help improve company performance in planning and controlling production. Some of the benefits obtained include information on the availability of raw materials which is always updated automatically, a fast calculation process, open information sharing between departments, and increased coordination and cooperation between divisions.

6. Conclusion

Based on the research that has been done, several conclusions can be drawn. The following are some conclusions that can be drawn.

a. Forecasting is an important first step in production planning. The right forecast in this study based on the smallest error is forecasting with the winter method with alpha 0.9 which has an error rate of 19.48% MAPE, 87576.90 MAD, and 11225900000.00 MSE.
b. The comparison of factory capacity and required capacity using the RCCP method states that the total required capacity of 446.58 hours can be fulfilled by the factory of 131152 hours.
c. The method of determining the right number of lots used by the factory is the Wagner Within method with a cost reduction percentage of 47.5%, a percentage decrease in ordering frequency by 10%, and a decrease in the amount of inventory by 75.8%.
d. The calculation of the capacity of each machine using the CRP method shows that the time it takes for each machine to produce consumer demand can be met. The need for 4546 hours on the cutting machine can be met with a capacity of 16960 hours, the need for 5891 hours on the printing machine can be met with a capacity of 57701 hours, the need for 10340 hours on the coating machine can be met with a capacity of 19843 hours, the need for 7432 hours on the ponding machine can be met with a capacity of 25446 hours and the need for 2136 hours on the glue machine can be met with a capacity of 11200 hours.
e. The implementation of an ERP system in planning and controlling production will make the company become and. ERP systems can help companies integrate all operational processes quickly and automatically

References

Agung, A. Penerapan Metode Single Moving Average Dan Exponential Smoothing Dalam Peramalan Permintaan Produk Meubel Jenis Coffee Table Pada Java Furniture Klaten. Surakarta. 2009.

Bustami, Bastian and Nurlela. Akuntansi Biaya. Edisi 4. Jakarta: Mitra Wacana Media 2013.Budiastuti, Fatkar. Pengaruh Volume Penjualan dan Biaya Produksi Terhadap Laba Bersih pada PT Indah Kiat Pulp and Paper Tbk., Jurnal Ekonomi & Bisnis, Vol. 1., No. XXIV, 2016 Christifan, A. J., & Gozali, L. Application of MRP System for Control ofRaw

Material Inventory with EOQ Lot Sizing. In IOP Conference Series: Materials Science and Engineering (Vol. 1007, No. 1, p. 012029). IOP Publishing. (2020, December).

Fahmi, Irham. Manajemen Produksi dan Operasi.Penerbit Alfabeta, Bandung. 2016.

Gozali, L., Marie, I. A., Hoswari, S., Christifan, A. J., Gunawan, P. A., Elliani, M. F. G. C., & Natasha, T. Forecasting Using Artificial Neural Networks and Aggregate Production Planning and Dynamic Model of Inventory Control for Rib and Single Knit Fabric.

In IOP Conference Series: Materials Science and Engineering (Vol. 1007, No. 1, p. 012023). IOP Publishing. (2020, December).

Gunawan, P. A., Gozali, L., Widodo, L., Daywin, F. J., & Olyvia, C. 2020. Production Planning and Capacity Control with Demand Forecasting Using Artificial Neural Network (Case Study PT. Dynaplast) for Industry 4.0. Proceeding IEOM, Singapore

Heizer J, dan Render B. Manajemen Operasi Edisi ketujuh. Jakarta: Salemba Empat. 2006.

Hasan, Irmayanti. Manajemen Operasional: Perspektif Integratif. Malang: UIN-Maliki Press 2011.Handoko, T., Hani. 2011. Dasar-dasar Manajemen Produksi dan Operasi. Yogyakarta: BPFE Indrajit, Richardus Eko and Richardus Djokopranoto. 2003. Manajemen Persediaan. PT. Gramedia Widiasarana Indonesia: Jakarta

Kusuma, Hendra. Production Planning and Inventory Control. Jakarta: Gramedia Pustaka Utama. 2009.

Lefta , F., Gozali, L., & Marie, I. A. Aggregate and Disaggregate Production Planning, Material Requirement, and Capacity Requirement in PT. XYZ. In IOP Conference Series: Materials Science and Engineering (Vol. 852, No. 1, p. 012123). IOP Publishing. (2020, July).

Lieberty, A. and Imbar, R. Sistem Informasi Meramalkan Penjualan Barang Dengan Metode Double Exponential Smoothing (Studi Kasus: PD. Padalarang Jaya). Jurnal Teknik Informatika Volume 1 Nomor 1, 27-32. 2015.

Manahan, P. Tampubolon. Manajemen Operasional Edisi Pertama. Ghalia Indonesia. 2012.

Putri, N. V., & Gozali, L. Material Requirement Planning on Y-Strainer Production (Case Study at PT. XYZ). Proceeding IEOM, Surakarta, Indonesia2021.

Rangkuti, Freddy. Manajemen Persediaan: Aplikasi di Bidang Bisnis. Jakarta: Raja Grafindo Persada 2007.

Santoso, Singgih. Business Forecasting, Metode peramalan bisnis masa kini dengan minitab dan SPSS. Jakarta: PT. Elex Media Komputindo. 2009.

Sinulingga, Sukaria. Perencanaan & Pengendalian Produksi. Yogyakarta: Graha Ilmu.

Sitompul, Rio, Oloan. Aplikasi Metode Economic Order Quantity (EOQ) untuk Mengoptimalkan Persediaan Bahan Bakar Minyak di PT Kereta Api (Persero) Medan. Fakultas 2011.

Matematika dan Ilmu Pengetahuan Alam Universitas Sumatera Utara, Medan. 2009.

Wijaya, A. T., Lefta, F., Gozali, L., & Daywin, F. J., December). Forecasting Analysis at PT. Lion Metal Works Using Artificial Neural Network. In IOP Conference Series: Materials Science and Engineering (Vol. 1007, No. 1, p. 012184). IOP Publishing. (2020

Biographies

Bratayuda Raya is a final year student at Tarumanagara University majoring in industrial engineering. He is active in campus organizations. He once become a leader in one of the campus organizations from 2020 to 2021. He also ever joins the student creativity program about product designing to get a scholarship from Tarumanagara University.

Lina Gozali is a lecturer in the Industrial Engineering Department at Universitas Tarumangara since 2006 and a free-lance lecturer at Universitas Trisakti since 1995. She got her bachelor's degree at Trisakti University, Jakarta - Indonesia, then she graduated master's degree at STIE IBII, Jakarta – Indonesia, and graduated with her Ph.D. at Universiti Teknologi Malaysia, Kuala Lumpur – Malaysia in 2018. Her apprentice college experience was in paper at Kertas Bekasi Teguh, shoe at PT Jaya Harapan Barutama, automotive chain drive industry at Federal Superior Chain Manufacturing. She teaches Production System and Supply Chain Management Subjects and her Ph.D. research about Indonesian Business Incubator. She actively writes for almost 40 publications since 2008 in the Industrial Engineering research sector, such as Production Scheduling, Plant LayOut, Maintenance, Line Balancing, Supply Chain Management, Production Planning, and Inventory Control. She had been worked at PT. Astra Otoparts Tbk as International.

Carla Olyvia Doaly is a lecturer in the Industrial Engineering Department at Universitas Tarumanagara graduated with my bachelor's degree from Institut Teknologi Nasional Malang, which study the Industrial Engineering program, then continued my master's degree at Institut Teknologi Bandung majoring in Industrial engineering and management and a special field of

Enterprise Engineering. I am very interested in studying industrial engineering by doing research related to System Design and Engineering, Supply Chain Management, Operations Research and Analysis, Information System Management, Occupational Health and Safety, Facilities Engineering, Quality and Reliability Engineering