Jurnal Teknik Informatika C.I.T Medicom, 15 (1) (2023) 01-08

Published by: Institute of Computer Science (IOCS)

Jurnal Teknik Informatika C.I.T Medicom

Journal homepage: www.medikom.iocspublisher.org

Material requirements planning method for controlling inventory of raw materials

Hendra Cipta[1], Rima Aprilia[2], Hari Kurniawan[3]
[1),2),3)]Faculty of Science and Technology, Universitas Islam Negeri Sumatera Utara, Medan, Indonesia

Article Info

Article history

Received: Feb 13, 2023
Revised: Mar 04, 2023
Accepted: Mar 30, 2023

Keywords:

Brownies;
Inventory Control;
Material Requirment Planning;
Production;
Raw materials.

Abstract

The existence of shortages and excesses of production raw materials often occurs in the NR Brownies company where this situation greatly influences the smooth production process, especially in the supply of raw materials which results in sub-optimal expenditure costs. The aim of this research is to find solution how to prevent companies from experiencing these problems on a regular basis which results in less than optimal spending costs. In overcoming this problem, the Material Requirement Planning method is applied, this method is expected to minimize expenditure costs so that the benefits obtained are more optimal. From the research results, the Material Requirement Planning Method for EOQ calculations produces the minimum costs for sugar and oil raw materials of 18.295.130 and 19.591.230 respectively, while the POQ calculation produces the minimum costs for raw materials 14.839.500 for flour, 15.450.000 for eggs, 1.356.650 for cocoa flour, and 2.504.387 for baking powder.

Corresponding Author:

Hendra Cipta,
Department of Mathmatics,
Universitas Islam Negeri Sumatera Utara,
Jln. Lapangan Golf, Kecamatan Pancur Batu, Deli Serdang, Sumatera Utara, Indonesia 20353
Email: hendracipta@uinsu.ac.id

1. Introduction

Economic growth in Indonesia continues to develop in line with the era of globalization, various scales and types of industries have supported the Indonesian economy with all the dynamics that occur [1]. The increasingly advanced trend and the development of the Indonesian economy make competition more intense in all industrial sectors and each company in carrying out its business activities [2]-[3]. The company is required to manage all the resources owned by the company better in order to increase productivity and optimal profits and face all challenges and obstacles in an effort to run business activities efficiently [4]. Therefore, raw material inventory planning and control activities are indispensable.

Inventory management is a systematic approach to acquiring, storing, and profiting from non-capital assets (raw materials and finished goods) with the right amount of stock, in the right place, at the right time, and at the right cost [5]. Simply put, the company will be able to control raw materials and production at the appropriate level so as not to cause excess or shortage of stock which results in losses. Inventory control is one of the company's assets that is closely related to sales and production levels. So, if there is a problem regarding inventory, it will directly affect business losses [6].

In regulate the control of trade inventory can be said to be difficult and easy, if the existing inventory is excessive, then the inventory will certainly cause high expenses. Therefore, every item that is stored must cost a lot [7]. However, if the available inventory is lacking, it will hamper production activities and eventually cause loss of consumers and sales. There is uncertainty about the time of ordering, supply from suppliers to unclear requests, all of which need to be regulated so that they do not arise in a company [8].

NR Brownies is one of the Brownies companies located in Benteng Hilir street, Medan Tembung, Deli Serdang Regency. It is one of the companies engaged in the Brownies sponge production sector. The problem of NR Brownies companies often face about controlling the inventory of raw materials. In receiving requests from customers, NR Brownies often experience problems in the raw material control system, it cause the raw material scheduling system is based on the estimates of the company owner and has not used analytical calculations regarding the number and time of orders. So that the inventory, especially the main raw materials, namely wheat flour and granulated sugar, is not well controlled, which results in waste on storage costs. There are many methods used to control the inventory of raw materials, one of which is by using the Material Requirement Planning (MRP) method or the raw material needs planning system [9],[10],[11].

MRP is a demand-dependent inventory control and planning system that schedules the right amount [12]-[13]. With the MRP system, it can be known the amount of raw materials needed to complete a product in the future [14]. The purpose of the MRP is to control inventory levels, determine the priority of operations on individual items and plan the capacity of the production system, in detail the inventory level includes ordering items with the right quantity and timing [15], [16]. Meanwhile, the priority of MRP is to obtain the right raw materials in the right place and at the right time in an effort to increase customer satisfaction [17]-[18].

In [1], the implementation of the Material Requirement Planning (MRP) system is expected to be able to find out the optimal amount of raw material inventory and the right ordering time to meet production needs with optimal costs. This study was aimed to determine the exact lot size technique based on inventory costs and to compare the MRP method with inventory in the company based on total inventory costs. According to [19], four products which are classified into A class. Then, this paper discusses the Triple Exponential Smoothing (TES) as the forecasting method. Aggregate planning is also conducted for better production planning. The results of aggregate planning provide solutions to increase the workforce to balance production capacity by the number of demands. Another argument from [10] mention that combining the ABC inventory method with subsequent MRP planning is beneficial if the combination is implemented in practice. To demonstrate the benefits, the framework is tested using a case study company. The presented case-study problem is to reduce the number of changeover downtimes in the environment of an engineering production company.

Based on previous research, this research will discuss more about the problem of production control in the availability of raw materials in making brownies. In this research, three things will be explained which are the main objects that were not explained in previous research. These three things are to calculate the optimal profit for each aspect of Lot For Lot (LFL), Economic Order Quantity (EOQ) and Period Order Quantity (POQ) at the NR Brownies company based on the availability of raw materials that are still in stock in storage. These three aspects will form the basis of the problems to be examined and discussed in this research. With these three things, it is hoped that the NR brownie company will be able to get minimum expenses so that the profits obtained are more optimal. The implementation of MRP method for NR Brownies company, it is hoped that it will provide a solution for the company to continue to make inventory control of production raw materials so that the company are continuously available and not lose stock. This method can also provide an overview of profits that are more significant than the profits obtained by the company by means of their calculations.

2. Research Methods

This research was conducted at the NR Brownis company located on Benteng Hilir street, Medan Tembung, Percun Sei Tuan, Deli Serdang Regency. The time of the research was carried out starting from March-August 2022. The type of research used in this research is quantitative research [20]. The type of data needed in this study is secondary data. Secondary data is internal data derived from documents records [21]. Research variables need to be determined and explained so that the flow of the relationship between two or more variables in the study can be searched and analyzed [20], [22]. After the secondary data is obtained from the company, the data is processed using the MRP method to obtain a solution to the raw material inventory for brownie production and provide profit calculation results which will later be compared with company profits.

Table 1.
Research Variables

Research Variables	
Y	Cost of production raw materials
X	Production raw materials
X_1	Wheat flour raw materials
X_2	Egg raw materials
X_3	Sugar raw materials
X_4	Oil raw materials
X_5	Brown flour raw materials

Based on table 1 above, this research requires research variables that are used to limit the extent to which this research will be investigated. The variables used consist of one influencing variable and 5 influenced variables. This research variable will also provide determining indicator factors in determining the optimal production inventory for brownies raw materials in the availability of material stock.

Research procedure, the procedures in this research [23]-[24]:

a) Start
b) Observation
c) MRP Method Analysis

After got the data from NR Brownies company, the next step was data processing as follows:

1) Create Bill Off Materials (BOM) table
2) Search inventory data
3) Looking for Lead time
4) Ordering raw materials
5) Develop a Master Production Schedule (MPS)
6) Looking for Netting calculatiom.
   The formula used to calculate net needs as follows [25]-[26]

$$NR = GR - SR - OH \quad (1)$$

where:
NR = Net Needs
GR = Gross Needs
SR = Acceptance Schedule
OH = Inventory on Hand

7) Determining Lot Sizing
   The lot technique used in this research [19],[27],[24]:
   a) Using the LFL system
      The aims to minimize storage costs for units to zero, because the lot size is adjusted to the needs.

b) Using the EOQ system.

$$EOQ = \sqrt{\frac{2DS}{H}} \quad (2)$$

where:
Q = Number of units per order with Q = EOQ
D = Annual demand
S = Setup for ordering cost
H = Holding/carrying cost

c) Using the POQ system.

$$POQ = Q = \sqrt{\frac{2S}{DH}} \quad (3)$$

where:
Q = Otimal number of items in each order
D = Annual demand for inventory items
S = Ordering cost for each order
H = Storage cost per unit per year

d) Creat the Material Requirements Planning (MRP) table
e) Determine the results

3. Results and Discussion

Data needed in compiling the MRP table is divided into production data, raw material data and raw material cost data.

Table 2.
Data of production brownies for 6 months

Week To	Production (in pack)					
	March	April	May	June	July	August
1	6900	7000	6900	6900	6800	6900
2	6900	6700	6700	6900	6600	6900
3	7100	7000	7100	7100	6900	6900
4	6800	6800	6800	6700	6800	6800
Total Production	27700	27500	27500	27600	27100	27500

Based on table 2 above, describes the description of the initial raw material production data for the next 6 months, this data is used as a reference for implementing MRP calculations.

Table 3.
Data of brownies raw material

No	Raw Material	Quantity (kg)
1	Flour	3
2	Egg	2,5
3	Sugar	3
4	Oil	3
5	Brown Flour	0,03
6	Company	0,02

And table 3 above describes the inventory composition of raw materials used in one production process.

Table 4.
Data of purchase raw materials brownies for 6 months

Raw Materials	Amount (in kg)					
	March	April	May	June	July	August
Flour	2450	2550	2450	2300	2500	2500
Brown Flour	900	900	1000	900	900	110
Sugar	1850	200	1850	200	1900	1800
Oil	2400	2250	2350	2250	2250	2400
Egg	2160	2160	2160	2160	2160	2160
Company	50	55	50	48	50	50
Total	9810	8115	9860	7858	9760	9020

Then the data in table 4 above shows data on raw material purchases made by the company for 6 consecutive months, which are as follows. Lead Time is the waiting time required when ordering raw materials until the receipt of the raw material order. In this research, the lead time used is the average lead time for buying brownies for 6 months from March 2022 to August 2022. Data calculation using MRP system:

a. Determination of the structure products

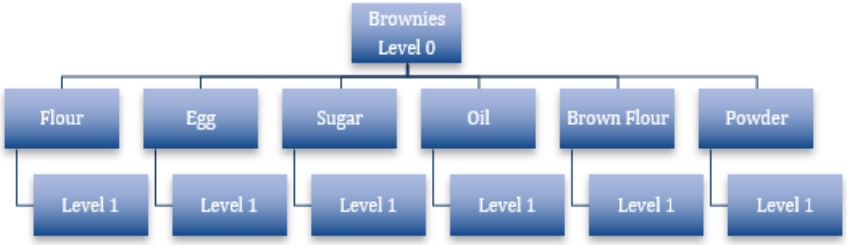

Figure 1. Product structure of NR Brownies

In this research, the selected product is brownies. The structure of brownies product can be seen in figure 1. The product structure will later be used as the basis for making Bill of Material (BOM). As can be seen in the picture above, planning for items that are at level 0 is production planning, while planning for raw material requirements is planning for items that are at level 1.

b. Creat of Bill of Material (BOM)

Table 5.
Bill off material

Material Level	Raw Materials	Quantity (In kg)	Source
-	Brownies	-	Production
1	Flour	3	Buy
1	Egg	2,5	Buy
1	Sugar	3	Buy
1	Oil	3	Buy
1	Brown Flour	0,03	Buy
1	Company	0,02	Buy

Bill Of Materials (BOM) is a table of the product structure that provides data on the level of each component, the amount needed for each component, and the source of the component. As can be seen in table 5. From the table above, it can be seen that in one brownie dough you need 3 kg of flour, 2.5 kg of eggs, 3 kg of sugar, 3 kg of oil, 0.03 kg (3 ounces) of cocoa flour and 0.02 kg (2 ounces) of developer. It can also be seen the flow of raw material purchases, namely raw materials purchased by the buyer. Then it enters the warehouse and is processed up to the packaging stage and then ready to be marketed.

c. Creat of Master Production Schedule (MPS)

Table 6.
MPS of brownies product

Week To	Quantity (Packaging)	Week To	Quantity (Packaging)	Week To	Quantity (Packaging)
1	6900	9	6900	17	6800
2	6900	10	6700	18	6600
3	7100	11	7100	19	6900
4	6800	12	6800	20	6800
5	7000	13	6900	21	6900
6	6700	14	6900	22	6900
7	7000	15	7100	23	6900
8	6800	16	6700	24	6800

Based on table 6, Master Production Schedule (MPS) is actually a table that contains production budget data for a product. In this research, the actual production data obtained from the company for 6 consecutive months starting from March 2022 to August 2022.

d. Calculation of the amount net need
The calculation of net needs is obtained from the amount of gross needs minus the amount of inventory in hand. The amount of gross blindness for each is obtained from the MPS table. The results of the calculation of net needs will be later used as a basis for calculating lot sizing every time a purchase is made. The unit in the calculation of net needs is kilograms (kg).

e. Lot Sizing calculation used for each raw material
In this research, the determination of the amount and time of purchase of each raw material will be calculated using lot sizing namely, Lot For Lot (LFL), Economic Order Quantity (EOQ), and Order Quantity Period (POQ). The lot sizing calculation in this research will provide optimal results with period of 24 weeks. The lot sizing calculation will produce different numbers if the time is prone to be changed to longer or shorter.

1) Lot for lot (LFL)
The calculation technique carried out in the lot for lot method is the purchase of raw materials in accordance with the needs of raw materials for each period. The costs incurred on this method are only the cost of ordering since the raw materials are not at the storage stage.

2) Economic Order Quantity (EOQ)
All data needs and storage costs must be annualized, so that obtained:
Raw material needs a year (D)= (needs 24 weeks)/24 × 52 weeks, A year's save fee (H) = percentage of storage cost × storage cost × price/unit × 52 weeks, By using eqt (2), it is known the economical order amount is 32.581 kg for wheat flour, 19.755 kg for eggs, 23.410 kg for sugar, 23.113 kg for oil, 4.452 kg for brown flour, and 1.145 kg for companys.

3) Periode Order Quantity (POQ)
POQ is calculated by equation (3), and gives the results in the table 7.

f. Analyzing research with comparing lot sizing methods
After the calculation is carried out with the three selected lots, the next step is to compare the results of the three lots and choose which lot produces the most minimum cost.

Table 7.
Lot sizing comparison

Lot Sizing	Flour	Egg	Sugar	Oil	Brown Flour	Company
LFL	124.200.000	124.200.000	124.200.000	124.200.000	124.200.000	124.200.000
EOQ	18.466.245	17.980.500	18.295.130	19.591.230	1.470.310	2.632.138

Lot Sizing	Flour	Egg	Sugar	Oil	Brown Flour	Company
POQ	14.839.500	15.450.000	19.182.850	20.204.000	1.365.650	2.504.387

After all the steps are satisfied, the last step in the MRP system is the manufacture or filling of the MRP table based on the number of purchases contained in the EOQ and POQ methods for each raw material with the least cost of expenditure. By looking at the MRP tables data, we can find out how many final orders there are how many orders need to be carried out and when the order is carried out. In addition, it can also be known when the goods we order can be received and the amount of raw material needs each week. In making the MRP table, there are several elements including gross needs, receipt schedule, warehouse inventory, net needs and goods ordering schedule.

4. Conclusions

This research applies the Material Requirtment Planning (MRP) method to NR Brownies companies by calculating lot sizing using the Lot For Lot (LFL), Economic Order Quantity (EOQ), and Order Quantity Period (POQ) systems. The application of the Material Requirtment Planning (MRP) method provides the minimum results on the total cost of production raw materials where from the three calculations LFL, EOQ, POQ seem in table 7. It is expected that if the company implements the MRP system in controlling inventory production raw materials, it can maximize the company's profits. This method is still calculated manually so that there are still errors in the production results. So that, for get the optimal production results it still needs to be checked again so that the available raw material supplies still have stock. By MRP, this method provides a solution to the company in controlling the inventory of production materials, this method can also estimate the availability of material stock, so that the company does not run out of production materials. This method also provides profit estimation so that the company can re-examine the profit obtained in one production. For further research using the MRP method, it is hoped that in the future the calculation of the MRP method will use software that is more accurate not just calculated manually with MS Excel or or assisted with Software Quantitative Management (QM) for Windows Version.

References

[1] H. D. Susanti, "Application of material requirement planning method in raw materials planning on sardine product in pt. Blambangan foodpackers indonesia," *Food Res.*, vol. 4, no. 6, pp. 2067–2072, 2020, doi: 10.26656/fr.2017.4(6).228.

[2] F. Lefta, L. Gozali, and I. A. Marie, "Aggregate and disaggregate produetion planning, material requirement, and capacity requirement in Pt. XYZ," *2nd TICATE 2019 IOP Conf. Ser. Mater. Sci. Eng.*, vol. 852, no. 1, 2020, doi: 10.1088/1757-899X/852/1/012123.

[3] H. indah Sari, S. Dur, and H. Cipta, "Forecasting Of Jansen ' S Rice Inventory Control Using Monte Carlo And Markov Chain Techniques," *Iternational J. Basic Appl. Scrience*, vol. 11, no. 2, pp. 76–85, 2022.

[4] F. Rakhmawati, "Optimization of Material Requirement Planning Using A Linear Program," vol. 2, no. 1, pp. 1–13, 2022.

[5] S. Permana, M. Andriani, and D. Dewiyana, "Production Capacity Requirements Planning Using The Capacity Method Requirement Planning," *Int. J. Eng. Sci. Inf. Technol.*, vol. 1, no. 4, pp. 36–40, 2021, doi: 10.52088/ijesty.v1i4.165.

[6] C. Furqon, M. A. Sultan, and R. J. Pramudita, "Analysis of Material Requirement Planning (MRP) Implementation on The Company," *Proc. ofthe 2nd Int. Conf. Econ. Educ. Entrep. (ICEEE 2017)*, no. February 2020, pp. 140–145, 2018, doi: 10.5220/0006882001400145.

[7] A. F. Rhufyano, M. F. Robbani, and H. R. Arifin, "Optimizing Efficiency through Application of the Materials Requirement Planning and Demand Forecasting : A Case Study of a Small and Medium-Sized Enterprise in the Tea Beverage Industry," pp. 1152–1162, 2022.

[8] B. Werth, J. Karder, A. Beham, and K. Altendorfer, "Simulation-based Optimization of Material

Requirements Planning Parameters," *Procedia Comput. Sci.*, vol. 217, no. 2022, pp. 1117–1126, 2023, doi: 10.1016/j.procs.2022.12.310.
[9] N. Hasanati, E. Permatasari, N. Nurhasanah, and S. Hidayat, "Implementation of Material Requirement Planning (MRP) on Raw Material Order Planning System for Garment Industry," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 528, no. 1, 2019, doi: 10.1088/1757-899X/528/1/012064.
[10] M. Malindzakova, P. Garaj, J. Trpčevská, and D. Malindzak, "Setting MRP Parameters and Optimizing the Production Planning Process," *Processes*, vol. 10, no. 4, 2022, doi: 10.3390/pr10040690.
[11] S. H. Santosa, A. P. Hidayat, and R. Siskandar, "Raw material planning for tapioca flour production based on fuzzy logic approach: a case study," *J. Sist. dan Manaj. Ind.*, vol. 6, no. 1, pp. 67–76, 2022.
[12] M. Thürer, N. O. Fernandes, and M. Stevenson, "Production planning and control in multi-stage assembly systems: an assessment of Kanban, MRP, OPT (DBR) and DDMRP by simulation," *Int. J. Prod. Res.*, vol. 60, no. 3, pp. 1036–1050, 2022, doi: 10.1080/00207543.2020.1849847.
[13] S. Thevenin, Y. Adulyasak, and J. F. Cordeau, *Material Requirements Planning Under Demand Uncertainty Using Stochastic Optimization*, vol. 30, no. 2. 2021.
[14] S. Purnamadewi, S. Purnamasari, and T. Sriwidadi, "Planning and Controlling Raw Material of Balado Seasoning Using Material Requirements Planning (MRP) Method," in *Proceedings of the 7th North American International Conference on Industrial Engineering and Operations Management, Orlando, Florida, USA*, 2022, pp. 1627–1635.
[15] D. Mukhlis, J. Indraefrialdi, and E. Rimawan, "Inventory Management using Demand Driven Material Requirement Planning for Analysis Food Industry," *Int. J. Innov. Sci. Res. Technol.*, vol. 4, no. 7, pp. 2456–2165, 2019.
[16] R. P. Ahlam Azzamouri, Pierre Baptiste, Guillaume Dessevre, "Demand Driven Material Requirements Planning (DDMRP): A Systematic Review and Classification," *J. Ind. Eng. Manag.*, vol. 14, no. 3, pp. 439–456, 2021.
[17] G. Ke, R. S. Chen, Y. C. Chen, S. Wang, and X. Zhang, "Using ant colony optimisation for improving the execution of material requirements planning for smart manufacturing," *Enterp. Inf. Syst.*, vol. 16, no. 2, pp. 379–401, 2022, doi: 10.1080/17517575.2019.1700552.
[18] H. A. P. Y A Titilias, L Linawati, "Optimasi Perencanaan Produksi Kayu Lapis PT. XXX Menggunakan Metode Goal Programming," *J. MIPA*, vol. 41, no. 1, pp. 13–19, 2018.
[19] F. Nurprihatin, "Improving the Performance of Planning and Controlling Raw Material Inventory in Food Industry," *Int. J. Res. Ind. Eng.*, vol. 10, no. 4, pp. 332–345, 2021.
[20] B. Mark and C. Peter, "Introduction to quantitative research," *S. Publ. Ed.), Sage Publ.*, vol. 1, 2001.
[21] S. Al-najjar, "Materials Requirements Planning : Performance Evaluation of Lot-Sizing Techniques," *Acad. if Entrep. J.*, vol. 28, no. 2, pp. 1–15, 2022.
[22] R. Jayaraman, C. Colapinto, D. Liuzzi, and D. La Torre, "Planning sustainable development through a scenario-based stochastic goal programming model," *Oper. Res.*, vol. 17, no. 3, pp. 789–805, 2017, doi: 10.1007/s12351-016-0239-8.
[23] H. Zijm and A. Regattieri, "Manufacturing Planning and Control Systems BT," in *Operations, Logistics and Supply Chain Management*, H. Zijm, M. Klumpp, A. Regattieri, and S. Heragu, Eds. Cham: Springer International Publishing, 2019, pp. 251–271.
[24] I. Setiawan, Nurdiansyah, M. Tosin, V. Lusia, and M. Wahid, "Aggregate Planning Implementation for Planning and Controlling the Materials in the Beverage Packaging Industry," *Spektrum Ind.*, vol. 20, no. 1, pp. 95–104, 2022.
[25] M. Díaz-Madroñero, J. Mula, M. Jiménez, and D. Peidro, "A rolling horizon approach for material requirement planning under fuzzy lead times," *Int. J. Prod. Res.*, vol. 55, no. 8, pp. 2197–2211, 2017, doi: 10.1080/00207543.2016.1223382.
[26] W. Sutrisno and H. N. P. Airlangga, "Analysis of crude oil inventory using the material requirement planning method," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 722, no. 1, 2020, doi: 10.1088/1757-899X/722/1/012059.
[27] S. Haryani and F. Aldini, "Analysis of the Application of Material Requirement Planning Method in Nature to Achieve the Production Targets of the Moraja Donggala Social Forestry Business Group," *Int. J. Heal. Econ. Soc. Sci.*, vol. 4, no. 4, pp. 243–251, 2022.