



Material Requirement Planning of Choco Roll Product with Least Total Cost (LTC) and Least Unit Cost (LUC) Method at PT. XYZ

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ABSTRACT

PT. XYZ is one of corporate company engaged in the snack industry. One of PT. XYZ fast moving product is Choco Roll. Choco Roll product have many forming raw material. There is around 20 raw material and packaging material to make 1 box of Choco Roll. Problem that arises at PT. XYZ is in the the supply of raw materials related to the scheduling of ordering raw materials. The company wants to store enough raw material inventory to be able to immediately fulfill all production processes, but this method is not effective and efficient because it will increase storage costs, expiration may occur, and there is a risk of price drops at any time. When a company wants to try to reduce costs by decrease the level of inventory of raw materials on hand, namely the inventory of raw materials that are already in the warehouse, but this condition will disrupt the production process if there are frequent shortages or stockouts of raw materials. Therefore to reduce the inventory cost, it needs to be make best planning in determining the number of ordered of raw material. The company must use a more scheduled raw requirements planning method to obtain a more optimal inventory cost. The purpose of this study is to determine the exact number quantity and order frequency to reduce inventory cost. This research uses lotting technique Least Total Cost (LTC) and Least Unit Cost (LUC) base on Material Requirement Planning (MRP) method. Based on the result of the Choco Roll demand from June 2022 to May 2023 obtained the total inventory cost of IDR 67,683.53 decrease by 25% to company real planning.

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1. INTRODUCTION

Inventories are managed by a corporate or factory to fulfill some future demand (Adeyemi & Salami, 2010). Inventory is a collection of goods stored for sale in the corporate's business process and can be used in the

operation process or will be used for a general purpose (Gaspersz, 1998). Material or goods preserved to provide a specific purpose shall also be another definition of inventory. For example, it is used for the production or assembly process, as well as for resale

(Yanuarsyah, Muhaqiqin, & Napianto, 2021). Lack of material inventory, or excessive accumulation in warehouses are often a problem for companies. The increase in material stocks, storage costs and the creation of an idle fund could also be damaged by overstock. If stocks do not exist, delays in production or the fulfilment of orders may occur and this could lead to customers being lost if they are not fulfilled. (Hasian, 2012). Based on the information above, it can be seen that inventory is very important for a company because it functions to connect successive operations in the manufacture of goods and deliver them to consumers (Vikaliana, Sofian, Solihati, Adji, & Maulia, 2020). In inventory management, there are several types of inventory costs, including: holding cost and set up cost. If holding costs are high, inventory levels should be kept low and restocked frequently (Jacobs & Chase, 2019). Ordering costs are costs incurred in connection with the issuance of purchase orders or contracts. Among them are expedition costs, wage costs, telephone costs, inspection fees, administrative costs, etc (Tampubolon M. P., 2018). Planning requirements for raw materials, i.e. the time to order and quantity and amount of inventory that shall be ordered on a scheduled basis. That is, purchasing and storage costs are optimal without disrupting production and sales (Ozule, Oke, & Nwankiti, 2023). Optimization processes is probably the most reliable route to achieving the best results based on the desire to maximize operation's productivity, efficiency, and resource utilization (Ozule, Oke, & Nwankiti, 2023). And then inventory control is related to two issues. How, when to order or order rate and how much to order or order quantity (Kumar & Suresh, 2008). Raw material planning and control has many advantages for companies that want to use it (Martha & Setiawan, 2018).

This study aims to determine the optimal order quantity for choco roll raw materials. Some of the raw materials are Cream, Dough, Cardboard, Plastic, Box. In order to determine the quantity of inventory, Lot Sizing technique is a suitable method because it minimises the optimal of orders and thus could be reduce the cost of inventory as well as an inverse price for Inventory Orders. (Yamit, 2005). The method

used in this research are Least Total Cost (LTC) and Least Unit Cost (LUC). The principle of the Least Total Cost (LTC) method is to determine the economic lot size when the holding costs balance the ordering costs (Rini & Ananda, 2021). The principle of the Least Unit Cost (LUC) method is to use the convexity property of the unit cost per unit (order cost and holding cost) to the order lot size as the basis for determining the size of the order lot size (Guslan & Laksono, 2022). The two lot size methods are based on Material Requirement Planning (MRP) matrix. To overcome and be profitable, one type of methods and strategies that are effective and must be implemented by a company organization (Syaputra & Aisyah, 2022). The main driving force behind planning for material requirements is therefore the master production schedule. MRPs provide information that enables managers to estimate the detailed requirements for each of the work centers, such as due dates for components (Kadim, 2017).

2. LITERATURE REVIEW

Material Requirement Planning (MRP) is a system that determines how much and when a component is needed according to the master production schedule. By using this method, the procurement (purchasing) of the components required for a production plan can be carried out only as needed so as to minimize inventory costs (Wahyuni & Syaichu, 2019). There are several tools used in MRP including: (a) Master Production Schedule (MPS). MPS is in the process of determining how much and when it intends to produce each end product. In which the forecast results are used to produce a production plan that is more detailed or short term, MPS occurs by dividing the overall production plan into individual final products intended for manufacture. MPS is the allocation process which takes into account capacity utilisation in order to produce desired product, (b) Bill of Material. BOM is a structure of items needed to create or assemble one unit of finished product. BOM's also commonly referred to as a product tree structure, because that shows how the products are made up of their components. The product structure shall indicate the number of each item and part that will be required, assembly order when a single BOM is entered in which details all

components, identification numbers, drawing dates or raw materials derived from outside suppliers as well as whether they are produced within an organisation or bought from third parties (Jacobs & Chase, 2019), (c) Safety Stock Safety Stock is the minimum level of inventory set by the planner to anticipate fluctuations in demand. On Hand is the quantity of items that are physically in the warehouse (Nugroho, Agung, & dkk, 2019).

$$SS = Z \times \sigma \times \sqrt{LT} \dots \dots \dots (1)$$

Note:

- SS = Safety Stock
- Z = Z score
- LT = Lead Time

(a) Lead Time. Lead time is the time needed to complete a series of processes, consisting of processing time as value added and wastage time as non-value added including waiting and delays, (b) Reorder Point. The amount of inventory required to be present when placing an order shall be the reorder point. (Dermawan, 2012). At what level of inventory the order must be placed is called the reorder point (Sudana, 2011). Reorder point is the amount of inventory that is ordered again depends on the inventory requirements for the conversion process, in fact the use of material inventory is never constant and always varies (Tampubolon M. , 2013), (c) Lot Sizing. There are two lot size methods used, namely Least Total Cost (LTC) and Least Unit Cost (LUC) which will later be compared to find the minimum inventory costs (Guslan & Laksono, Meminimalkan, 2022). According to (Jacobs & Chase, 2019), The advantage (gap analysis) of the LUC methods is that the analysis is more complete and will include ordering or delivery costs which may change as the order size increases. If ordering or setup costs remain constant, the LTC method will be preferred because it is simpler and easier to calculate, but it will only be accurate within these constraints

3. RESEARCH METHOD

This research was conducted at PT. XYZ is located in Sidoarjo City, East Java. This study began in June 2023 until August 2023. The data used in this study was by observation and interviews with the company. While the secondary data used in this study is a number of

production of Choco Roll data document that the author obtained form PT. XYZ internal data.

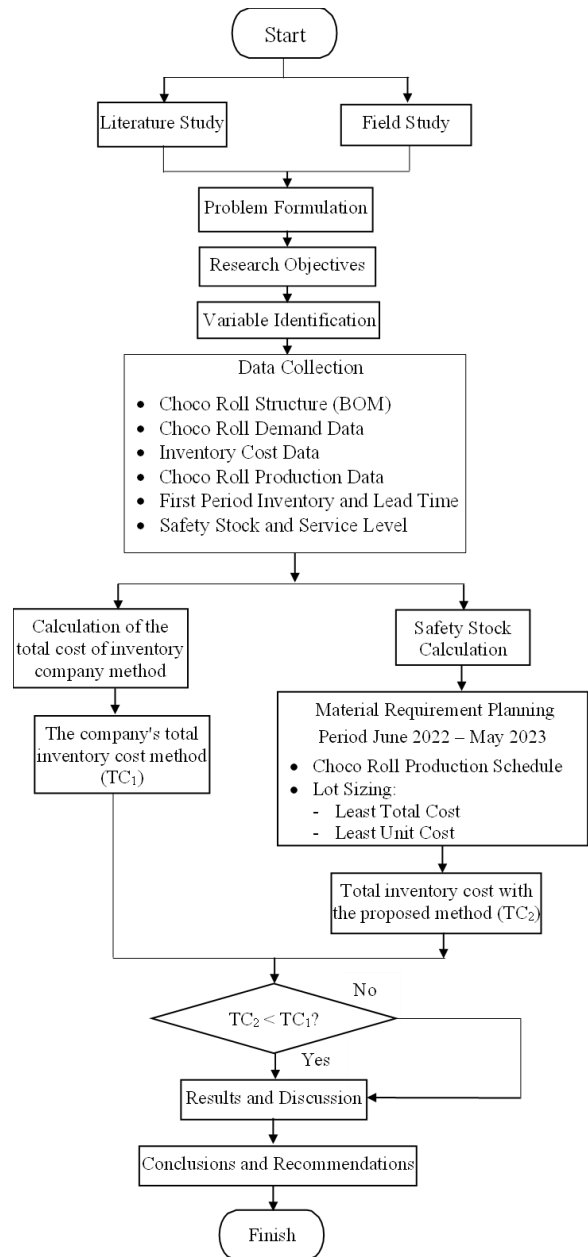


Figure 1. Research stage

Based on Figure 1, are the steps of problem solving, the first stage begins with the introduction of research location, the there is a field survey and literature study, followed by the formulation of existing problems in the company, followed by research objectives, the next step is to identify variables, then there is data collection including bill of material, demand, inventory cost (holding and set up cost), production data, inventory and lead time, safety stock and service level. The next stage is

calculation of the total cost of inventory company method (TC_1). Then calculation safety stock for proposed method. The next step is processing data based on Material Requirement Planning (MRP) matrix with lot sizing Least Total Cost (LTC) and Least Unit Cost. Obtained

total inventory cost with proposed method (TC_2). Compare company method (TC_1) and proposed method (TC_2) to get the best inventory method. Next is result and discussion and the last one is conclusions and recommendations.

4. RESULT AND DISCUSSION

The data collected are total production data

from June 2022 to May 2023. The total data on the production of Choco Roll are as follows:

Table 1. Total choco roll production data

Period	Production Quantity (Box)	Period	Production Quantity (Box)
Period 1	343.728	Period 7	324.428
Period 2	275.332	Period 8	323.981
Period 3	316.052	Period 9	308.688
Period 4	316.688	Period 10	370.388
Period 5	287.639	Period 11	260.754
Period 6	302.849	Period 12	360.608
Total		3.791.135	

Bill of material

No Raw Material shall be included, just the material that is used as a chocolate roll product.. In this case bill of material just

consist 2 raw material and 3 packaging material. The other material is been shared with another produc

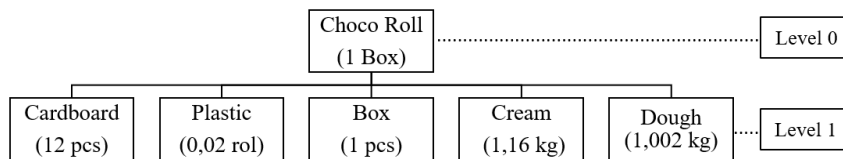


Figure 2. Bill of material of choco roll

Table 2. Total demand each raw materials of choco roll

Period	Cardboard (pcs)	Plastic (rol)	Box (pcs)	Cream (kg)	Dough (kg)
Period 1	4124736	6875	343728	398724	344415
Period 2	3303981	5507	275332	319385	275882
Period 3	3792627	6321	316052	366621	316684
Period 4	3800259	6334	316688	367358	317322
Period 5	3451671	5753	287639	333662	288215
Period 6	3634191	6057	302849	351305	303455
Period 7	3893130	6489	324428	376336	325076
Period 8	3887766	6480	323981	375817	324628
Period 9	3704256	6174	308688	358078	309305
Period 10	4444659	7408	370388	429650	371129
Period 11	3129048	5215	260754	302475	261276
Period 12	4327299	7212	360608	418306	361329
Total	45493623	75823	3791135	4397717	3798718

Safety Stock

Safety stock is an minimum number of inventory held to protect or maintain the possibility of shortages (stock out). All raw

materials which will be used in the production of stock shall be subject to this safety stock calculation.. Table 3 shows the safety stock calculation results for each raw material.

Table 3. Safety stock each raw material of choco roll

Material	Z score	LT	STd	Safety Stock
Cardboard	1.65	0.23	372914	295091
Plastic	1.65	0.2	622	459
Box	1.65	0.1	31076	16215
Cream	1.65	1	36048	59480
Dough	1.65	0.03	31138	8899

Total inventory cost using the company’s method

Total inventory cost that obtained by the company schedule for restocking the raw material. This calculation is purpose to know existing condition inventory management at

PT. XYZ. Therefore author need to defined condition before improvement to get difference between company’s method and author's proposed method. Table 6 shows company inventory cost.

Table 4. Holding cost company’s method

Period	Cardboard	Plastic	Box	Cream	Dough
Period 1	IDR 860.317	IDR 55.250	IDR 48.931	IDR 7.940	IDR 5.466
Period 2	IDR 633.130	IDR 186.792	IDR 40.932	IDR 8.778	IDR 6.545
Period 3	IDR 1.181.711	IDR 143.708	IDR 3.434	IDR 6.811	IDR 5.178
Period 4	IDR 606.201	IDR 117.917	IDR 61.944	IDR 3.475	IDR 5.610
Period 5	IDR 637.993	IDR 44.292	IDR 40.773	IDR 6.285	IDR 5.897
Period 6	IDR 501.375	IDR 81.792	IDR 55.683	IDR 7.191	IDR 5.034
Period 7	IDR 621.250	IDR 77.500	IDR 31.648	IDR 2.660	IDR 7.480
Period 8	IDR 956.833	IDR 46.708	IDR 25.733	IDR 8.588	IDR 5.250
Period 9	IDR 489.235	IDR 122.833	IDR 54.617	IDR 9.211	IDR 5.250
Period 10	IDR 589.158	IDR 103.875	IDR 53.058	IDR 5.318	IDR 5.322
Period 11	IDR 594.875	IDR 60.042	IDR 53.501	IDR 3.538	IDR 7.264
Period 12	IDR 640.584	IDR 91.625	IDR 38.215	IDR 4.598	IDR 6.473
Total	IDR 8.312.668	IDR 1.132.333	IDR 508.470	IDR 74.393	IDR70.769

Table 5. Set up cost company’s method (in million rupiah)

Period	Cardboard	Plastic	Box	Cream	Dough
Period 1	IDR 1,5	IDR 1,0	IDR 1,4	IDR 1,6	IDR 1,2
Period 2	IDR 1,5	IDR 1,0	IDR 1,4	IDR 1,6	IDR 1,2
Period 3	IDR 1,5	IDR 1,0	IDR 1,4	IDR 1,6	IDR 1,2
Period 4	IDR 1,5	IDR 1,0	IDR 1,4	IDR 1,6	IDR 1,2
Period 5	IDR 1,5	IDR 1,0	IDR 1,4	IDR 1,6	IDR 1,2
Period 6	IDR 1,5	IDR 1,0	IDR 1,4	IDR 1,6	IDR 1,2
Period 7	IDR 1,5	IDR 1,0	IDR 1,4	IDR 1,6	IDR 1,2
Period 8	IDR 1,5	IDR 1,0	IDR 1,4	IDR 1,6	IDR 1,2
Period 9	IDR 1,5	IDR 1,0	IDR 1,4	IDR 1,6	IDR 1,2
Period 10	IDR 1,5	IDR 1,0	IDR 1,4	IDR 1,6	IDR 1,2
Period 11	IDR 1,5	IDR 1,0	IDR 1,4	IDR 1,6	IDR 1,2
Period 12	IDR 1,5	IDR 1,0	IDR 1,4	IDR 1,6	IDR 1,2
Total	IDR 18,0	IDR 12,0	IDR 16,8	IDR 19,2	IDR 14,4

Table 6. The company's total inventory cost

Material	Holding Cost	Set Up Cost	Total Cost (Rupiah)
Cardboard	IDR 8.312.668	IDR 18.000.000	IDR 26.312.668
Plastic	IDR 1.132.333	IDR 12.000.000	IDR 13.132.333
Box	IDR 508.470	IDR 16.800.000	IDR 17.308.470
Cream	IDR 74.393	IDR 19.200.000	IDR 19.274.393
Dough	IDR 70.769	IDR 14.400.000	IDR 14.470.769
Total	IDR 10.098.633	IDR 80.400.000	IDR 90.498.633

Least Total Cost

The principle of the Least Total Cost (LTC) method is to determine the economic lot size when the holding costs balance the ordering

costs. The calculation includes all raw materials in level 1 bombs. to fill in the MRP matrix, it is necessary to first determine the lot size with LTC iterations.

Table 7. MRP LTC cardboard (in million pcs)

Period	1	2	3	4	5	6	7	8	9	10	11	12	
GR	0	3,15	3,79	3,80	3,45	3,63	3,89	3,89	3,70	4,44	3,13	4,33	
SR													
POH	1,90	1,90	2,20	6,29	2,49	6,42	2,79	6,97	3,08	7,82	3,38	8,00	3,67
NR		1,54	1,89		1,25		1,40		0,92		0,05		
PORec		3,44	7,89		7,38		8,08		8,44		7,75		
PORel		3,44	7,89		7,38		8,08		8,44		7,75		

From Table 7, it can be seen that orders for cardboard raw materials using the LTC method occurred 6 times in period 2; period 3; period 5;

period 7; period 9; and period 11 with an amount for each period of 3,44; 7,89; 7,38; 8,08; 8,44; and 7,75 in million pcs.

Table 8. MRP LTC plastic (in thousand rol)

Period	1	2	3	4	5	6	7	8	9	10	11	12	
GR	0	5,5	6,6	6,6	6,0	6,3	6,8	6,7	6,4	7,7	5,4	7,5	
SR													
POH	2,0	2,0	9,0	2,4	15,2	9,2	2,9	16,5	9,8	3,4	16,8	11,3	3,8
NR		3,9		4,6			4,3			4,8			
PORec		12,5		19,4			20,4			21,1			
PORel		12,5		19,4			20,4			21,1			

From Table 8, it can be seen that orders for plastic raw materials using the LTC method occurred 4 times in period 2; period 4; period 7;

and period 10 with an amount for each period of 12,5; 19,4; 20,4; and 21,1 in thousand rol.

Table 9. MRP LTC box (in hundred thousand pcs)

Period	1	2	3	4	5	6	7	8	9	10	11	12	
GR	0	2,6	3,2	3,2	2,9	3,0	3,2	3,2	3,1	3,7	2,6	3,6	
SR													
POH	0,7	0,7	7,2	4,0	0,9	10,5	7,5	4,3	1,0	11,1	7,4	4,8	1,2
NR		2,1			2,2				2,2				
PORec		9,1			12,6				13,2				
PORel		9,1			12,6				13,2				

From Table 9, it can be seen that orders for box raw materials using the LTC method occurred 3 times in period 2; period 5; and period 9 with an

amount for each period of 9,1; 12,6; and 13,2 in hundred thousand pcs.

Table 10. MRP LTC cream (in hundred thousand kg)

Period	1	2	3	4	5	6	7	8	9	10	11	12	
GR	0	3,0	3,7	3,7	3,3	3,5	3,8	3,8	3,6	4,3	3,0	4,2	
SR													
POH	0,04	0,0	4,3	0,6	8,1	4,7	1,2	9,2	5,4	1,8	9,6	6,6	2,4
NR		3,6		3,6			3,1			3,1			

PORec		7,3		11,1		11,7		12,1
PORel	7,3		11,1		11,7		12,1	

From Table 10, it can be seen that orders for cream raw materials using the LTC method occurred 4 times in period 1; period 3; period 6;

and period 9 with an amount for each period of 7,3; 11,1; 11,7; and 12,1 in hundred thousand kg.

Table 11. MRP LTC dough (in hundred thousand kg)

Period	1	2	3	4	5	6	7	8	9	10	11	12	
GR	0	2,6	3,2	3,2	2,9	3,0	3,3	3,2	3,1	3,7	2,6	3,6	
SR													
POH	0,2	0,2	6,7	3,5	0,3	6,7	3,7	0,4	7,3	4,2	0,5	4,2	0,6
NR			2,5			2,7			2,9			2,2	
PORec			9,1			9,3			10,1			6,3	
PORel			9,1			9,3			10,1			6,3	

From Table 11, it can be seen that orders for dough raw materials using the LTC method occurred 4 times in period 2; period 5; period 8;

and period 11 with an amount for each period of 9,1; 9,3; 10,1; and 6,3 in hundred thousand kg.

Least Unit Cost

The principle of the Least Unit Cost (LUC) method is to use the convexity property of the unit cost per unit (order cost and holding cost) to the order lot size as the basis for the purpose

of determining the size of the order lot. The calculation includes all raw materials in level 1 bombs. to fill in the MRP matrix, it is necessary to first determine the lot size with LUC iterations.

Table 12. MRP LUC cardboard (in million pcs)

Period	1	2	3	4	5	6	7	8	9	10	11	12	
GR	0	3,1	3,8	3,8	3,5	3,6	3,9	3,9	3,7	4,4	3,1	4,3	
SR													
POH	1,9	1,9	2,2	6,0	2,2	5,8	2,2	6,1	2,2	6,6	2,2	6,5	2,2
NR			1,5	1,9		1,5		2,0		1,8		1,2	
PORec			3,4	7,6		7,1		7,8		8,1		7,5	
PORel			3,4	7,6		7,1		7,8		8,1		7,5	

From Table 12, it can be seen that orders for cardboard raw materials using the LUC method occurred 6 times in period 2; period 3; period 5;

period 7; period 9; and period 11 with an amount for each period of 3,4; 7,6; 7,1; 7,8; 8,1; and 7,5 in million pcs

Table 13. MRP LUC plastic (in thousand rol)

Period	1	2	3	4	5	6	7	8	9	10	11	12	
GR	0	5,5	6,6	6,6	6,0	6,3	6,8	6,7	6,4	7,7	5,4	7,5	
SR													
POH	2,0	2,0	15,6	9,0	2,4	15,5	9,2	2,4	16,6	10,2	2,4	9,9	2,4
NR			3,9			4,0			4,8			3,5	
PORec			19,1			19,1			20,9			12,9	
PORel			19,1			19,1			20,9			12,9	

From Table 13, it can be seen that orders for plastic raw materials using the LUC method occurred 4 times in period 2; period 5; period 8;

and period 11 with an amount for each period of 19,1; 19,1; 20,9; and 12,9 in thousand rol.

Table 14. MRP LUC box (in hundred thousand pcs)

Period	1	2	3	4	5	6	7	8	9	10	11	12	
GR	0	2,6	3,2	3,2	2,9	3,0	3,2	3,2	3,1	3,7	2,6	3,6	
SR													
POH	0,7	0,7	7,2	4,0	0,9	7,1	4,1	0,9	7,7	4,6	0,9	4,5	0,9
NR			2,1			2,2			2,5			1,9	
PORec			9,1			9,1			10,0			6,2	
PORel			9,1			9,1			10,0			6,2	

From Table 14, it can be seen that orders for box raw materials using the LUC method occurred 4 times in period 2; period 5; period 7; and

period 11 with an amount for each period of 9,1; 9,1; 10,0; and 6,2 in hundred thousand pcs.

Table 15. MRP LUC cream (in hundred thousand kg)

Period	1	2	3	4	5	6	7	8	9	10	11	12	
GR	0	3,0	3,7	3,7	3,3	3,5	3,8	3,8	3,6	4,3	3,0	4,2	
SR													
POH	0,04	0,04	4,3	0,6	4,0	0,6	4,4	0,6	4,2	0,6	3,7	0,6	0,6
NR			3,6		3,6		3,5		3,7		4,3		4,1
PORec			7,3		7,0		7,3		7,3		7,3		4,2
PORel		7,31		7,0		7,3		7,3		7,3		4,2	

From table 15 above, it can be seen that orders for cream raw materials using the LUC method occurred 6 times in period 1; period 3; period 5;

period 7; period 9; and period 11 with an amount for each period of 7,31; 7,0; 7,3; 7,3; 7,3; and 4,2 in hundred thousand kg.

Table 16. MRP LUC Dough (in hundred thousand kg)

Period	1	2	3	4	5	6	7	8	9	10	11	12	
GR	0	2,6	3,2	3,2	2,9	3,0	3,3	3,2	3,1	3,7	2,6	3,6	
SR													
POH	0,2	0,2	6,7	3,5	0,3	6,6	3,6	0,3	7,1	4,0	0,3	3,9	0,3
NR			2,5			2,7			3,0			2,4	
PORec			9,1			9,2			10,1			6,2	
PORel			9,1			9,2			10,1			6,2	

From Table 16, it can be seen that orders for dough raw materials using the LUC method occurred 4 times in period 2; period 5; period 8;

and period 11 with an amount for each period of 9,1; 9,2; 10,1; and 6,2 in hundred thousand kg.

Cost Comparison

The total amount of inventory cost is acquired by combine the ordering costs and storage costs. The set up cost is get from the ordering frequency multiplied by the cost of order. The

storage cost multiplied by the amount of stored materials and their duration is used as a basis for calculating holding costs.. Table 17 shows the value of set up costs and holding costs each method each raw material.

Table 17. Comparison of inventory cost between company policy, LTC, and LUC

Materials	Company Plan (IDR)	Least Total Cost		Least Unit Cost	
		Cost (IDR)	Saving	Cost (IDR)	Saving
Cardboard	IDR 26.312.668	IDR 31.931.320	-21%	IDR 28.242.682	-7%
Plastic	IDR 13.132.333	IDR 8.261.042	37%	IDR 8.072.013	39%
Box	IDR 17.308.470	IDR 9.254.069	47%	IDR 9.212.264	47%
Cream	IDR 19.274.393	IDR 15.423.861	20%	IDR 13.675.307	29%
Dough	IDR 14.470.769	IDR 8.614.750	40%	IDR 8.481.266	41%
Total	IDR 90.498.633	IDR 73.485.043	19%	IDR 67.683.531	25%

From the comparison above, it was found that the decrease in inventory costs was due to company policy. there was a decrease of IDR 22,815,102 or around 25% from IDR 90,498,633. From previous studies there was a

significant decrease in inventory costs. Companies can try to apply this MRP based lot size LUC method to real material ordering scenarios.

5. CONCLUSION

Based on the results of the research which was carried out and descriptions given, The result of an analysis of requirements for raw materials by Least Total Cost (LTC) and Least Unit Cost (LUC) method could be reduce the cost of the operational in aspect of inventory cost compared to the use of the company's policy when it comes to the fulfilment of the raw materials. In the case observed, for determining for the period of June 2022 - May 2023, raw materials can be ensured to the optimum conditions of Cardboard, Plastic, Box, Cream, and Dough using Least Total Cost (LTC) can save total inventory cost by 19%. With the same raw material using Least Unit Cost can reduce total inventory cost up to 25%. Least Unit Cost (LUC) chosen for the best lot sizing method for Choco Roll Product. For future researchers, optimization of ordering raw materials can be done with other lot size methods.

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