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Material Planning Analysis with Material Requirement Planning Method in High-rise Building Projects

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Abstract: Planning material supplies well is very important in implementing construction projects to ensure smoothness and efficiency. Smoothness includes thorough planning, including ensuring materials are met as planned, while efficiency aims to reduce time and cost. In this study, material planning will be carried out using the Material Requirement planning (MRP) method, using three different lot measurement techniques, namely Lot for Lot (LFL), Economic Order Quantity (EOQ), and Period Order Quantity (POQ). The MRP method is carried out to accurately calculate the amount of material needed to avoid excessive material inventory levels. After the MRP method, the most optimal number of orders and the total cost required for each lot measurement technique are obtained. The results of this study show that the LFL technique produces the optimum number of orders for gelam wood, plywood, reinforcement, bendrat wire, and ready-mix concrete. Meanwhile, for materials such as lubricating oil, meranti wood, randu wood, and nails, it is optimal to order using the POQ technique.

Keywords: Total Cost, Lot Sizing, Material Requirement Planning

Introduction

In the execution of a construction project, planning a good material inventory is important to ensure smooth and efficient work. Smoothness includes thorough planning, including ensuring materials are met as scheduled, while efficiency aims to reduce time and cost (Maddeppungeng et al., 2021). Materials are the most important resource on construction projects because they can consume more than half of the total project cost, so it is important to implement efficient planning strategies in purchasing, storing, distributing, and calculating construction materials (Lu, 2021; Shoar, 2022; Wu, 2022; Yang, 2021). This aims to ensure the smooth flow of materials as the project progresses.

Implementation of the X Building construction project requires optimal material procurement planning to prevent delays in implementation (Chen, 2021; Q. Wang, 2021; T. Wang, 2021; Zhang, 2021). To determine optimal material inventory, carrying out material inventory planning is necessary, which can calculate material inventory levels to ensure the required materials are available at the required time (Domenico, 2020; Li, 2021; Tian, 2021; Xu, 2020). This method allows companies to order materials accurately, determine the quantity of goods to be purchased, and reduce the risk of delays in the supply of raw materials (Suflani et al., 2023).

In this research, material planning will be carried out using the Material Requirement planning (MRP) method. In the MRP method, some stages must be passed, including the lotting stage, which aims to identify the number of orders (lot size) that produce the lowest material inventory costs and plan the order time (offsetting) (Martinez, 2020; Santos, 2020; Sun, 2020). Material inventory planning uses 3 three different lot measurement techniques, including the Lot For Lot (LFL), Economic Order Quantity (EOQ), and Period Order Quantity (POQ) Techniques.

Methodology

Data Collection

The data used to plan the materials in this research are primary data and secondary data. Primary data is obtained through an interview process with logistics. Meanwhile, the required secondary data, such as Project Planning Drawings, Material Data, S-Curves, and Budget Plans, are obtained by submitting the data to the project construction management.

Create a Bill of Materials

A Bill of Materials is a comprehensive list of all materials needed to produce or produce a job on a project. Specifically, the BOM does not only contain materials but can also contain steps for completing a product or job (Alrahman et al., 2017). *The Bill of Materials* for the upper structure work in this study can be seen in the following table.

Table 1. Bill of Material

No	Job	Material	Unit
A	**Column Work**		
1	Formwork Work	Gelam wood 8-10 cm	rods
		Lubricating oil	liter
		Meranti wood beams	m3
		Randu wood	m3
		1 Sided plywood film	sheets
		2-5 inch nails	kg
2	Column Reinforcement Work	10 mm, 13 mm, 16 mm, 22 mm, 25 mm diameter iron	kg
		Bendrat wire	kg
3	Concreting Work	Beton Ready Mix fc' = 30 Mpa	m3
B	**Beam Work**		
1	Formwork Work	2-5 inch nails	kg
		Gelam wood 8-10 cm	rods
		Lubricating oil	liter
		1 Sided plywood film	sheets
		Meranti wood beams	m3
		Randu wood	m3
2	Beam Reinforcement Work	10 mm, 13 mm, 16 mm, 22mm diameter iron	kg
		Bendrat wire	kg
3	Concreting Work	Beton Ready Mix fc' = 30 Mpa	m3
C	**Floor Slab Work**		
1	Formwork Work	Randu wood	m3
		2-5 inch nails	kg
		Meranti wood beams	m3
		Gelam wood 8-10 cm	rods
		Lubricating oil	liter
		1 Sided plywood film	sheets
2	Floor Slab Reinforcement Work	10 mm & 12 mm diameter iron	kg
		Bendrat wire	kg
3	Concreting Work	Beton Ready Mix fc' = 30 Mpa	m3

(Source: HSPK Surabaya 2022)

Create a Master Production Schedule

The production master schedule is described to find out information about the amount of material needed in the form of a requirement plan schedule. The data needed to create a production master schedule consists of the upper structure work schedule and Bill of Quantitiy (BOQ). The job schedule provides an estimate of the time needed for each job. While BOQ provides information regarding the volume of each work item. By using the production master schedule, material needs can be known by dividing the total material needs by the duration required for each job (Widhiawati et al., 2022).

Determining the Amount of Material Requirement

After identifying what materials are needed from Table 1, the amount of material requirements can be calculated by multiplying the volume of material required for a job by the material coefficient of the work. This calculation uses the coefficient value from

HSPK Surabaya 2022. Then, the multiplication result is divided by the number of weeks the work will be carried out. The example of calculating material needs is as follows.

Types of Jobs : 10 mm Diameter Iron for Beam Iron Work
Material Type : 10 mm Diameter Iron and Bendrat Wire
Coefficient : - 10 mm Diameter Iron = 1.05
- Bendrat Wire = 0.015
Volume Material : 2250.79 kg
Total Weeks Required for Work : 2 weeks
Requirement for 10 mm Diameter Iron = Material Volume x 10 mm Diameter Iron Coefficient
= 2250.79 x 1.05
= 2363.33 kg
Material Requirements for a week $= \frac{\text{Amount of Materials}}{\text{Total Weeks}}$
$= \frac{2363{,}33}{2}$
= 1181.66 kg
Requirement for Bendrat Wire = Material Volume x Bendrat Wire Coefficient
= 2250.79 x 0.015
= 33.76 kg
Material Requirement for a week $= \frac{\text{Amount of Material}}{\text{Total Weeks}} = \frac{33{,}76}{2}$ = 16,88 kg

After knowing the material requirements for each week, a recapitulation table of material requirements for each week is made according to the same type and price. The recapitulation table for upper structure construction material requirements is shown in Table 2.

Table 2. Recapitulation of Material Requirements

No	Material	Unit	Sept	October					November		
			9	10	11	12	13	14	15	16	17
			24 - 30	01 - 07	8 - 14	15 - 21	22 - 28	29 - 4	5 - 11	12 - 18	19 - 25
1	Gelam wood (column & beam work)	rods	343	117	322	322	351	439	213	213	205
2	Gelam wood (floor slab work)	rods	0	0	220	220	220	220	440	0	186
3	Lubricating oil	liter	105,41	36,01	121,69	121,69	130,61	157,70	110,84	65,64	82,17
4	Meranti wood beams (column & floor slab work)	m3	2,45	0,84	1,36	1,36	2,20	1,36	1,11	0,06	0,44
5	Meranti wood beams (beam work)	m3	0,00	0,00	1,76	1,76	1,00	2,77	1,76	5,04	5,04

No	Material	Unit	Sept	October					November		
			9	10	11	12	13	14	15	16	17
			24 - 30	01 - 07	8 - 14	15 - 21	22 - 28	29 - 4	5 - 11	12 - 18	19 - 25
6	Randu wood (column work)	m3	6,32	2,16	2,16	2,16	4,32	2,16	0,15	0,15	0,00
7	Randu wood (beam & floor slab work)	m3	0,00	0,00	6,85	6,85	4,69	4,69	3,61	5,04	6,57
8	1 Sided plywood film	sheets	184	63	213	213	229	276	194	115	144
9	2-5 inch nails	kg	210,8	72,0	243,4	171,4	189,2	315,4	221,7	131,3	164,3
10	10 mm diameter iron	kg	1275,9	5866,8	3437,9	3437,9	3437,9	4619,5	5772,8	1234,5	4655,4
11	12 mm diameter iron	kg	0,0	27821,6	13443,3	13443,3	13443,3	13443,3	26886,5	0,0	8789,3
12	13 mm diameter iron	kg	15086,1	8330,1	8881,2	8881,2	12862,8	13780,9	6138,5	6114,6	4875,8
13	16 mm diameter iron	kg	1148,2	1148,2	1148,2	1148,2	1148,2	2296,3	1478,0	329,8	0,0
14	19 mm diameter iron	kg	5473,8	5473,8	5473,8	5473,8	5473,8	10947,5	5473,8	5548,8	5548,8
15	22 mm diameter iron	kg	6992,3	5372,6	5372,6	5372,6	6443,9	9673,8	4642,4	4642,4	4301,3
16	25 mm diameter iron	kg	10169,0	4064,7	4064,7	4064,7	4080,0	15,3	1085,4	1085,4	0,0
17	12 mm diameter iron	kg	573,5	829,7	597,5	597,5	727,7	840,4	735,4	287,2	418,8
18	Ready mix concrete K-350	m3	134,0	232,7	156,0	156,0	182,8	213,7	203,3	60,8	115,4

(Source: Calculation Data)

Result and Discussion

Material Requirement Planning

Material requirement planning is a systematic system to determine the right amount and time to control material requirements for interconnected demand components (Bayudhana & Kamandang, 2023). In applying the MRP method, it is important to consider the grace period (Lead Time) from the process of ordering and producing components to know when it is appropriate to order or manufacture those components (Irawan & Syaichu, 2017).

A. Purchasing Cost

Purchasing cost is the cost required to obtain each material to be purchased (Lienardo & Jin, 2020). This cost depends on the applicable unit price and the amount of materials that will be needed. In this research, unit prices for materials use HSPK Surabaya 2022.

Table 3. Material Price List

No	Material	Unit	Prices
1	Gelam wood (column & beam work)	rods	IDR 6.500
2	Gelam wood (floor slab work)	rods	IDR 19.500
3	Lubricating oil	liter	IDR 5.300
4	Meranti wood beams (column & floor slab work)	m3	IDR 19.995
5	Meranti wood beams (beam work)	m3	IDR 23.994
6	Randu wood (column work)	m3	IDR 36.000
7	Randu wood (beam & floor slab work)	m3	IDR 48.000
8	1 Sided plywood film	sheets	IDR 68.250
9	2-5 inch nails	kg	IDR 7.200
10	10 mm diameter iron	kg	IDR 10.395
11	12 mm diameter iron	kg	IDR 10.395
12	13 mm diameter iron	kg	IDR 10.395
13	16 mm diameter iron	kg	IDR 10.395
14	19 mm diameter iron	kg	IDR 10.395
15	22 mm diameter iron	kg	IDR 10.395
16	25 mm diameter iron	kg	IDR 10.395
17	12 mm diameter iron	kg	IDR 3.000
18	Ready mix concrete K-350	m3	IDR 780.000

(Source: HSPK Surabaya 2022)

B. Ordering Cost

Ordering costs include all costs associated with importing or ordering materials from outside. The MRP method considers ordering costs when calculating material requirements to ensure appropriate availability at the required time (Pratiwi et al., 2014).

Table 4. Material Ordering Costs

No	Details	Prices
1	Administrative costs	IDR 1.000
2	Internet and telephone costs	IDR 4.000
	Total	IDR 5.000

(Source: Project Data)

C. Holding Cost

Holding costs include all costs due to holding an inventory of materials for a certain period. In this research, material storage costs are 6.75% a year based on bank interest rates in 2024, which can be seen through the Deposit Insurance Corporation (LPS). The amount of material damage costs or depreciation costs have different percentages depending on the type of material. It is assumed that iron, concrete, nails, and lubricating oil are 1% of the material price per unit, while wood material is assumed to be 1% of the material price for each unit, while for wood materials, it is assumed at 2%. (Wahyuni & Wardhono, 2016). Here is an example of a holding cost calculation assuming 52 weeks in one year :

Concrete material $= \frac{0,5\ \% + 6,75\ \%}{52}\ x$ Material prices

Meranti wood material $= \frac{2\ \% + 6,75\ \%}{52}$ x Material prices

Table 5. Material Holding Costs

No	Material	Holding Costs (%)	Prices	Holding Costs/ week
a	b	c	d	e = (c/52) x d
1	Gelam wood (column & beam work)	8,75%	IDR 6.500	IDR 10,9
2	Gelam wood (floor slab work)	8,75%	IDR 19.500	IDR 33
3	Lubricating oil	7,75%	IDR 5.300	IDR 8
4	Meranti wood beams (column & floor slab work)	8,75%	IDR 19.995	IDR 34
5	Meranti wood beams (beam work)	8,75%	IDR 23.994	IDR 40
6	Randu wood (column work)	8,75%	IDR 36.000	IDR 61
7	Randu wood (beam & floor slab work)	8,75%	IDR 48.000	IDR 81
8	1 Sided plywood film	8,75%	IDR 68.250	IDR 115
9	2-5 inch nails	7,75%	IDR 7.200	IDR 11
10	10 mm diameter iron	7,75%	IDR 10.395	IDR 15
11	12 mm diameter iron	7,75%	IDR 10.395	IDR 15
12	13 mm diameter iron	7,75%	IDR 10.395	IDR 15
13	16 mm diameter iron	7,75%	IDR 10.395	IDR 15
14	19 mm diameter iron	7,75%	IDR 10.395	IDR 15
15	22 mm diameter iron	7,75%	IDR 10.395	IDR 15
16	25 mm diameter iron	7,75%	IDR 10.395	IDR 15
17	Bendrat wire	7,75%	IDR 3.000	IDR 4
18	Ready mix concrete K-350	7,75%	IDR 780.000	IDR 1.163

(Source: Calculation Data)

Analysis of the Optimum Booking Amount

Analysis of the optimum order amount includes determining the number of lots (lotting) and ordering plan (offsetting*).* The *lotting* process is an effort to find the most optimal order amount for each material based on the net requirement calculation. The size of the order or *lot sizing* determines the amount of material ordered, this is related to storage costs and order costs that will be incurred.

A. Lot for Lot Technique

The LFL technique is a lot sizing technique that is often encountered, where orders are made by reducing storage costs by minimizing them, even when there are no storage costs (zero). The amount of net requirements when using the LFL technique is met when materials are needed, so the number of orders is equal to the amount of net requirements in that period. In this situation, the storage costs incurred by LFL Technique are zero, so the calculation of Lot for Lot Engineering costs includes material purchase costs and ordering costs.

Table 6. MRP Method with LFL Technique

No	Material	Unit		September		October					November		
				8	9	10	11	12	13	14	15	16	17
				17 - 23	24 - 30	01 - 07	8 - 14	15 - 21	22 - 28	29 - 4	5 - 11	12 - 18	19 - 25
1	Gelam wood (column & beam work)	rods	*Demand*		343	117	322	322	351	439	213	213	205
			On Hand Inventory	0	0	0	0	0	0	0	0	0	0
			Order receipt		343	117	322	322	351	439	213	213	205
			Order release	343	117	322	322	351	439	213	213	205	
2	Gelam wood (floor slab work)	rods	*Demand*		0	0	220	220	220	220	440	0	186
			On Hand Inventory	0	0	0	0	0	0	0	0	0	0
			Order receipt		0	0	220	220	220	220	440	0	186
			Order release	0	0	220	220	220	220	440	0	186	
3	Lubricating oil	liter	*Demand*		105,41	36,01	121,69	121,69	130,61	157,70	110,84	65,64	82,17
			On Hand Inventory	0	0	0	0	0	0	0	0	0	0
			Order receipt		105,41	36,01	121,69	121,69	130,61	157,70	110,84	65,64	82,17
			Order release	105,41	36,01	121,69	121,69	130,61	157,70	110,84	65,64	82,17	
18	Ready mix concrete K-350	m3	*Demand*		134,02	232,69	155,95	155,95	182,83	213,72	203,27	60,76	115,37
			On Hand Inventory	0	0	0	0	0	0	0	0	0	0
			Order receipt		134,02	232,69	155,95	155,95	182,83	213,72	203,27	60,76	115,37
			Order release	134,02	232,69	155,95	155,95	182,83	213,72	203,27	60,76	115,37	

(Source: Calculation Data)

Table 7. Recapitulation of MRP Costs using LFL Technique

No	Material	Unit	Purchasing Costs	Ordering Costs	Holding Costs	Total Costs using LFL Technique
1	Gelam wood (column & beam work)	rods	IDR 16.416.955,75	IDR 45.000	IDR 0	IDR 16.461.955,75
2	Gelam wood (floor slab work)	rods	IDR 29.396.747,25	IDR 30.000	IDR 0	IDR 29.426.747,25
3	Lubricating oil	liter	IDR 4.938.285,60	IDR 45.000	IDR 0	IDR 4.983.285,60
4	Meranti wood beams (column & floor slab work)	m3	IDR 223.718,80	IDR 45.000	IDR 0	IDR 268.718,80
5	Meranti wood beams (beam work)	m3	IDR 459.248,62	IDR 35.000	IDR 0	IDR 494.248,62
6	Randu wood (column work)	m3	IDR 705.494,88	IDR 35.000	IDR 0	IDR 740.494,88
7	Randu wood (beam & floor slab work)	m3	IDR 1.839.144,96	IDR 35.000	IDR 0	IDR 1.874.144,96
8	1 Sided plywood film	sheets	IDR 111.286.129,50	IDR 45.000	IDR 0	IDR 111.331.129,50
9	2-5 inch nails	kg	IDR 12.380.169,60	IDR 45.000	IDR 0	IDR 12.425.169,60
10	10 mm diameter iron	kg	IDR 350.712.347,29	IDR 45.000	IDR 0	IDR 350.757.347,29

No	Material	Unit	Purchasing Costs	Ordering Costs	Holding Costs	Total Costs using LFL Technique
11	12 mm diameter iron	kg	IDR 1.219.026.645,29	IDR 35.000	IDR 0	IDR 1.219.061.645,29
12	13 mm diameter iron	kg	IDR 883.069.734,90	IDR 45.000	IDR 0	IDR 883.114.734,90
13	16 mm diameter iron	kg	IDR 102.338.357,23	IDR 40.000	IDR 0	IDR 102.378.357,23
14	19 mm diameter iron	kg	IDR 570.557.298,31	IDR 45.000	IDR 0	IDR 570.602.298,31
15	22 mm diameter iron	kg	IDR 549.000.327,09	IDR 45.000	IDR 0	IDR 549.045.327,09
16	25 mm diameter iron	kg	IDR 297.599.135,86	IDR 40.000	IDR 0	IDR 297.639.135,86
17	Bendrat wire	kg	IDR 16.822.760,67	IDR 45.000	IDR 0	IDR 16.867.760,67
18	Ready mix concrete K-350	m3	IDR 1.134.533.400,00	IDR 45.000	IDR 0	IDR 1.134.578.400,00
	Total		IDR 5.301.305.901,61	IDR745.000	IDR 0	IDR 5.302.050.901,61

(Source: Calculation Data)

B. Economic Order Quantity Technique

The EOQ technique is carried out to avoid the accumulation of raw materials and calculate the optimal order amount for reordering so that there are no delays in raw material inventory. EOQ must meet several conditions before it can be used by a company, meaning it must know the number of requests, the *Lead Time*, the availability of ordered materials, and the stable purchase price (Mawadah & Mulyana, 2023). Here is an example of a calculation for the EOQ Technique:

Material = Gelam Wood (for column and beam)
Ordering cost (K) = IDR 5000,-
Number of Material Request (D) = 2526 rods
Holding Cost (H) = IDR 10,9,-

$$EOQ = \sqrt{\frac{2Dk}{H}}$$

$$= \sqrt{\frac{2(2526)(5000)}{10,9}}$$

= 1520 rods

Based on the results of these calculations, the EOQ value for gelam wood material is obtained at 1520 logs or multiples for each order. The result of the calculation of the EOQ method is shown in Table 8.

Table 8. EOQ Value

No	Material	Unit	K	D	H	EOQ
1	Gelam wood (column & beam work)	rods	IDR 5.000	2525,69	IDR 10,9	1520
2	Gelam wood (floor slab work)	rods	IDR 5.000	1507,53	IDR 33	678
3	Lubricating oil	liter	IDR 5.000	931,752	IDR 8	1086,083
4	Meranti wood beams (column & floor slab work)	m3	IDR 5.000	11,19	IDR 34	57,667
5	Meranti wood beams (beam work)	m3	IDR 5.000	19,14	IDR 40	68,852
6	Randu wood (column work)	m3	IDR 5.000	19,60	IDR 61	56,878
7	Randu wood (beam & floor slab work)	m3	IDR 5.000	38,32	IDR 81	68,875
8	1 Sided plywood film	sheets	IDR 5.000	1630,57	IDR 115	377
9	2-5 inch nails	kg	IDR 5.000	1719,47	IDR 11	1265,848
10	10 mm diameter iron	kg	IDR 5.000	33738,56	IDR 15	4666,614
11	12 mm diameter iron	kg	IDR 5.000	117270,48	IDR 15	8700,274
12	13 mm diameter iron	kg	IDR 5.000	84951,39	IDR 15	7404,979

No	Material	Unit	K	D	H	EOQ
13	16 mm diameter iron	kg	IDR 5.000	9844,96	IDR 15	2520,842
14	19 mm diameter iron	kg	IDR 5.000	54887,67	IDR 15	5952,179
15	22 mm diameter iron	kg	IDR 5.000	52813,88	IDR 15	5838,653
16	25 mm diameter iron	kg	IDR 5.000	28629,07	IDR 15	4298,750
17	Bendrat wire	kg	IDR 5.000	5607,59	IDR 4	3541,426
18	Ready mix concrete K-350	m3	IDR 5.000	1454,53	IDR 1.163	111,857

(Source: Calculation Data)

Table 9. MRP Method with EOQ Technique

No	Material	Unit		September		October					November			
				8	9	10	11	12	13	14	15	16	17	
				17 - 23	24 - 30	01 - 07	8 - 14	15 - 21	22 - 28	29 - 4	5 - 11	12 - 18	19 - 25	
1	Gelam wood (column & beam work)	rods	*Demand*		343	117	322	322	351	439	213	213	205	
			On Hand Inventory	0	0	1177	1060	738	416	65		1306	1093	888
			Order receipt		1520						1520			
			Order release	1520						1520				
2	Gelam wood (floor slab work)	rods	*Demand*		0	0	220	220	220	220	440	0	186	
			On Hand Inventory			0	0	458	237	17	475	34	34	526
			Order receipt				678			678			678	
			Order release			678			678			678		
18	Ready mix concrete K-350	m3	*Demand*		134,02	232,69	155,95	155,95	182,83	213,72	203,27	60,76	115,37	
			On Hand Inventory		0	89,69	80,72	36,63	104,40	33,43	43,43	63,88	114,98	111
			Order receipt		223,71	223,71	111,86	223,71	111,86	223,71	223,71	111,86	111,86	
			Order release	223,71	223,71	111,86	223,71	111,86	223,71	223,71	111,86	111,86		

(Source: Calculation Data)

Calculations using the EOQ technique produce the same order quantity for each order. In these circumstances, the Economic Order Quantity Technique calculation includes the costs of purchasing, ordering, and holding materials. This is because most of the materials will be stored during the project.

Table 10. Recapitulation of MRP Costs using EOQ Technique

No	Material	Unit	Purchasing Costs	Ordering Costs	Holding Costs	Total Costs using EOQ Technique
1	Gelam wood (column & beam work)	rods	IDR 19.754.859,93	IDR 10.000	IDR 73.745	IDR 19.838.605,13
2	Gelam wood (floor slab work)	rods	IDR 39.652.314,24	IDR 15.000	IDR 58.472	IDR 39.725.786,59
3	Lubricating oil	liter	IDR 5.756.240,39	IDR 5.000	IDR 40.492	IDR 5.801.732,81

No	Material	Unit	Purchasing Costs	Ordering Costs	Holding Costs	Total Costs using EOQ Technique
4	Meranti wood beams (column & floor slab work)	m3	IDR 1.153.051,97	IDR 5.000	IDR 15.214	IDR 1.173.266,36
5	Meranti wood beams (beam work)	m3	IDR 1.652.043,87	IDR 5.000	IDR 22.621	IDR 1.679.665,24
6	Randu wood (column work)	m3	IDR 2.047.597,44	IDR 5.000	IDR 22.934	IDR 2.075.531,06
7	Randu wood (beam & floor slab work)	m3	IDR 3.306.021,14	IDR 5.000	IDR 37.241	IDR 3.348.262,40
8	1 Sided plywood film	sheets	IDR 128.584.366,23	IDR 25.000	IDR 234.147	IDR 128.843.513,27
9	2-5 inch nails	kg	IDR 18.228.213,78	IDR 10.000	IDR 71.739	IDR 18.309.952,99
10	10 mm diameter iron	kg	IDR 388.075.598,18	IDR 40.000	IDR 290.918	IDR 388.406.515,74
11	12 mm diameter iron	kg	IDR 1.356.590.210,78	IDR 30.000	IDR 1.501.979	IDR 1.358.122.189,81
12	13 mm diameter iron	kg	IDR 923.697.071,90	IDR 40.000	IDR 590.469	IDR 924.327.541,12
13	16 mm diameter iron	kg	IDR 104.816.591,41	IDR 20.000	IDR 128.869	IDR 104.965.460,15
14	19 mm diameter iron	kg	IDR 618.728.973,05	IDR 45.000	IDR 359.692	IDR 619.133.665,47
15	22 mm diameter iron	kg	IDR 606.927.928,00	IDR 40.000	IDR 546.346	IDR 607.514.274,41
16	25 mm diameter iron	kg	IDR 312.798.522,84	IDR 25.000	IDR 365.692	IDR 313.189.214,39
17	Bendrat wie	kg	IDR 21.248.557,36	IDR 10.000	IDR 72.760	IDR 21.331.317,72
18	Ready mix concrete K-350	m3	IDR 1.221.483.202,73	IDR 45.000	IDR 788.922	IDR 1.222.317.124,88
	Total		IDR 5.774.501.365,25	IDR 380.000	IDR 5.222.254	IDR 5.780.103.619,54

(Source: Calculation Data)

C. Period Order Quantity Technique

POQ Techniques is one of the techniques used in inventory management to find the optimal number of items to order in a certain period. Ordering with the POQ technique is a process that can be done after making calculations using the EOQ technique. This is because the results of the EOQ calculation are used as input for the POQ method (Bunga & Rinawati, 2019). Here are the steps of calculating using the POQ Technique.

Material = Gelam wood (for column and beam)
Number of Material Request (D) = 2526 rods
EOQ = 1520 rods

Calculate the EOQ value

$$EOQ = \sqrt{\frac{2Dk}{H}} = 1520 \text{ rods}$$

Calculate the number (frequency) of bookings

$$f = \frac{D}{EOQ} = \frac{2526}{1520} = 1{,}7 \approx 2$$

f = Order frequency

Calculate period coverage

$$T = \frac{N}{f} = \frac{9}{2} = 4{,}5 \approx 5 \text{ period}$$

T = Period demand coverage
N = Total weeks in 1 period

Once it is known that the period coverage value for gelam wood material is 5, it is known that orders for gelam wood are made every five periods or once every five weeks, and requests are combined into 1 in one order.

Table 11. MRP Method with POQ Technique

No	Material	Unit		September		October				November				
				8	9	10	11	12	13	14	15	16	17	
				17 - 23	24 - 30	01 - 07	8 - 14	15 - 21	22 - 28	29 - 4	5 - 11	12 - 18	19 - 25	
1	Gelam wood (column & beam work)	rods	*Demand*		343	117	322	322	351	439	213	213	205	
			On Hand Inventory	0	0	1112	995	673	351	1071	632	418	205	0
			Order receipt		1455				1071					
			Order release	1455				1071						
2	Gelam wood (floor slab work)	rods	*Demand*		0	0	220	220	220	220	440	0	186	
			On Hand Inventory		0	0	0	440	220	0	440	0	0	0
			Order receipt				661			661			186	
			Order release			661			661			186		
3	Lubricating oil	liter	*Demand*		105,41	36,01	121,69	121,69	130,61	157,70	110,84	65,64	82,17	
			On Hand Inventory		0	826,34	790,34	668,65	546,96	416,35	258,65	147,81	82,17	0
			Order receipt		931,75									
			Order release	931,75										
18	Ready mix concrete K-350	m3	*Demand*		134,02	232,69	155,95	155,95	182,83	213,72	203,27	60,76	115,37	
			On Hand Inventory		0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0
			Order receipt		134,02	232,69	155,95	155,95	182,83	213,72	203,27	60,76	115,37	
			Order release	134,02	232,69	155,95	155,95	182,83	213,72	203,27	60,76	115,37		

(Source: Calculation Data)

Calculations using the Period Order Quantity technique produce the number of orders where there is material storage in the following week. Under these circumstances, the calculation of the Period Order Quantity Technique consists of the costs of purchasing, ordering, and holding materials. This is because most of the materials will be saved during the project.

Table 12. Recapitulation of MRP Costs using POQ Technique

No	Material	Unit	Purchasing Costs	Ordering Costs	Holding Costs	Total Costs using POQ Technique
1	Gelam wood (column & beam work)	rods	IDR 18.699.026,13	IDR 10.000	IDR 78.892	IDR 16.486.647,59

No	Material	Unit	Purchasing Costs	Ordering Costs	Holding Costs	Total Costs using POQ Technique
2	Gelam wood (floor slab work)	rods	IDR 29.396.747,25	IDR 15.000	IDR 36.126	IDR 29.447.872,83
3	Lubricating oil	liter	IDR 4.938.285,60	IDR 5.000	IDR 29.521	IDR 4.972.806,42
4	Meranti wood beams (column & floor slab work)	m3	IDR 223.718,80	IDR 5.000	IDR 1.140	IDR 229.859,15
5	Meranti wood beams (beam work)	m3	IDR 459.248,62	IDR 5.000	IDR 4.557	IDR 468.806,03
6	Randu wood (column work)	m3	IDR 705.494,88	IDR 5.000	IDR 2.609	IDR 713.103,39
7	Randu wood (beam & floor slab work)	m3	IDR 1.839.144,96	IDR 5.000	IDR 15.027	IDR 1.859.171,51
8	1 Sided plywood film	sheets	IDR 111.286.129,50	IDR 25.000	IDR 76.578	IDR 111.387.707,80
9	2-5 inch nails	kg	IDR 12.380.169,60	IDR 10.000	IDR 30.120	IDR 12.420.290,10
10	10 mm diameter iron	kg	IDR 350.712.347,29	IDR 25.000	IDR 234.848	IDR 350.972.195,02
11	12 mm diameter iron	kg	IDR 1.219.026.645,29	IDR 35.000	IDR 0	IDR1.219.061.645,29
12	13 mm diameter iron	kg	IDR 883.069.734,90	IDR 45.000	IDR 0	IDR 883.114.734,90
13	16 mm diameter iron	kg	IDR 102.338.357,23	IDR 15.000	IDR 147.413	IDR 102.500.770,59
14	19 mm diameter iron	kg	IDR 570.557.298,31	IDR 45.000	IDR 0	IDR 570.602.298,31
15	22 mm diameter iron	kg	IDR 549.000.327,09	IDR 45.000	IDR 0	IDR 549.045.327,09
16	25 mm diameter iron	kg	IDR 297.599.135,86	IDR 20.000	IDR 142.997	IDR 297.762.132,69
17	Bendrat wire	kg	IDR 16.822.760,67	IDR 10.000	IDR 41.555	IDR 16.874.315,77
18	Ready mix concrete K-350	m3	IDR 1.134.533.400,00	IDR 45.000	IDR 0	IDR 1.134.578.400,00
	Total		IDR 5.303.587.971,98	IDR 370.000	IDR 841.383	IDR 5.302.498.084,47

(Source: Calculation Data)

Conclusion

From the analysis results using the three MRP techniques in material planning for the X Building Construction project, it can be concluded that the Lot for Lot technique provides the optimum order quantity for gelam wood, plywood, reinforcement, bending wire, and ready-mix concrete. Meanwhile, lubricating oil, meranti wood, randu wood, and nails are more optimal if you order using the Period Order Quantity technique.

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