Material management comparison between lot for lot and field actual condition

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Abstract. Project material management aims to regulate effective and efficient use materials because material is a resource the largest percentage of the total project cost. In reality, the process of providing materials encounters many obstacles such as late material arrival cause human error and natural disaster, materials not available, overcost, undercost. This research was carried out substructure of the Inpres Market Development Project located in Painan, Pesisir Selatan. Materials for substructure were imported from Padang, which is 70 km from project located. The topographic conditions of areas that prone to disasters such as floods and landslides, which cause connecting road Padang and Painan to be cut off. Arrival materials delay, which results in project delays and wasted costs, so material management is needed. This study aims to obtain the actual material management costs of the field, further compared to the lot for lot technique. The results, total cost *field actual condition* of Rp8,909,250,238.42, with *a lot for lot* technique of Rp8,789,667,046. The cost use lot for lot technique is cheaper by Rp119,583,192.42 or 1.34% due, this technique makes the storage cost zero, meaning that every material that comes will be used directly at the project site.

1 Introduction

Material management is defined as a management system that is necessary to plan and control the quality of materials, the quantity of materials, and the timely placement of equipment, good prices and quantities that are in accordance with the needs [1].

Project material management aims to regulate the use of materials effectively and efficiently during the implementation of work, so that there is no shortage or excess of materials [2]. Material management is carried out with several stages of implementation starting from the process of calculating material quantity needs, stages of material needs, finding *suppliers*, purchasing and delivering materials to the project site, material inspection and *quality control*, material storage and supervision, to the process of implementing material handling and distribution for a job [3].

If there is an error in the material supply process, it can result in delays in the work and have an impact on the next work, resulting in delayed completion time and waste of project costs [4]. If material management is well managed, it will help achieve the smooth and successful of the project [5].

In the implementation of construction projects, common problems that are often faced are ordering too many materials or those that are too available (*overstock*) or ordering too few materials (*understock*). If there is an order with an excessive amount, there will be a waste resulting in increased storage costs, material damage, and shrinkage of the amount of material. Likewise, vice versa, if the materials ordered are too few, there will be a shortage of materials that can interfere with the smooth running of the project or delay the activities so that the project is not completed on time [6].

In addition to *overstock* and *understock*, sometimes the material is not available, or the material ordered can only be partially fulfilled, sometimes even the material is not there All of these problems will have an impact on delaying the implementation of work which causes delays and inflated costs.

To overcome these problems, it is necessary to plan material management as early as possible, especially related to material inventory and control. One of the material planning methods is *the lot for lot* (LFL) technique. The *lot-for-lot* (LFL) technique aims to minimise the cost of savings, so that the cost of savings becomes zero [7]. In this technique, the cost component of material supplies consists of several types of costs [8], including:

1. Purchasing cost, which is the cost incurred by the purchase of equipment or materials carried out by a company from the supplier.
2. Order/*set-up cost*, which is the cost that must be incurred in connection with the order procurement process, such as transportation costs, administrative costs, telephone costs, fax costs and other costs related

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to the order, but if the procurement is produced by the factory itself, then the production cost is analogous to the order cost and is often called *set-up cost.*

3. Storage costs *(holding cost* or *carrying cost),* which are costs incurred as a result of having inventory, such as warehouse costs, employee wages, electricity, stored capital and the amount is usually measured as a percentage of the value of stored goods, the unit is Rp/unit in units of time (years).

The application of the lot for lot technique in the Office Renovation Project (Vedca) makes this project more controllable in storage costs, which is Rp0,- [9]. In the construction of the Airport X package 2, the calculation of the total need and cost of structural material supplies for column and beam work by comparing *the lot for lot* method, *economic order quantity*, and *periodic order quantity*, the minimum cost is obtained using the lot for lot *method* [4]. A comparison of the cost of *the sub-structure* of the manual method and *the lot for lot* (LFL) method found that the material cost with the LFL method was 1.48% cheaper than the manual method [3]. In the Simpang Niam-Lubuk Kambing 1 Road Preservation project, Jambi material management using *the lot-for-lot* method, procurement reduces the cost of material procurement by Rp48,471,706, cheaper than the planning cost of the project [2]. In the Westown View Wiyung *Apartment construction project* for basement 2 floor structure work, the material cost component consists of purchase costs, ordering costs and storage costs. The analysis was carried out using *the lot for lot, economic order quantity, period order quantity method*. The results of the study show that the minimum purchase cost for D10 concrete iron material uses LFL and POQ techniques, with a nominal value of Rp17,719,240.00. The minimum order fee for D10 concrete iron material uses EOQ and POQ techniques, with a nominal value of Rp2,698.50. Minimum storage costs for all types of materials using the LFL technique with a nominal zero cost [10]. The material planning of the Kapuas Indah Market Renovation Project and Public Service Mall (*Multiyears*) in Pontianak City, was analyzed using *the lot for lot* (LFL) and *period order quantity* (POQ) methods. The materials controlled are 25 cm x 25 cm minipile, formwork, scaffolding, and U32 rebar. For minipile, the lowest material cost is obtained by *the lot for lot* method. Meanwhile, the lowest cost for formwork, scaffolding, and U32 rebar is to use the *period order quantity* method, which can cause material accumulation if the field is not well controlled over the use of materials [11].

Application of the lot sizing technique, the most efficient lotting method is obtained from the Lot for Lot method at a cost of Rp5.29 billion. The application of MRP also has an impact on improving inventory performance, changes in minimum and maximum stock changes that are adjusted to production activities. Efficient purchase costs from total raw material needs with an average value of Rp8.33 billion [12].

Lot sizing methods are better suited than others to be applied in specific scenarios marked by a considerable variation in demand or peaks of seasonality. Thus, contributes to further clarify industrial practitioners on the selection of the best suited lot-sizing methods for each type of application scenario regarding MRP or JIT/Kanban manufacturing environments [13].

The lot for lot method aims to minimize the amount of spending on inventory in the warehouse. Lot for lot (LFL) method to calculate inventory control in minimizing inventory costs and ordering costs for wire-mouse product is IDR 204,000.00 and the wire-mouse inventory cost/year is IDR 204,245.00 [14].

The MRP method used at PT. Lixil Aluminium Indonesia has not been cost-efficient, both ordering costs and storage costs can be seen in the method used in 2022, namely FOQ with safety stock additions then accumulated with the Top Management policy, from the analysis with 2 MRP methods that have been carried out, there is a cost difference, namely with the FOQ results of Rp689,994,712.00 and for LFL Rp652,748,558.00 with a cost efficiency difference of Rp37,246,154.00 for the coming year [15].

This research was carried out on the work of the substructure of the Inpres Market Development Project located in Painan, Pesisir Selatan. Material management is needed in this project because the material is imported from Padang City which is 70 km from the project location. Road access to the project location is often cut off if rainfall, because the topography of the surrounding area causes flooding and landslides. Of course, this problem will have an impact on project completion time and costs. There are 2 methods that will be analyzed in this research, namely the actual field method and the lot for lot technique (LFL). The purpose of this study is to compare *the lot for lot* (LFL) technique with the field method on material management consist of of purchase, ordering and storage costs.

2 Research methods

2.1 Data collection

Primary data is obtained from observations in the field, interviews and project documentation. Observation by making direct observations of the stages of the implementation of the substructure work, Project data includes documentation of administrative forms related to the procurement of substructure materials, work plan drawings, technical specifications, *bill of materials*, *time schedule* and data related to logistics/procurement of project materials. Interviews were conducted directly with construction management consultants and contractors during field visits, to obtain information on the material procurement process, data related to *suppliers,* infrastructure conditions during the material *delivery* process, and what obstacles often occur during the material management process at the project site.

2.2 Data processing

Using *the lot for lot* (LFL) technique, material planning begins by calculating the quantity of material for the substructure work which includes bore *pile, pile cap* and *sloof foundation work*. Furthermore, calculate the cost of

material needs, namely the cost of purchasing materials, ordering costs and storage costs. For the calculation of the quantity of ironing using *a bar bending schedule* (BBS). Furthermore, the application of *the lot for lot* (LFL) technique with the consideration of minimization of storage costs, where the inventory cost is zero and the amount ordered is equal to the amount needed [4].

The targets of the use of this technique [16] are:

1. Reduction of the amount of inventory, by specifying how many components are needed and when they are needed, materials are supplied only when needed so that the cost of overstocking can be avoided.
2. Production reduction and delivery lead time, by identifying the amount of material needed, delivery time, availability, procurement and production to complete at the time needed to be delivered.
3. Increase efficiency, by providing close coordination between the various work centers involved in the production process. As a result, production can run more efficiently.

Furthermore, an analysis was carried out by comparing the cost of material management of *the lot for lot* (LFL) technique with the actual material cost of the field.

3 Results

3.1 Actual plan

The actual plan was obtained from field data, which consisted of purchase costs and material storage costs for the construction of the lower structure of the Painan Inpres market project. The purchase cost can be seen in Table 1, the order cost does not exist because it is included with the purchase cost, the storage cost is obtained based on the duration of the time the material is stored from the field data, it can be seen in Table 2.

Table 1. Cost of purchasing actual *substructure* plan materials

No	Material	Volume	Unit	Material price /unit (Rp)	Total fees (Rp)
A	FOUNDATION D600mm				
1	5m Steel Pipe	238	unit	13050000	3,105,900,000.00
2	12m Steel Pipe	57	unit	31320000	1,785,240,000.00
3	Reinforcement Bar D10	1883	pieces	78000	146,874,000.00
4	Reinforcement Bar D19	1883	pieces	285000	536,655,000.00
5	Readymix Concrete fc' 24,9 Mpa	453.86	m3	1671000	758,400,060.00
B	PILE CAP	0			
1	Reinforcement Bar D22	1718	pieces	385000	661,430,000.00
2	Multiplex12 mm	152	pieces	180900	27,496,800.00
3	Wood 5/7	852	pieces	35000	29,820,000.00
4	Beton Readymix Fc 24,9 Mpa	477.22	m3	1671000	797,434,620.00
C	SLOOF				
1	Reinforcement Bar D10	790	pieces	78000	61,620,000.00
2	Reinforcement Bar D19	683	pieces	285000	194,655,000.00
3	Reinforcement Bar D25	660	pieces	510000	336,600,000.00
4	Multiplex 12 mm	92	pieces	180900	16,642,800.00
5	Wood 5/7	514	pieces	35000	17,990,000.00
6	Readymix Concrete fc' 24,9 Mpa	250.87	m3	1671000	419,202,366.36
				Total cost of purchasing material	8,895,960,646.36

Table 2. Cost of material storage of actual *substructure* plan

No	Material Name	Volume	Unit	Total Inventory	Storage Fees /unit	Total Storage Costs
1	5m Steel Pipe	238	unit	623.00	2,888.11	1,799,295.49
2	12m Steel Pipe	57	unit	138.50	6,931.48	960,009.34
3	Reinforcement Bar D10	2673	pieces	14,467.20	17.26	249,737.08
4	Reinforcement Bar D19	2566	pieces	1,738.00	77.09	133,982.70
5	Reinforcement Bar D22	1718	pieces	4,495.00	85.20	382,996.11
6	Reinforcement Bar D25	660	pieces	1,980.00	112.87	223,480.33
7	Multiplex 12 mm	244	pieces	1,967.00	14.83	29,166.42
8	Wood 5/7	1366	pieces	10,988.00	865.57	9,510,924.59
9	Readymix Concrete fc 24,9 Mpa	1182	m3	0.00	451.99	0.00
					Total storage costs	13,289,592.06

Table 3. Recapitulation of actual *sub-structure* material costs plan

No	Cost components	Amount (Rp)
1	Purchase fee	8,895,960,646.36
2	Booking fee	0
3	Storage costs	13,289,592.06
	Total material costs actual field	8,909,250,238.42

Based on Table 1, the cost of purchasing the actual *sub structure* material plan was Rp8,895,960,646.36. From Table 2, the actual *sub-structure* plan material storage cost is Rp13,289,592.06,

From Table 3, the total recapitulation of the material cost of the lower structure was obtained at Rp8,909,250,238.42, From here, it can be seen that the order fee is zero because the order fee is included in the cost of purchasing materials to the project site. So, the total material cost *of the actual sub-structure plan is only the purchase cost and storage costs*.

3.2 Technical lot for lot (LFL)

3.2.1 Sub structure cost LFL

The calculation of the components of the cost of purchasing materials for the lower structure (foundation *bore pile, pile cap* and *sloof*) can be seen in Table 4.

Table 4. Cost of purchasing materials *substructure* lot for lot *technique*

No	Material	Amount	Unit	Material price /unit (Rp)	Purchase fee amount (Rp)
A	FOUNDATION D600mm				
1	5m Pipe Steel	235	unit	13,050,000	3,066,750,000
2	12m Pipe Steel	55	unit	31,320,000	1,722,600,000
3	Reinforcement Bar D10	1880	pieces	78,000	146,640,000
4	Reinforcement Bar D19	1880	pieces	285,000	535,800,000
5	Readymix Concrete fc' 24,9 Mpa	453.86	m3	1,671,000	758,400,060
B	PILE CAP				-
1	Reinforcement Bar D22	1716	pieces	385,000	660,660,000
2	Multiplex 12 mm	150	pieces	180,900	27,135,000
3	Wood 5/7	849	m3	35,000	29,715,000
4	Readymix Concrete fc 24,9 Mpa	477.22	m3	1,671,000	797,434,620
C	SLOOF				-
1	Reinforcement Bar D10	788	pieces	78,000	61,464,000
2	Reinforcement Bar D19	681	pieces	285,000	194,085,000
3	Reinforcement Bar D25	658	pieces	510,000	335,580,000
4	Multiplex 12 mm	90	pieces	180,900	16,281,000
5	Wood 5/7	512	m3	35,000	17,920,000
6	Readymix Concrete fc 24,9 Mpa	250.87	m3	1,671,000	419,203,770
	Total cost of material purchase				8,789,667,046

Based on Table 4, the cost of purchasing materials is Rp12,171,753,450.00, this fee is only in the form of purchase costs at the store/distributor, not the cost to the project site.

3.2.2 Cost of ordering LFL sub structure materials

The booking fee per unit can be seen in Table 5, the booking cost of *the lot for lot* (LFL) technique based on the time period can be seen in Table 6.

In Table 5, it can be seen that the booking fee consists of telephone fees and administrative fees. The total order cost is obtained by calculating the number of message frequencies with the cost of ordering materials per unit, obtained by Rp2,087,880.00.

Table 5. Sub structure material ordering fee per unit

No	Material	Total phone charges (Rp)	Total phone charges (Rp)	Total booking fee (Rp)
A	FOUNDATION D600mm			
1	5m Steel Pipe	13,440	3,000	16,440
2	12m Steel Pipe	13,440	3,000	16,440
3	Reinforcement Bar D10	13,440	3,000	16,440
4	Reinforcement Bar D19	13,440	3,000	16,440
5	Readymix Concrete fc 24,9 Mpa	13,440	3,000	16,440
B	PILE CAP			
1	Reinforcement Bar D22	13,440	3,000	16,440
2	Multiplex 12 mm	13,440	3,000	16,440
3	Wood 5/7	13,440	3,000	16,440
4	Readymix Concrete fc 24,9 Mpa	13,440	3,000	16,440
C	SLOOF			
1	Reinforcement Bar D10	13,440	3,000	16,440
2	Reinforcement Bar D19	13,440	3,000	16,440
3	Reinforcement Bar D25	13,440	3,000	16,440
4	Multiplex 12 mm	13,440	3,000	16,440
5	Wood 5/7	13,440	3,000	16,440
6	Readymix Concrete fc 24,9 Mpa	13,440	3,000	16,440

Table 6. Cost of ordering *sub structure* materials with *lot for lot technique*

No	Material	Message frequency	Booking fee (Rp)	Total booking fee (Rp)
A	PONDASI D600mm			
1	5m Steel Pipe	10	16,440	164,400
2	12m Steel Pipe	10	16,440	164,400
3	Reinforcement Bar D10	12	16,440	197,280
4	Reinforcement Bar D19	12	16,440	197,280
5	Readymix Concrete fc 24,9 Mpa	12	16,440	197,280
B	PILE CAP			
1	Reinforcement Bar D22	11	16,440	180,840
2	Multiplex 12 mm	12	16,440	197,280
3	Wood 5/7	12	16,440	197,280
4	Readymix Concrete Fc 24,9 Mpa	11	16,440	180,840
C	SLOOF			
1	Reinforcement Bar D10	4	16,440	65,760
2	Reinforcement Bar D19	4	16,440	65,760
3	Reinforcement Bar D25	4	16,440	65,760
4	Multiplex 12 mm	4	16,440	65,760
5	Wood 5/7	4	16,440	65,760
6	Readymix Concrete fc 24,9 Mpa	5	16,440	82,200
			Total cost of ordering materials	2,087,880

3.2.3 LFL substructure material storage costs

The cost of material storage can be seen in Table 7. This storage cost is a cost incurred as a result of having inventory or goods stored and the unit size is Rp/unit in a unit of time [8].

The calculation of storage costs is carried out because it has an inventory of capital costs and damage or depreciation costs. The cost of capital can be measured by BI's December 2020 interest rate of 3.75% per year. The cost of depreciation and material damage during storage is assumed to be 0.5% of the material price per unit for ferrous materials [17]. Then for other materials by 2% [18].

Table 7. Substructure material storage costs

No	Material	Amount	% Storage fees	Material price /unit (Rp)	Storage price /unit (Rp)	Total storage fees (Rp)
A	FOUNDATION D600mm					
1	5m Steel Pipe	235	8.25	13,050,000	2,888.11	678,705.85
2	12m Steel Pipe	55	8.25	31,320,000	6,931.48	381,231.40
3	Reinforcement Bar D10	1880	6.75	78,000	21.1	39,668.00
4	Reinforcement Bar D19	1880	6.75	285,000	77.09	144,929.20
5	Readymix Concrete fc 24,9	46	6.75	1,671,000	451.99	20,791.54
B	PILE CAP					
1	Reinforcement Bar D22	1716	6.75	385,000	85.2	146,203.20
2	Multiplex 12 mm	150	8.25	180,900	14.83	2,224.50
3	Wood 5/7	849	8.25	3,200,000	865.57	734,868.93
4	Readymix Concrete Fc 24,9	48	8.25	1,671,000	451.99	21,695.52
C	SLOOF					
1	Reinforcement D10	788	675	78,000	17.26	13,600.88
2	Reinforcement D19	681	675	285,000	63.07	42,950.67
3	Wood D25	658	6.75	510,000	112.87	74,268.46
4	Multiplex 12 mm	90	8.25	180,900	48.93	4,403.70
5	Wood 5/7	512	8.25	3,200,000	865.57	443,171.84
6	Readymix Concrete Fc 24,9 Mpa	22	8.25	1,671,000	45.99	9,943.78
	Total cost of ordering materials					2,758,657.47

Table 8. Cost of substructure material storage *with lot for lot technique*

No	Material	Unit	Inventory	Storage price /unit (Rp)	Total storage fees (Rp)
A	FOUNDATION D600mm				
1	5m Steel Pipe	unit	0	2,888.11	
2	12m Steel Pipe	pieces	0	6,931.48	
3	Reinforcement Bar D10	pieces	0	21.10	
4	Reinforcement Bar D19	Unit	0	77.09	
5	Readymix Concrete fc' 24,9 Mpa	m3	0	451.99	
B	PILE CAP				
1	Reinforcement Bar D22	pieces	0	85.20	
2	Multiplex 12 mm	pieces	0	14.83	
3	Wood 5/7	m3	0	865.57	
4	Readymix Concrete fc' 24,9 Mpa	m3	0	451.99	
C	SLOOF				
1	Reinforcement Bar D10	pieces	0	17.26	
2	Reinforcement Bar D19	pieces	0	63.07	
3	Reinforcement Bar D25	pieces	0	112.87	
4	Multiplex 12 mm	pieces	0	48.93	
5	Wood 5/7	m3	0	865.57	
6	Readymix Concrete fc' 24,9 Mpa	m3	0	451.99	
	Total cost of material storage				0

The cost of capital can be measured by BI's December 2020 interest rate of 3.75% per year. The cost of depreciation and material damage during storage is assumed to be 0.5% of the material price per unit for ferrous materials [17]. Then for other materials by 2% [18].

Based on *the concept of lot for lot*, storage costs are costs obtained from the multiplication of the amount of *inventory* with the storage cost per unit per day, where inventory costs are zero. The cost of material storage with *the lot for lot* technique can be seen in Table 8.

From Table 7, it can be seen that the cost of material storage is Rp2,758,657.47, with material management lot-for-lot technique, inventory costs are zero, so there are no storage costs (Table 8). In other words, after the material is purchased, ordered, immediately used in the field.

The recapitulation of sub-structure material costs *with the lot for lot* (LFL) technique is shown in Table 9.

Table 9. Recapitulation of material cost components substructure with *LFL technique*

No	Cost components	Amount (Rp)
1	Purchase fee	8,789,667,046
2	Booking fee	2,087,880
3	Storage fees	0
	Total cost of LFL engineering	8,791,754,926

From Table 9, it can be seen that the total material cost of the sub structure with *the lot for lot* (LFL) technique is Rp8,791,754,926.00.

4 Discussion

The cost components reviewed in the material management costs of the lower structure of the Inpres Market Project, Painan, Pesisir Selatan Regency are material purchase costs, material ordering costs and material storage costs. Based on the results of the recapitulation of the total actual material costs of the field in Table 3, a cost of Rp8,909,250,238.42 was obtained. The actual cost of the field consists of purchase costs and storage costs, while the order cost is considered zero because it is included in the purchase cost to the project site.

Meanwhile, the recapitulation of the total material cost of *the lot for lot* (LFL) technique in Table 9, was obtained at Rp8,791,754,926.00. Thus, the difference in cost is Rp117,495,312.42. Meanwhile for the lot for lot (LFL) technique, the cost is 1,32% cheaper than the actual cost of the field. This is because the inventory cost in the lot-for-lot technique is zero, so there are no storage costs. In other words, when the material arrives at the project site, the material is immediately used.

5 Conclusion

Comparison material management of actual field method and lot for lot technique on Inpres Market Development Project Painan are needed alternative solution if material problems occur in the field, which are caused by human error and disaster factors. In the work of the substructure of this project, the actual material cost component of the field consists of purchase costs including orders of Rp8,895,960,646.36, storage costs of Rp8,895,960,646.36. The total actual material cost of the field is Rp8,909,250,238.42. On the other hand, for the lot for lot technique, a purchase cost component of Rp12,171,753,450.00, the booking fee is Rp2,087,880.00 and the storage fee is zero. The total cost of lot for lot engineering materials was Rp8,789,667,046, 1.34% cheaper than the actual cost of the field.

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