*International Journal of Marine Engineering Innovation and Research, Vol. 9(3), Sept. 2024. 408-416*
*(pISSN: 2541-5972, eISSN: 2548-1479)*



# Implementation of Material Control in Tugboat Ship Building Using the Lot For Lot (LFL) Method Case Study : (PT.PMP)

Intan Baroroh[1], Eko Febrianto Tarigan[2], Siswo Hadi Sumantri[3], Ali Azhar[4], Didik Hardianto[5], Tri Agung Kristiyono[6]
(Received: 9 July 2024 / Revised: 2 August 2024 /Accepted: 9 August 2024)

**Abstract—Material procurement in the shipping industry accounts for 2/3 of the total production cost. PT.PMP is a company that focuses on the shipbuilding industry including Ship Design, Ship Building and Ship Repair. In the implementation of material procurement, there are often delays in the delivery of materials from suppliers resulting in delayed production time. Material inventory in the warehouse is sometimes insufficient to meet production needs. In the Pre-Order system, the company must ensure the availability of prepared planning items, but the Company sometimes faces a shortage of raw materials which results in delays in the delivery of promised goods. Material Requirement Planning (MRP) is a method used to organize and plan material orders. The purpose of this study is to determine the material planning strategy using the Lot for Lot method and the Economic Order Quantity method comparison between efficient methods at PT.PMP and to determine the efficiency results of the comparison between the Lot for Lot (LFL) method, Economic Order Quantity (EOQ) and the existing method at PT.PMP. The materials analyzed are Plate and Profile in the New Building Tugboat Project. The results obtained from the inventory cost research that the Lot for Lot method is 28%, the Economic Order Quantity method results in an inventory cost of 29% and the company method that is still being applied results in a high cost of 43%. The Lot for Lot method is more efficient by 15% than the existing method applied by the company.**

Keywords—Material Requirements planning, Lot for Lot, Efficient

## I. INTRODUCTION

Procurement of materials requires an orderly and coordinated design because material costs cover 2/3 of total production costs. Therefore, if control of material delays is poorly coordinated, it will result in lost time, increased costs, poor quality and inefficiency. This implementation is important for achieving a smooth and high-performance production process. Material is an elemental component. Materials, labor, production facilities, financial resources, etc. are combined in the production process to create the final product. The smoothness of the production process is greatly influenced by the availability of materials at the shipbuilding company [1]. Scheduling is closely related to raw material planning, which helps manage inventory in the most effective and fastest way [2]. The ability of shipyards to bring in materials depends on the shipyard's Material Supply Chain, especially material procurement activities to reduce unexpected risks in business on supply chain performance on modular shipbuilding has been discussed [15], [16].and repair process planning based on material requirements [17].

Material Requirement Planning (MRP) is a technique to plan the needs of materials or parts that must be produced or ordered, by determining the required quantity and when it is available [3].

The objectives of MRP are to Minimize Inventory in the Warehouse, reduce the risk of delivery delays, realistic commitment to MRP and improve time, quality and cost efficiency [4], [18],

His research on MRP found that determining the lot size using the Material Requirements Planning method can help companies reduce excess raw materials [5].

From this study, it is concluded that the Economic Part Period method is the most optimal method in Material Requirement Planning [6] and material procurement system efficiency [19], [20].

PT PMP is a company that focuses on the shipbuilding industry including Ship Design, Ship Building and Ship Repair. The problem that occurs is the late delivery of materials from the supplier, which results in delayed production time. In addition, material inventory in the warehouse is sometimes insufficient to meet production needs. In the Pre-Order system, the company must ensure the availability of prepared planning items. but the Company sometimes faces a shortage of raw materials which results in delays in the delivery of promised goods. Delays in delivery of materials from suppliers that result in production time being delayed. Material inventory in

Intan Baroroh, Naval Architecture, Faculty of Science and Marine Engineering, Hang Tuah University, Surabaya, Indonesia. E-mail: intan.baroroh@hangtuah.ac.id
Eko Febrianto Tarigan, Naval Architecture, Faculty of Science and Marine Engineering, Hang Tuah University, Surabaya, Indonesia. E-mail: Tarigan.ship20@hangtuah.ac.id
Siswo Hadi Sumantri, Public administration doctoral program, Faculty of Social and Political Sciences, Hang Tuah University, Surabaya, Indonesia. Email: siswo.hs@hangtuah.ac.id
Ali Azhar, Naval Architecture, Faculty of Science and Marine Engineering, Hang Tuah University, Surabaya, Indonesia. Email: ali.azhar@hangtuah.ac.id
Didik Hardianto, Naval Architecture, Faculty of Science and Marine Engineering, Hang Tuah University, Surabaya, Indonesia. Email: didik.hardianto@hangtuah.ac.id
Tri Agung Kristiyono, Naval Architecture, Faculty of Science and Marine Engineering, Hang Tuah University, Surabaya, Indonesia. Email: didik.hardianto@hangtuah.ac.id

the warehouse is sometimes insufficient to meet production needs, requiring inventory management costs, costs for purchasing administration and maintaining storage facilities.

The previous research was related to delays in material distribution and material accumulation. The results of this research are that the MRP method with the Period Order Quantity technique obtains the most economical calculations for materials such as U32 Reinforcement, Formwork and Scaffolding, while the Lot for Lot technique obtains the lowest costs with Mini Pile material. The weakness of this research is that controlling material build-up has not been discussed [7].

for predicting demand for material requirements. The method uses an economical approach to planning material requirements, at a cost of $164.48, able to reduce costs by up to 90.06% with the difference in methods currently used by the company. The weakness of this research is that it is difficult to apply this method due to the insufficient amount of raw materials [8]. Through the presentation of previous research studies, the research gap is to implement Material Requirement Planning (MRP) in the Shipping Industry, in the form of a material planning strategy using the Lot for Lot method. The material analysed and the location of the research are able to produce planning material requirements for the amount of

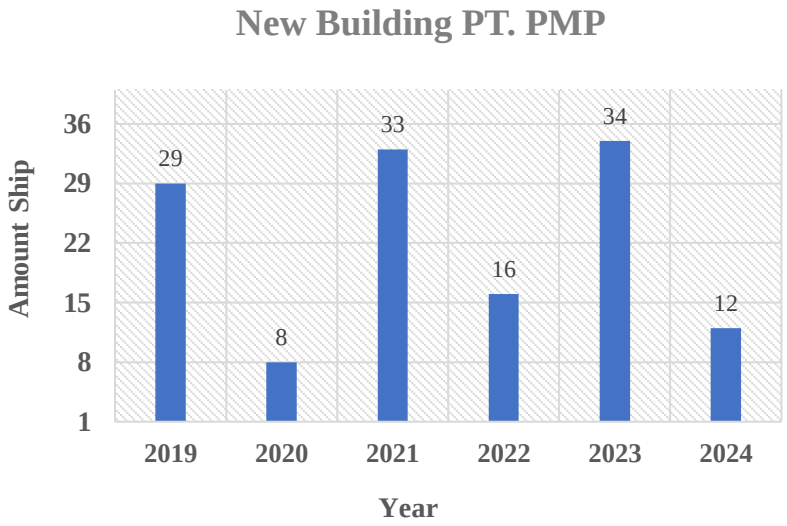


Figure 1. Building of PT.PMP New Ship

Furthermore, previous research, The results of the research are that the linear regression method is effective Based on data on new ship building at PT. The decrease in the number of new ship building was due to the Covid-19 situation which caused a drastic reduction in ship Building from 2019, which was 29, down to 8 units.

According to previous research, Lot for Lot optimal results Inventory costs resulting from the application of the LFL technique amounted to Rp 509,644,500 [9].

material and time needed to get efficiency in terms of material inventory costs.

And in another study, the lot-for-lot technique can reduce costs by Rp. 8,171,824 [10]. Through the presentation of the previous research study, it was found that the renewal was the material analyzed by the Plate and Profile, the Research Location.

**TABLE 1.**
**DATA FOR 4 TUGBOAT UNITS**

| Name | Size (Meters) |
|---|---|
| Overall length (LOA) | 26 |
| Length of vertical line (LBP) | 23.68 |
| Width (B) | 8 |
| Height (H) | 3.65 |
| Loaded (T) | 3 |

This case study research took the Tugboat ship, PT. PMP, Batam. This ship was built with a block system, namely block 1 and block 2 for 4 Tugboats of the same size. Ship owner from PT. CAKRAWALA NUSA BAHARI. This Tugboat has an overall length (LOA) of 26 meters, width of 8 meters, height of 3.65 meters and draft of 3 meters.

## II. METHOD

Material requirements planning (MRP) can be used to organize and plan material orders during the production process to produce finished products [11]. The process stages that will be carried out in the research are in accordance with the flowchart below:

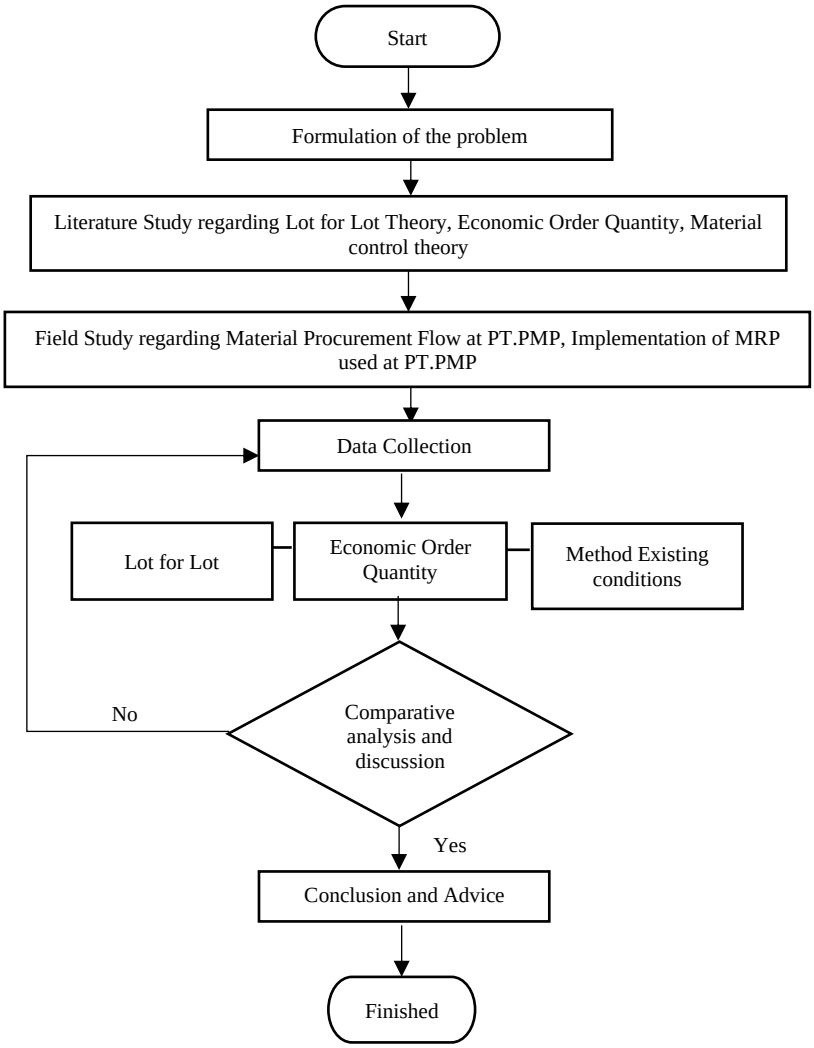


Figure 2 Flow Diagram of Research Methods

### A. Description of Research Flow Diagram

1. Formulation of the problem

The problem is that there is a delay in sending material from the supplier, which results in delayed production time. In addition, material supplies in the warehouse are sometimes insufficient to meet production needs. From this problem, the formulation of the problem is to plan efficient/minimal material procurement at PT. PMP and the application of total inventory costs from the Lot for Lot (LFL), Economic Order Quantity (EOQ) and Comparison Method methods at PT. PMP.

2. Study of literature

The literature sources in this research are books, journals and previous research which include material procurement theory, material requirements planning theory, lot for lot theory and economic order quantity theory.

3. Field Study

At this stage, the field study is to explore problems in the field through informants, get an overview and identify the material procurement flow and existing conditions in the field.

4. Method of collecting data
   a. Data in the form of transportation costs, material prices, material supplies, ordering costs, purchasing costs, lead time (waiting time), main ship size data, material order quantity data
   b. Secondary data is obtained from documented information such as photos, important files and notes. The secondary data obtained is ship Building data at PT.PMP

5. Research methods

At this stage, the research method uses a qualitative approach through interviews, field notes and documentation to provide answers to problems.

a. Lots for Lots
Material ordered = Material required
So the minimum amount of material stored is none or 0 [12].

b. Economic Order Quantity
This formulation is to determine the amount materials that must be ordered [13]

$$EOQ = \sqrt{\frac{2\,DS}{H}}.$$

Information:

| | |
|---|---|
| Average Need (D) | = Units/Pcs |
| Order Fee (S) | = Rupiah/Dollar |
| Storage Costs (H) | = Rupiah/Dollar |
| **EOQ** | **= Units/Pcs** |

6. Method Application Analysis

Descriptive Analysis is an analysis to be able to provide an overview of the relationship between problems. In descriptive analysis, data is usually displayed in the form of ordinary tables or frequency tables, graphs, bar charts, line charts, pie charts, data concentration measures, data dispersion measures and so on [14].

At this stage, we explain the comparison of efficient costs with the existing method used by PT. PMP from the application of Lot for Lot and the application of the Economic Order Quantity method. Descriptive analysis was carried out by collecting material inventory data in the period January to May 2024 at PT. PMP for the material planning analysis process using the Lot for Lot, Economic Order Quantity and Company Methods

7. Conclusions and recommendations

At this stage, the answers to the research results must be in accordance with the problem formulation, while the suggestions section contains input and recommendations for consideration for implementing the research.

## III. Results and Discussion

The material procurement flow at PT.PMP can be seen as follows:

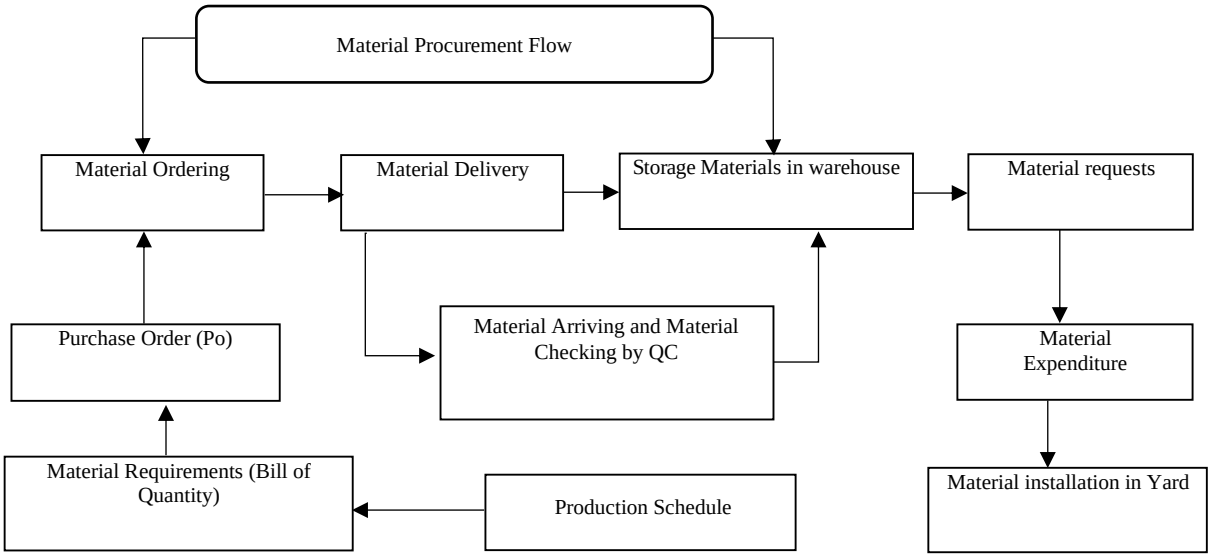


Figure 3 Material Procurement Flow

Figure 3 shows the flow of material procurement which starts with ship design and continues with determining the production schedule for when to use the material and when to order the material, after that a material order is made (Purchase Order) based on the required requirements after the Procurement party coordinates with the Supplier to order the material. , The process of sending imported materials is delivered by sea at the port and the materials are checked by Customs and Excise and the entry permit for imported goods to Indonesia, after that the materials arrive at the location, after they arrive the materials will be checked by QC and the warehouse to ensure the materials according to the company's request, after that the material is stored in the warehouse

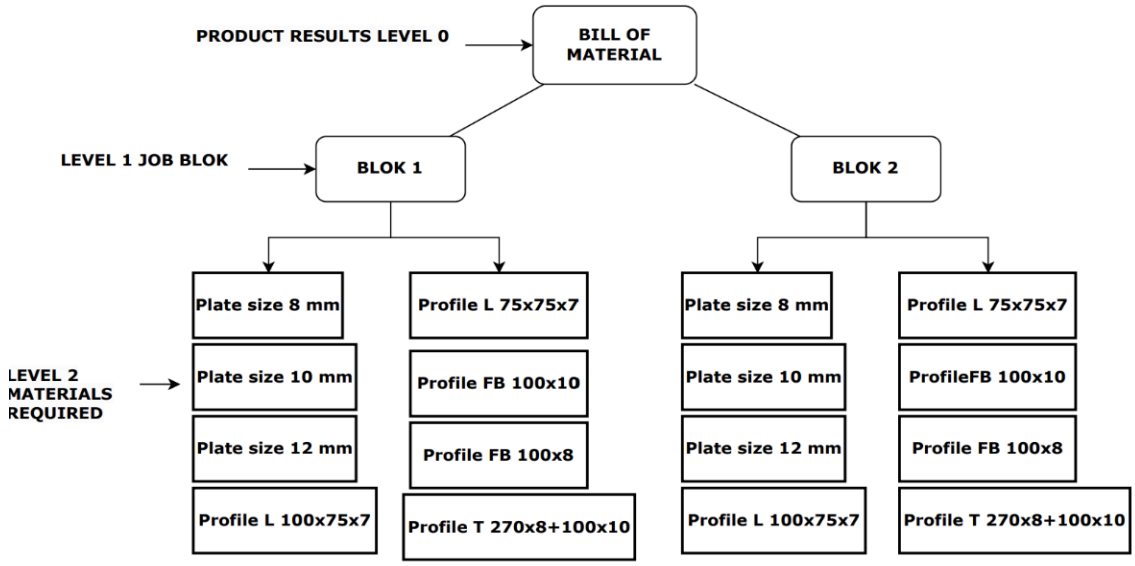


Figure 4. Bill Of Materials For New Tugboat Building Project

Figure 4 depicts a product structure that explains in detail the sequence of work components in the project. Block 1 is the block from the rear of the ship to the middle of the ship, and Block 2 is the block from the front of the ship to the middle of the ship. In Blocks 1 and 2 there are the required plate and profile materials. In the Building of Tugboats, 2 blocks are used to make it easier to connect the blocks in terms of short welding.

**TABLE 2.**
**MATERIAL REQUIREMENTS PLANNING FOR PROJECT 4 TUGBOATS**

| No | Material | Amount |
|---|---|---|
| 1 | Steel Plate Grade A 8 FT x 30 FT x 8 mm | 57 |
| 2 | Steel Plate Grade A 8 FT x 30 FT x 10 mm | 59 |
| 3 | Steel Plate Grade A 8 FT x 30 FT x 12 mm | 20 |
| 4 | Profile L 100x75x7x9m | 392 |
| 5 | Profile L 75x75x7x9m | 23 |
| 6 | Profile T 270x8+100x10 | 140 |
| 7 | Profile FB 100x10 | 76 |
| 8 | Profile FB 100x8 | 40 |

Table 2 presents the total material requirements to complete each part of the work. In terms of the MRP stage process, determining gross and net requirements is the first step. The total material requirements above are 8.10 and 12 mm thick plates and L, T and Flat Bar profiles used for the project of 4 Tugboats 26 meters long. It is known that in the manufacture of the Project New Building Tugboat a total of 4 ships of the same size require 57 pcs of Plate Size 8 mm, 59 pcs of Size 10 mm, 20 pcs of Size 12 mm and 392 pcs of L Profile 100x75x7x9m, 23 pcs of L Profile 75x75x7x9m, 140 pcs of T Profile 270x8+100x10, 76 pcs of FB Profile 100x10 and 40 pcs of FB Profile 100x8.

The calculation of storage costs at PT.PMP is based on the price of materials in the warehouse. This storage cost includes:

- Costs due to damage or loss (1% of the material price)
- Costs associated with inventory management (0.5% of the material price)
- Costs to provide and maintain facilities where goods are stored (0.5% of the material price). Overall cost of storing goods (2% of material cost) of the total material storage costs listed above, there are the following Table 3.

**TABLE 3.**
**MASTER SCHEDULE PLANNING FOR PRODUCTION OF 4 SHIPS**

| Material | January | | | | February | | | | March | | | | April | | | | May | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| Plate Size 8 mm | 10 | | | 10 | | 15 | 7 | | | | | | | | | 3 | | 12 | | |
| Plate Size 10 mm | | | 16 | | 10 | 10 | | | | | 8 | | | | | 15 | | | | |
| Plate Size 12 mm | | | | | | | | | | | 10 | | 5 | | | | | 5 | | |
| Profile L 100x75x7x9m | 60 | 30 | | 90 | | 120 | | | | | | | | | 60 | | 32 | | | |
| Profile L 75x75x7x9m | | | | | | | 7 | | | | | 5 | 4 | | | | 7 | | | |
| Profile T 270x8+100x10 | | | | | | | | | | | 35 | | 35 | | | | 70 | | | |
| Profile FB 100x10 | | | 19 | | 19 | | | | | | | 19 | | | | | | 19 | | |
| Profile FB 100x8 | | | 10 | | 10 | | | | | | | 10 | | | | | | 10 | | |

The Master Production Schedule is a detailed and comprehensive preparation for producing the final product in a project, in this case the production schedule is used for 4 New Building ships.

The table above shows the Plate and Profile material data required, the amount of material and when the material is needed for Building.

**TABLE 4.**
**LEAD TIME FOR ORDERING MATERIALS FOR THE 4 SHIP PROJECT**

| No | Material | Lead Time |
|---|---|---|
| 1. | Steel Plate Grade A 8 FT x 30 FT x 8 mm | 2 weeks |
| 2. | Steel Plate Grade A 8 FT x 30 FT x 10 mm | 2 weeks |
| 3. | Steel Plate Grade A 8 FT x 30 FT x 12 mm | 2 weeks |
| 4. | Profile L 100x75x7x9 m | 2 weeks |
| 5. | Profile L 75x75x7x9m | 2 weeks |
| 6. | Profile T 270x8+100x10 | 2 weeks |
| 7. | Profile FB 100x10 | 2 weeks |
| 8. | Profile FB 100x18 | 2 weeks |

Table 4 explains that delivery of imported Plate and Profile materials takes 2 weeks due to the distance and administration process of sending materials from abroad to the Company. Order planning from submitting material requests from the material procurement department, submitting offers to suppliers to sending materials from PT. HS XPRESS PTE LTD arrived at the destination location on time at PT.PMP, Batam.

**TABLE 5.**
**ACTUAL DATA OF MATERIAL INVENTORY FOR 4 SHIPS**

| No | Material | Amount of stockpile |
|---|---|---|
| 1. | Steel Plate Grade A 8 FT x 30 FT x 8 mm | 51 Sheets |
| 2. | Steel Plate Grade A 8 FT x 30 FT x 10mm | 33 Sheets |
| 3. | Steel Plate Grade A 8 FT x 30 FT x 12mm | 45 Sheets |
| 4. | Profile L 100x75x7x9 m | 77 Pcs |
| 5. | Profile L 75x75x7x9m | 49 Pcs |
| 6. | Profile T 270x8+100x10 | 25 Pcs |
| 7. | Profile FB 100x10 | 0 Pcs |
| 8. | Profile FB 100x18 | 0 Pcs |

`

Table 5 explains the amount of material inventory the company has in the period beginning January 2024. This inventory is leftover material that is not used from the previous project, therefore the remaining material inventory is added to the material needs of the next projec

**TABLE 6.**
**NET MATERIAL REQUIREMENT PLANNING FOR 4 SHIP PROJECT**

| No | Material | Amount |
|---|---|---|
| 1. | Steel Plate Grade A 8 FT x 30 FT x 8 mm | 6 Sheets |
| 2. | Steel Plate Grade A 8 FT x 30 FT x 10 mm | 26 Sheets |
| 3. | Steel Plate Grade A 8 FT x 30 FT x 12 mm | 25 Sheets |
| 4. | Profile L 100x75x7x9 m | 315 Pcs |
| 5. | Profile L 75x75x7x9m | 26 Pcs |
| 6. | Profile T 270x8+100x10 | 115 Pcs |
| 7. | Profile FB 100x10 | 76 Pcs |
| 8. | Profile FB 100x18 | 76 Pcs |

Net requirements are used as the main data for method calculations in order to explain the requirements that must be ordered to avoid material shortages. Table 6 explains the net material requirements for the period January 2024 to May 2024, obtained from calculating the difference between gross requirements and the amount of inventory still available at the company.

**TABLE 7.**
**MATERIAL ORDERING PLANNING COSTS FOR PROJECT 4 SHIPS**

| Material | Telephone Fee (IDR) | Transportation Fee (IDR) | Administration Fee (IDR) |
|---|---|---|---|
| Steel Plate 8 FT x 30 FT x 8 mm | 5,000.00 | 2,852,096.55 | 2,091,537.47 |
| Steel Plate 8 FT x 30 FT x 10 mm | 5,000.00 | 4,589,580.60 | 3,365,692.44 |
| Steel Plate 8 FT x 30 FT x 12 mm | 5,000.00 | 5,507,496.75 | 4,038,830.95 |
| Profile L 100x75x7x9 m | 5,000.00 | 171,242.85 | 125,578.09 |
| Profile L 75x75x7x9m | 5,000.00 | 114,973.65 | 84,314.01 |
| Profile T 270x8+100x10 | 5,000.00 | 1,404,973.65 | 1,030,314.01 |
| Profile FB 100x10 | 5,000.00 | 104,220.00 | 76,428.00 |
| Profile FB 100x18 | 5,000.00 | 83,370.00 | 61,138.00 |

Table 7 shows that telephone costs are the costs of contacting the supplier, then transportation costs include costs for the distance between the supplier and the company, which includes fuel costs and driver costs, administration costs are the costs of import taxes on materials to be supplied to the company.

**TABLE 8.**
**MATERIAL STORAGE PLANNING COSTS FOR PROJECT 4 SHIPS**

| No | Material | Storage fee (/Pcs) |
|---|---|---|
| 1. | Steel Plate Grade A 8 FT x 30 FT x 8 mm | 380,279.54 |
| 2. | Steel Plate Grade A 8 FT x 30 FT x 10 mm | 611,944.08 |
| 3. | Steel Plate Grade A 8 FT x 30 FT x 12 mm | 734,332.90 |
| 4. | Profile L 100x75x7x9 m | 22,832.38 |
| 5. | Profile L 75x75x7x9m | 15,329.82 |
| 6. | Profile T 270x8+100x10 | 187,329.82 |
| 7. | Profile FB 100x10 | 13,896.00 |
| 8. | Profile FB 100x18 | 11,116.00 |

In Table 8 it can be seen that each material requires different storage costs, including damage costs of 1% of the material price, handling costs of 0.5% of the material price and facility costs for materials, namely 0.5% of the material price itself, to get the overall storage costs. material per unit, namely 2% of the material price and storage costs are costs incurred during the period Jan-May 2024

**TABLE 9.**
**MATERIAL PURCHASING PLANNING COSTS FOR PROJECT 4 SHIPS**

| No | Material | Material Cost (/Pcs/Order) |
|---|---|---|
| 1. | Steel Plate Grade A 8 FT x 30 FT x 8 mm | 19,013,977.00 |
| 2. | Steel Plate Grade A 8 FT x 30 FT x 10 mm | 30,597,204.00 |
| 3. | Steel Plate Grade A 8 FT x 30 FT x 12 mm | 36,716,645.00 |
| 4. | Profile L 100x75x7x9 m | 1,141,619.00 |
| 5. | Profile L 75x75x7x9m | 766,491.00 |
| 6. | Profile T 270x8+100x10 | 9,366,491.00 |
| 7. | Profile FB 100x10 | 694,800.00 |
| 8. | Profile FB 100x18 | 555,800.00 |

The table above shows that the cost of purchasing materials/pcs to be used by 4 Tugboats. The purchasing costs are the costs of purchasing materials from suppliers. Prices per material and profile are the dollar exchange rate in effect at the time of research in early 2024.

**TABLE 10.**
**TOTAL INVENTORY COSTS FOR EACH METHOD**

| Method | Cost (IDR) | Percentage | Savings (IDR) |
|---|---|---|---|
| Lots For Lots | 3,191,286,565.90 | 28% | |
| Economic Order Quantity | 3,335,289,136.02 | 29% | 1,750,346,266.38 |
| Company Method | 4,941,632,832.28 | 43% | |

Table 10. Explain that each Lot Sizing technique with each material is affected by different storage costs, material costs, inventory on hand, and ordering costs. And in each Lot Sizing technique has a different output as well, the Lot for Lot Technique produces efficient and minimal storage costs for material storage, the Economic Order Quantity Technique is also useful for reducing order costs and order costs. by taking into account the cost of material needs during a certain period and the company's method of using Safety Stock which results in more storage costs and the determination of material needs is ordered as minimally as possible but in larger quantities

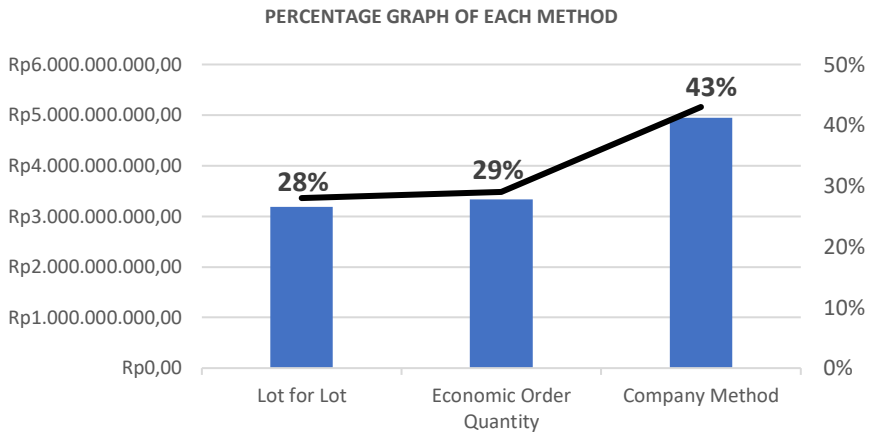


Figure 5. Percentage Of Each Method for Project 4 Tugboat

Figure 4.4 shows that the Lot for Lot (LFL) method is the most efficient in terms of percentage of total inventory costs, while the highest inventory costs occur with the method used by the company. The results of inventory cost calculations show that the Lot for Lot method is a percentage of 28%, the Economic Order Quantity method produces a result of a percentage of 29% and the company method that is still applied produces high costs of a percentage of 43%.

Therefore, based on the relationship between the percentage efficiency of the Lot for Lot method to the Economic Order Quantity method of 1.3%, the Lot for Lot method to the Company's method of 15.3%, and the Economic Order Quantity method to the Company's method of 14%, the Lot for Lot Method is considered an efficient method between the two methods.

Material planning at PT.PMP with the Lot for Lot Method during the period January-May 2024, at Lot for Lot Material ordering is the same as the material requirements needed, so the efficient planning strategy is as follows: Material Plate size 8 mm Ordering as many as 6 pieces of plate with 1 order. Material Plate size 10 mm Ordering as many as 26 pieces of plate with 3 orders. Material Plate size 12 mm there is no order because the stock in the warehouse is able to cover the gross needs and the remaining 20 sheets of plate. Material Profile L 100x75x7 Ordering 315 units with 5 orders. Material Profile L 75x75x7 there are no orders because the stock in the warehouse is able to cover the gross needs and the remaining 19 units. T 270x8 + 100x10 Profile Material Ordered 115 units with 3 orders. FB 100x10 Profile Material ordered 76 units with 4 orders and FB 100x8 Profile Material ordered 40 units with 4 orders.

## IV. Conclusion

Based on the results of research regarding the Implementation of Material Control in Tugboat Building Using the Lot For Lot (LFL) Method (Case Study at PT. PMP. Material planning strategies using the Lot for Lot method and the Economic Order Quantity method against existing conditions at PT.PMP on Plate and Profile inventory in the New Building Tugboat Project. The results obtained in the form of inventory costs that the Lot for Lot method is 28%, the Economic Order Quantity method results in an inventory cost of 29% and the company method that is still being applied results in a high cost of 43%. The Lot for Lot method is more efficient by 15% than the existing method applied by PT.PMP. So the Lot for Lot method obtained from January to May 2024 can be applied to the shipyard located in Batam.

Based on the results of the research, the suggestions are as follows:

- Recommendations and suggestions using the lot for lot technique for consideration by the company.
- It is hoped that future research will carry out further analysis of other materials in the fields of manufacturing, shipping and health. They will use forecasting such as moving averages, single exponential smoothing, and other MRP methods.

## Acknowledgements

The author expresses his gratitude to God Almighty in completing this research. And also thank you to the Hang Tuah University Surabaya.

## References

[1] Rahmat, Fathul SF. 2018. Analysis of plate and profile material requirements for the Building of the 300 GT Ferry Ship superstructure. Hasanuddin University.

[2] Sarkar, A. 2013. A Simple Case Study of Material Requirement Planning. IOSR E-Jurnal Manajemen, Vol. 9, No. 2, 2020 : 426-445 445 Journal of Mechanical and Civil Engineering, 9(5), 58–64.

[3] Husen, 2011. Project Management. ANDI. Yogyakarta.
[4] Desiyanti, R. 2020. Operations Management. LPPM Hatta University
[5] Theresia, P., & Salomon, L. L. (2015). Proposal for Controlling the Inventory of Raw Materials for Ant Ink Products (Case Study: CV. Sinar Mutiara). Journal of Technology Studies, 11(1), 43–54.
[6] Martha, K. A., & Setiawan, P. Y. (2018). Material Requirement Planning Analysis of Coconut Sugar Products at Kul-Kul Farm. E-Journal of Management of Udayana University, 7(12), 6532–6560.
[7] Ramadhan, MAI, Rafie, R., & Nuh, SM 2023. Material Planning Using the Material Requirement Planning (Mrp) Method Using Lot for Lot (Lfl) and Period Order Quantity (Poq) as Lot Sizing Techniques in Material Control (Study Case: Renovation of Kapuas Indah Market and Public Service Mall (Multiyears) Pontianak City). JeLAST: PWK Journal, Marine, Civil, Mining, 10(2).
[8] Lestari Sri, Nurdiansah DD, 2018. Analysis of Material Requirement Planning in Paper Manufacturing Companies using the Material Requirement Planning (MRP) Method. Journal of Industrial and Logistics Management, 4(2).
[9] Tanisri, R. H. A., & Rye, E. 2022. Controlling the inventory of caster wheel raw materials using the MRP (Material Requirement Planning) method at CV Karya Teknik Makmur. Inkofar Journal, 6(1).
[10] Suryanto, G. D., Widyaningrum, D., & Jufriyanto, M. 2021. Planning Of Raw Material Needs For Songkok Products Using The Material Requirement Planning Method (Case Study: Putroe MSMEs Undergraduate Songkok, Gresik). JUSTI (Journal of Industrial Systems and Engineering), 2(1), 167-174.
[11] Greasley, A. 2008. Operations Management. Thousand Oaks: AGE Publications Inc.
[12] Purwati, Sri. 2008. Analysis of the Role of MRP (Material Requirement Planning) for Benelux Chair Products on CV Aksen Rattan Cirebon. Thesis. Faculty of Business and Management, WidyatamaUniversity.http://dspace.widyatama.ac.id/handle/10364/981.
[13] Herjanto, 2010, Operations Management, ed: Revisi, Gramedia, Jakarta.
[14] Sugiono, 2010. Classroom Action Research Methods Quantitative, Qualitative, and R&D Approaches, Bandung: Alfabeta
[15] Baroroh, 2020. Supply chain performance analysis on modular construction shipbuilding, Maritime Safety International Conference, IOP Conf. Series: Earth and Environmental Science **557** (2020) 012048, doi:10.1088/1755-1315/557/1/012048
[16] Baroroh. 2023. Risk Analysis of Delay in Ship Repair KM Binaiya with Bayesian Network Method, International Journal of Marine Engineering Innovation and Research, Vol. 8(3), Sept. 2023. 449-459 (pISSN: 2541-5972, eISSN: 2548-1479)
[17] Baroroh. 2023. Risk Evaluation of Ship Repair Delays with The Failure Modes and Effects Analysis (FMEA) Method, International Journal of Marine Engineering Innovation and Research, *Vol. 8(4), Dec. 2023. 605-615 (pISSN: 2541-5972, eISSN: 2548-1479)* 605
[18] Chandradevi, A., Puspitasari, N. B. 2016. Application of Material Requirement Planning (MRP) by Considering Lot Sizing in Raw Material Control at PT Phapros, Tbk. PERFORMA*: Media Ilmiah Teknik Industri, 15*(1).
[19] Xue, Lei, Guofu Shi, Dashuang Dai, and Yizhuang Xu, 2020. "Two-Stage Efficiency Structure Analysis Model of Shipbuilding Based on Driving Factors: The Case of Chinese Shipyard." 182–200.
[20] SeungHoon Nam a, HuiQiang Shen A, and Jong Gye Shin Cheolho Ryu b. 2017. "SCPMatrix Based Shipyard APS Design: Application to Long-Term Production Plan,." *International Journal of Naval Architecture and Ocean Engineering Xxx* 1– 21.

`