DEVELOPMENT OF OPERATION PROCESS CHART AND ANALYSIS OF INVENTORY CONTROL BASED ON MATERIAL REQUIREMENT PLANNING IN ASSEMBLY LINE

Annisa Indah Pratiwi[1], Afif Hakim[2], Ragil Yuli Santosa[3]
[1, 2, 3]Department of Industrial Engineering, Faculty of Technology and Computer Science, University of Buana Perjuangan Karawang
Jl. HS Ronggowaluyo East Telukjambe Karawang, Phone 0267-8403140
E-mail: annisa.indah@ubpkarawang.ac.id

Abstract

Production planning and control is a theory which discusses all the activities that take place in a production process which includes product planning, costs, production processes, scheduling, forecasting demand and many other products. Planning the amount of inventory that will be owned company is one of the problems often faced by companies. Especially when the inventory is one important factor that can support the company's production processes and help meet customer demand. For companies that have strategies make to stock, inventory can have a major impact on the pricing of the product or the company's finances. Appropriate inventory management can be one of the keys to minimize and optimize the company's costs to be incurred. Determination lot size in MRP is a complex and difficult problem. Lot size is defined as a quantity stated in the order acceptance and delivery of orders in the MRP. Decisions about the size of the lot and when production is very important because it involves the use of labor and equipment are economical. Based on observations there are 13 components which are arranged in the trolley assembly process and are divided into 4 work stations in the production process. After making a process operations chart per each work station, the cycle time for 1800 seconds is obtained. Based on data analysis about inventory costs for each component, it can be seen that the calculation using the EOQ method is the method that produces the calculation results with the largest value of IDR 111,000,500 then for the L4L and POQ methods produce the calculation results that have the same value of IDR 16,200,000. Then the decision taken is to choose the L4L method because with this technique can produce exactly how many raw materials needed.

Keywords: Lot sizes, Process Operation Chart; Product Structure; Material Requirement Planning

Introduction

A work method is important in industry. With a very tight competition and spacious, an industry being required to meet the needs of consumers in terms of quality and quantity. For that, it takes some tips in the company so the method of work, especially on the production floor work effectively and efficiently. It can be associated with time and motion studies in the science of Ergonomics. A working system or production involves many things, such as people/workers, methods, machinery, information, material, equipment, and much more. These pieces have to integrate these components in order to obtain a good production process even better than the existing working methods. If one of the above components work less well or even worse,then the other componentswill feel a significant effect and will result in the instability of the production line.

Planning and supply of raw materials is very important in a production process, especially in the manufacturing industry. If the supply of raw materials are not available in conformity with the plan or production needs, it will hinder the production process. Inventories are raw materials, WIP (work in process), finished goods, auxiliary materials, supplementary materials, components stored in anticipation of the fulfillment of the request. Inventories of raw materials should be regulated, so that the production process continues to run in accordance with customer demand meet market needs.

One way to control the inventory is the Material Requierment Planning (MRP) method. MRP is a technique that aims to improve the productivity approach the company by scheduling the need for materials and components to assist companies in addressing the minimum requirements of the components that need dependent and guarantee the

achievement of the final production.The use of the MRP method requires high precision, and when used to structure complex products and in a period of long production, processing will manually is difficult and requires a long time, taking into account these factors is necessary to develop a program to help computer-based in terms of this software POM QM.

Formulation of the Problem

Based on the above background, the formulation of the problem in this research is to analyze the steps to create the Operation Process Chart (OPC) of an assembly system and identify the structure of the product of an assembled product. Besides that, the formulation of the problem in this study also analyzes about how to perform the calculation process in the manufacturing of MRP method for ordering parts from the supplier.

Research Purposes

Based on the formulation of the above problems, the following are the objectives of this study are:

1. To analyze and identify the Operation Process Chart for design and product structure.
2. To analyze and identify the calculation process in the manufacturing of Material Requirement Planning (MRP) for ordering parts from the supplier.

Literature Review

1. Operation Process Chart

According to (Sutalaksana, 2006) Operation Process Chart is a diagram illustrating process steps that will be experienced raw materials regarding the sequence of operation and examination from the initial stage to the final product or component, and contains information that is required for further analyzes such as time, materials, space, tools, and machines used.

2. Product Structure

The structure of the product or the Bill of Material (BOM) is defined as the way the components are joined into a product during the manufacturing process (Gaspersz, 2004). Structure inverted fewer subassemblies compared with the end product, and fewer components and raw materials compared subassemblies (shape of an inverted triangle, with the upper part is the end product center is the assemblies, and below is the raw material components (Gaspersz, 2004). The product structure is divided into two, namely the product structure implotion and explotion. The product structure explotion a product structure which illustrates a flowchart which starts from the final product into its components while the product structure implotion is a structure that illustrates a flowchart which starts from its components to the final product.

3. *Material Requirement Planning* (MRP)

According to Heizer and Render (2005) mentioned that the MRP is bound demand model that uses the list of material requirements, inventory status, receipt of which is estimated, and the master production schedule, which is used to determine the material needs to be used. Tampubolon (2004) mentions the MRP is a computerized inventory system ingredients needed in the conversion process of a company, both manufacturing and service business venture.

Research Methodology

1. Data Collection Technique

Data collection techniques in this study used the data on trolley assembly production system of University of Buana Perjuangan Karawang. Data collection begins by finding the relevant information materials and materials used in the method used in the trolley assembly. Then the data is processed for further analysis using the Material Requirement Planning. The data collected was secondary data.

The primary data was done by direct observation and interviews of the students in the process of assembling a trolley in the laboratory production system. The results of observations and interviews were used as supporting data analysis map-making role in the operation process, the product structure and how to make improvements.

2. Steps Research

Here are the steps of the flow of this study will be described in the form of images.

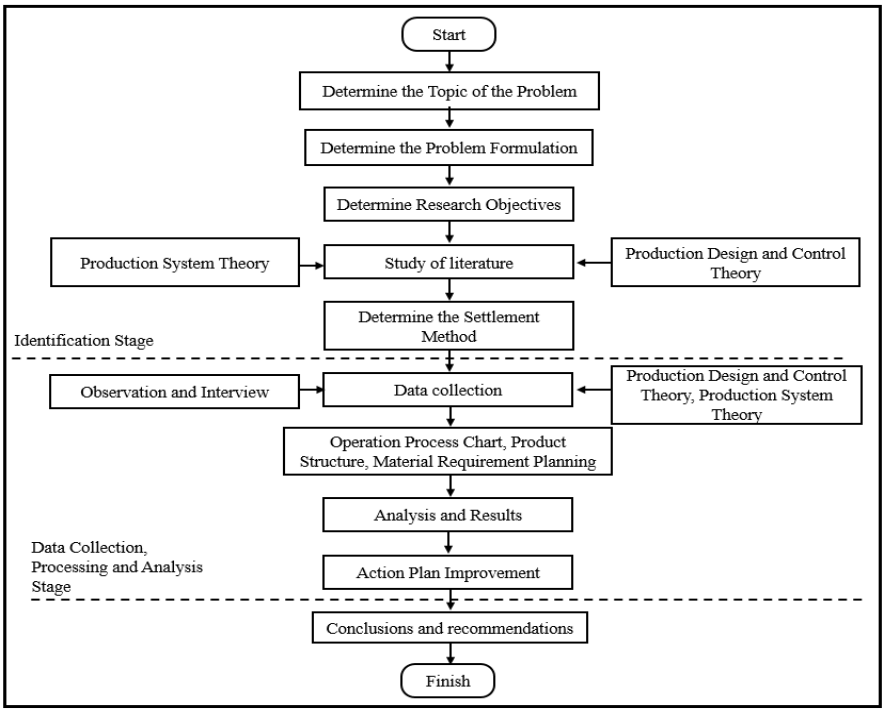


Figure 1. Flow chart of research

3. Data Analysis Technique

Data analysis techniques used in this study is to collect data and interview data from observations of trolley assembly production system of University of Buana Perjuangan Karawang. Then the data is processed and analyzed to map the design manufacture and operation process of the product structure. While data trolley assembly results used as supporting data in the analysis and design of production planning methods Material Requirement Planning.

Results and Discussion

1. Data Collection

Data needed in this research is data material required in the assembly trolley. Here is the data material required in the assembly trolley:

Table 1. Data trolley assembly material

No.	Component name	Type / Size	Model	Qty (Pcs)	Price / Pcs (IDR)
1	Iron pipe	15 cm	DY1	2	15,000
2	Iron pipe	34.5 cm	DY1	6	34.500
3	Iron pipe	65.5 cm	DY1	4	65.500
4	Iron pipe	69.5 cm	DY1	2	69.500
5	Iron pipe	79.5 cm	DY1	2	79.500
6	*metal joint*	HJ1	DY1	4	7.500
7	*metal joint*	HJ2	DY1	10	12,000
8	*metal joint*	HJ3	DY1	6	12.500
9	*metal joint*	HJ5	DY1	6	10,000
10	*Screw*	L	DY1	28	4.000
11	*Nut*	-	DY1	28	200
12	Board	69 cm x 39 cm	DY1	2	9,000
13	wheel	-	DY1	4	6.000

In addition to the above data, the lab is also obtained data on the needs of materials used in the calculation of the MRP. In terms of activities to implement the provision of goods such as components trolley, of the company will be charged from the beginning of the process of ordering, shipping, arrival till when the goods are to be charged in the form of warehouse storage costs, the cost component is the cost of inventory that includes:

1. Storage costs (Holding Costs) per item components for 1 month
   a. Electricity cost : IDR 200
   b. Building maintenance costs : IDR 1000
   c. Cost of damage : IDR 500
   Total : IDR 1,700

2. Set up fee
   a. Expedition cost : IDR 60,000
   b. telephone charges : IDR 30,000
   c. Cost scheduling : IDR 30,000
   Total : IDR 120,000

Table 2. Requirement per parent request trolley

Component name	Qty (Pcs)
Pipe 79.5 cm	2
Pipe 69.5 cm	4
Pipe 65.5 cm	2
Pipe 34.5 cm	6
Pipe 15 cm	2
HJ 1	2
HJ 2	10
HJ 3	6
HJ 5	6
Screw L	30
Nut	30
Board 69 x 39	2
wheel	4

Table 3. Output of POM QM trolley demand forecast

Period	Forecast (Pcs)
January	716
February	716
March	720
April	733
May	744
June	752
July	742
August	704
September	668
October	640
November	620
December	622

2. Process Operations Chart and Product Structure

After making observations at the time of assembly lab trolley, then making the operations process chart and product structure can be described as follows:

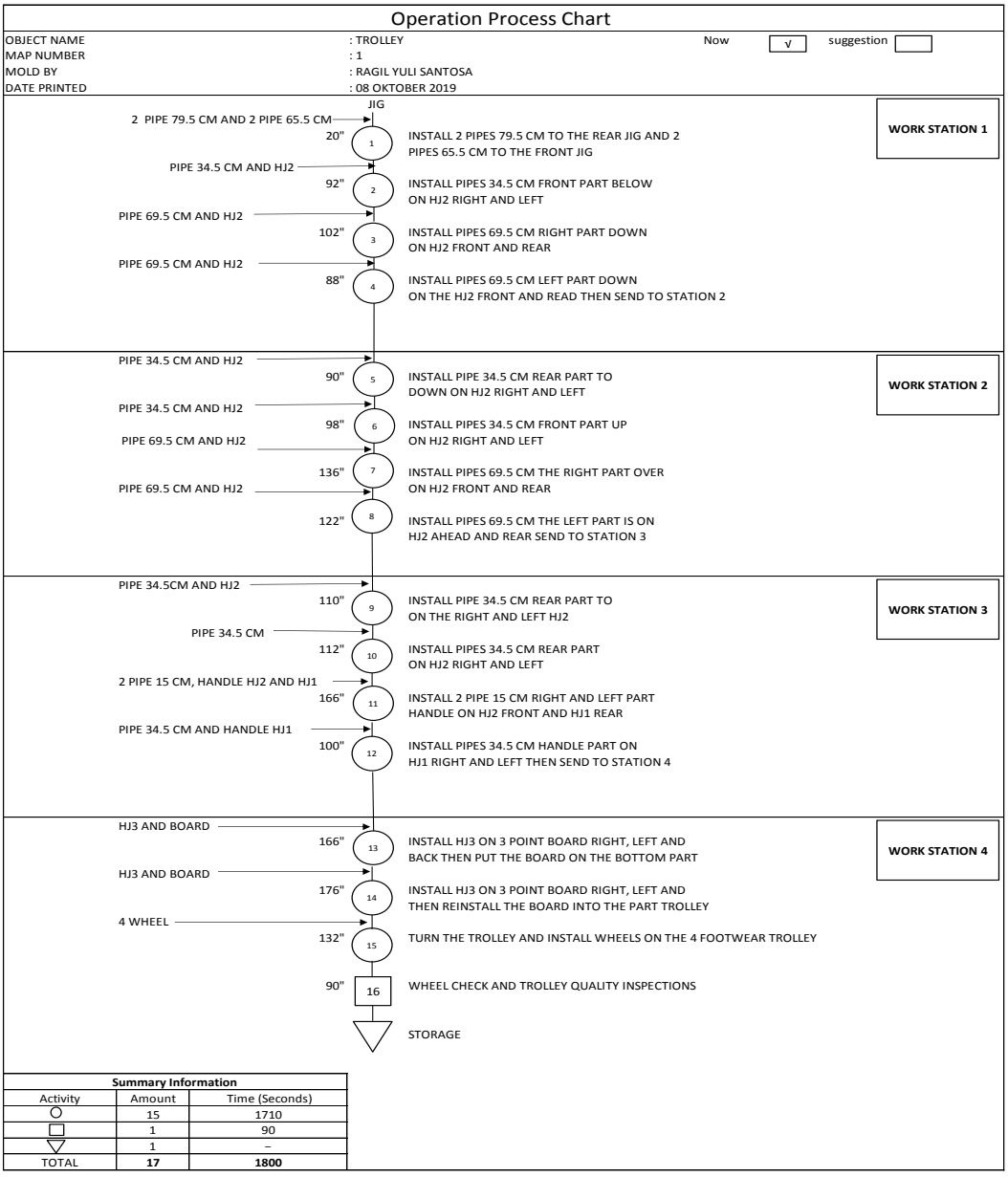


Figure 2. Operation process chart of trolley assembly

3. BOM (*Bill Of Materials*)

Bill of Materials is defined as the way the components are joined into a product during the manufacturing process (Gaspersz, 2004). Fewer subassemblies inverted structure compared with the end product, and fewer components and raw materials compared subassemblies (inverted triangle-shaped, with the upper part is the end product is a central part assemblies, and below is the raw material components (Gaspersz, 2004).

Here is Bill Of Material of products consisting of a trolley trolley which is level 0 and the constituent components Cart numbering as many as 13 components is level 1. Bill Of Material from Cart products is as follows:

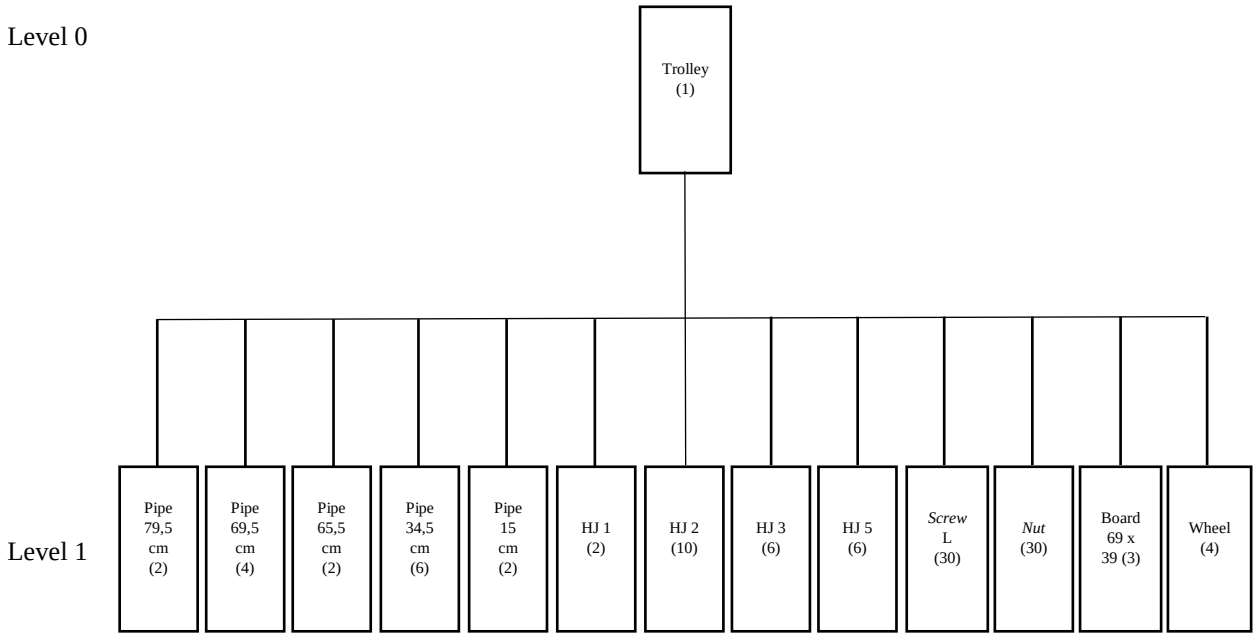


Figure 3. Bill of material of trolley

4. The Calculation Results

The next calculation is to use QM POM with input of further purchase cost data with component data from table 2 and also the demand forecast data from table 3. The following is data of material and component requirements for each period, expected:

Table 4. Material requirements data for each period

Period	Forecast (Pcs)	Pipe 79.5 cm	Pipe 69.5 cm	Pipe 65.5 cm	Pipe 34.5 cm	Pipe 15 cm	HJ 1	HJ 2	HJ 3	HJ 5	*Screw* L	*Nut*	Board 69 x 39	Wheel
		2	4	2	6	2	2	10	6	6	30	30	2	4
January	716	1.432	2.864	1.432	4.296	1.432	1.432	7.160	4.296	4.296	21.480	21.480	1.432	2.864
February	716	1.432	2.864	1.432	4.296	1.432	1.432	7.160	4.296	4.296	21.480	21.480	1.432	2.864
March	720	1.440	2.880	1.440	4.320	1.440	1.440	7.200	4.320	4.320	21.600	21.600	1.440	2.880
April	733	1.466	2.932	1.466	4.398	1.466	1.466	7.330	4.398	4.398	21.990	21.990	1.466	2.932
May	744	1.488	2.976	1.488	4.464	1.488	1.488	7.440	4.464	4.464	22.320	22.320	1.488	2.976
June	752	1.504	3.008	1.504	4.512	1.504	1.504	7.520	4.512	4.512	22.560	22.560	1.504	3.008
July	742	1.484	2.968	1.484	4.452	1.484	1.484	7.420	4.452	4.452	22.260	22.260	1.484	2.968
August	704	1.408	2.816	1.408	4.224	1.408	1.408	7.040	4.224	4.224	21.120	21.120	1.408	2.816
September	668	1.336	2.672	1.336	4.008	1.336	1.336	6.680	4.008	4.008	20.040	20.040	1.336	2.672
October	640	1.280	2.560	1.280	3.840	1.280	1.280	6.400	3.840	3.840	19.200	19.200	1.280	2.560
November	620	1.240	2.480	1.240	3.720	1.240	1.240	6.200	3.720	3.720	18.600	18.600	1.240	2.480
December	622	1.244	2.488	1.244	3.732	1.244	1.244	6.220	3.732	3.732	18.660	18.660	1.244	2.488
Totals	**8.377**	**16.754**	**33.508**	**16.754**	**50.262**	**16.754**	**16.754**	**83.770**	**50.262**	**50.262**	**251.310**	**251.310**	**16.754**	**33.508**

After getting the data that will be input to the QM POM software, the next step is processing using the QM POM software with the following steps:

a. Open the QM POM software.
b. Click Module (Lot Sizing).

c. Click File New and fill in the dialog box below and click OK.

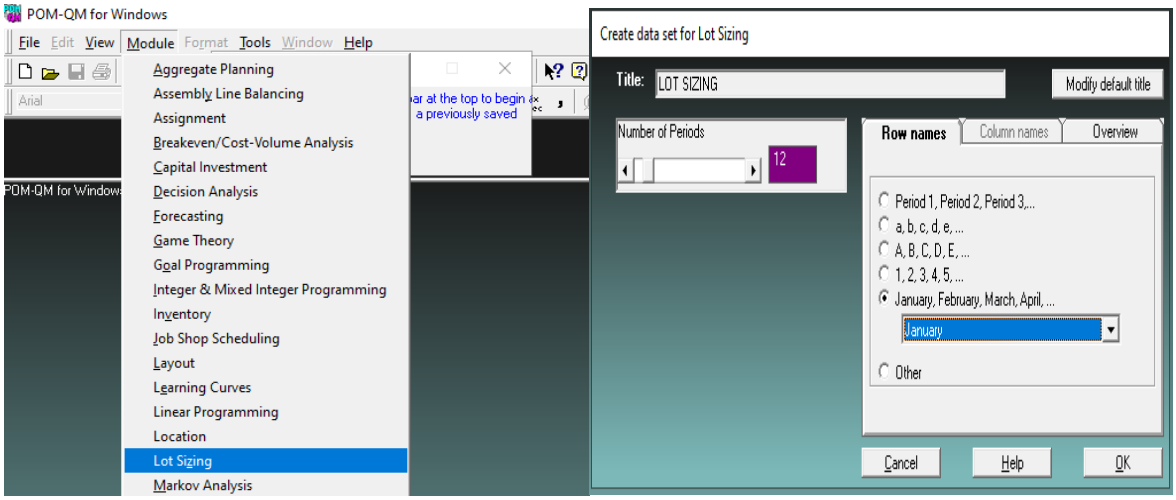
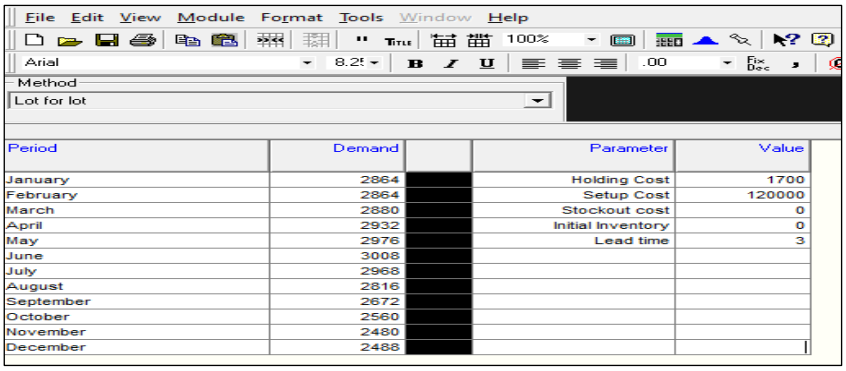


Figure 4. Selection of Lot Sizing Module, Dialog Box Title, Number of Periods and Row Name

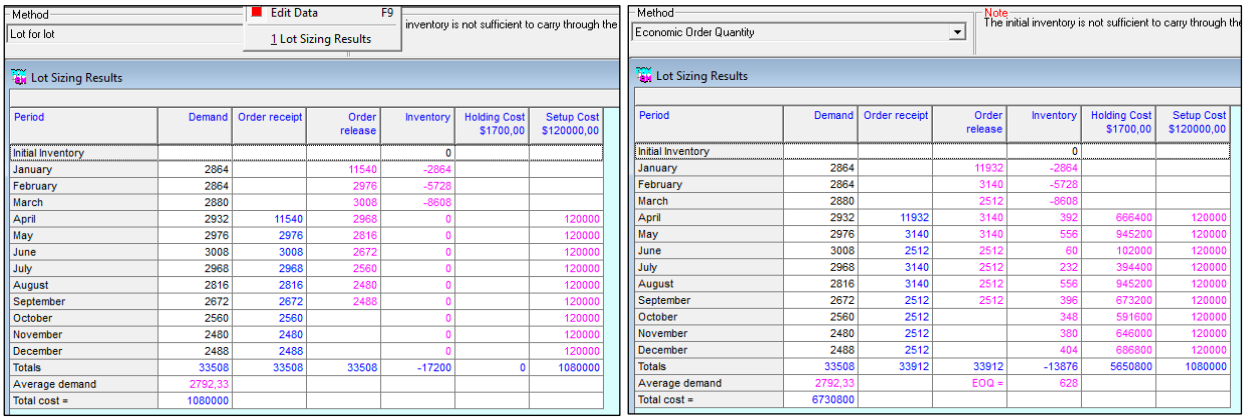
d. Fill in the data demand for each component based on the number of component requirements for one Trolley.
e. Select a method and click Solve



Period	Demand		Parameter	Value
January	2864		Holding Cost	1700
February	2864		Setup Cost	120000
March	2880		Stockout cost	0
April	2932		Initial Inventory	0
May	2976		Lead time	3
June	3008			
July	2968			
August	2816			
September	2672			
October	2560			
November	2480			
December	2488			

Figure 5. Demand of wheel components

f. Wheel Component Running Results



Period	Demand	Order receipt	Order release	Inventory	Holding Cost $1700,00	Setup Cost $120000,00
Initial Inventory				0		
January	2864		11540	-2864		
February	2864		2976	-5728		
March	2880		3008	-8608		
April	2932	11540	2968	0		120000
May	2976	2976	2816	0		120000
June	3008	3008	2672	0		120000
July	2968	2968	2560	0		120000
August	2816	2816	2480	0		120000
September	2672	2672	2488	0		120000
October	2560	2560		0		120000
November	2480	2480		0		120000
December	2488	2488		0		120000
Totals	33508	33508	33508	-17200	0	1080000
Average demand	2792,33					
Total cost =	1080000					

Period	Demand	Order receipt	Order release	Inventory	Holding Cost $1700,00	Setup Cost $120000,00
Initial Inventory				0		
January	2864		11932	-2864		
February	2864		3140	-5728		
March	2880		2512	-8608		
April	2932	11932	3140	392	666400	120000
May	2976	3140	3140	556	945200	120000
June	3008	2512	2512	60	102000	120000
July	2968	3140	2512	232	394400	120000
August	2816	3140	2512	556	945200	120000
September	2672	2512	2512	396	673200	120000
October	2560	2512		348	591600	120000
November	2480	2512		380	646000	120000
December	2488	2512		404	686800	120000
Totals	33508	33912	33912	-13876	5650800	1080000
Average demand	2792,33		EOQ =	628		
Total cost =	6730800					

Figure 6. The result of L4L and EOQ method

After receiving the data, then do the analysis of the calculation results. The result of this calculation analysis obtained from the calculation using POM QM software. The calculations in this analysis is the calculation method Lot for Lot, Economic Order Quantity and Period Order Quantity is then performed a comparison between the three methods method chosen for any material that is not always the same depending on which method produces the most minimum cost. The following comparative analysis method:

Table 5. Calculation Results Lot Sizing using POM-QM Software

Component	frequency Booking			Storage costs			Setup fee			Total cost		
	L4L	EOQ	POQ	L4L	EOQ	POQ	L4L	EOQ	POQ	L4L	EOQ	POQ
Pipe 79.5 cm	11	11	11	-	Rp4.069.800	-	Rp1.320.000	Rp1.320.000	Rp1.320.000	Rp1.320.000	Rp5.389.800	Rp1.320.000
Pipe 69.5 cm	11	11	11	-	Rp6.902.000	-	Rp1.320.000	Rp1.320.000	Rp1.320.000	Rp1.320.000	Rp8.222.000	Rp1.320.000
Pipe 65.5 cm	11	11	11	-	Rp4.069.800	-	Rp1.320.000	Rp1.320.000	Rp1.320.000	Rp1.320.000	Rp5.389.800	Rp1.320.000
Pipe 34.5 cm	11	11	11	-	Rp7.034.600	-	Rp1.320.000	Rp1.320.000	Rp1.320.000	Rp1.320.000	Rp8.354.600	Rp1.320.000
Pipe 15 cm	11	11	11	-	Rp4.069.800	-	Rp1.320.000	Rp1.320.000	Rp1.320.000	Rp1.320.000	Rp5.389.800	Rp1.320.000
HJ 1	10	10	10	-	Rp3.655.000	-	Rp1.200.000	Rp1.200.000	Rp1.200.000	Rp1.200.000	Rp4.855.000	Rp1.200.000
HJ 2	10	10	10	-	Rp9.487.700	-	Rp1.200.000	Rp1.200.000	Rp1.200.000	Rp1.200.000	Rp10.687.700	Rp1.200.000
HJ 3	10	10	10	-	Rp5.953.400	-	Rp1.200.000	Rp1.200.000	Rp1.200.000	Rp1.200.000	Rp7.153.400	Rp1.200.000
HJ 5	10	10	10	-	Rp5.953.400	-	Rp1.200.000	Rp1.200.000	Rp1.200.000	Rp1.200.000	Rp7.153.400	Rp1.200.000
Screw L	10	10	10	-	Rp16.942.200	-	Rp1.200.000	Rp1.200.000	Rp1.200.000	Rp1.200.000	Rp18.142.200	Rp1.200.000
Nut	10	10	10	-	Rp16.942.200	-	Rp1.200.000	Rp1.200.000	Rp1.200.000	Rp1.200.000	Rp18.142.200	Rp1.200.000
Board 69 x 39	11	11	11	-	Rp4.069.800	-	Rp1.320.000	Rp1.320.000	Rp1.320.000	Rp1.320.000	Rp5.389.800	Rp1.320.000
wheel	9	9	9	-	Rp5.650.800	-	Rp1,080,000	Rp1,080,000	Rp1,080,000	Rp1,080,000	Rp6.730.800	Rp1,080,000
amount	**135**	**135**	**135**							**Rp16.200.000**	**Rp111.000.500**	**Rp16.200.000**

Based on the above table for each component inventory costs trolley seen that the value of the inventory by calculating the EOQ method is a method that generates the calculation results with the greatest value is Rp. 111 000 500, - then for L4L and POQ methods produce results of calculations have the same value that is equal to Rp. 16.2 million, -. So the decision is to choose the method of L4L because with this technique produces exactly how the needs of the necessary raw materials. This technique is consistent with the goal of MRP is to meet the needs that demand is bound. When orders are often economically and just in time inventory techniques applied, then it becomes very efficient technique (Heizer and Render, 2015).

Conclusion

From the analysis and discussion in this study it can be concluded that the determination of lot size in MRP is a complex and difficult problem. Lot size is defined as a quantity stated in the order acceptance and delivery of orders in the MRP. For components that are manufactured in the factory, lot size is the amount of production while for purchased components, lot size means the amount ordered from the supplier. Thus the lot size is generally the fulfillment of components for one or more periods.

For the calculation of the MRP on the trolley production using POM-QM software above example, the inventory policies developed to determine when replacement back in inventory and how much must be booked in one booking. Decisions about the size of the lot and when production is very important because it involves the use of labor and equipment are economical.

Based on data analysis about inventory costs for each component, it can be seen that the calculation using the EOQ method is the method that produces the calculation results with the largest value of IDR 111,000,500 then for the L4L and POQ methods produce the calculation results that have the same value of IDR 16,200,000. Then the decision taken is to choose the L4L method because with this technique can produce exactly how many raw materials needed.

References

Gaspersz, Vincent. 2004. Production Planning and Inventory Control. Jakarta: PT Gramedia Pustaka Umum.
Heizer, Jay and Render Barry. 2005. Operations Management. Jakarta: Salemba Empat.

Heizer, Jay and Render Barry. 2015. Manajemen Operasi : Manajemen. Keberlangsungan dan Rantai Pasokan, edisi 11. Jakarta: Salemba Empat.
Sutalaksana, Iftikar Z. 2006. Teknik Perancangan Sistem Kerja. Bandung: ITB.
Tampubolon. 2004. Manajemen Operasional. Jakarta: PT. Ghalia Indonesia.