Planning of warehouse area for vise manufacturing by considering raw material requirements

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Planning of warehouse area for vise manufacturing by considering raw material requirements

Muhammad Haikal Sitepu[*1], Alison McKay[2], Tania Alda[1], Lamsihar Siregar[1] and Ali Akbar Irawan[1]

[1]Industrial Engineering Department, Faculty of Engineering, Universitas Sumatera Utara, Medan, Indonesia, 20155
[2]Institute Design, Robotic and Optimization, School of Mechanical Engineering, University of Leeds, United Kingdom

[*]Email: mhd_haikalkarana@usu.ac.id

Abstract. Availability of raw materials is important for maintaining the continuity of production. However, in planning inventory for raw materials, several factors such as availability of warehouse space for raw material, handling cost, order cost, transportation time are used in determining amount of raw material need to be stocked. Vise is important tool to support finishing process such as cutting and grinding. Vise consists of several parts such as base, right clamp body and handle. These parts need to be stored in warehouse to support the manufacturing of vise. Hence, the warehouse space must be adequate to store raw materials for manufacturing vise within certain period of time. This paper aims to demonstrate the calculation of warehouse area based on the material requirements that are calculated based on material removal rate for each process.

1. Introduction

Availability of raw materials is important for maintaining the continuity of production. However, in planning inventory for raw materials, several factors such as availability of warehouse space for raw material, handling cost, order cost, transportation time are used in determining amount of raw material need to be stocked [1]. Warehouse space is critical in inventory planning. If the warehouse space too small, it can reduce the quantity of raw materials that can be stored in the warehouse. On contrary, if the warehouse space is too large, although it can store large quantity of raw materials, the handling cost might increase. Hence, the manufacturing needs warehouse with space that can store enough raw material to support the production for certain period of time. For this reason, the calculation of warehouse space needs to consider the material requirements from production [2]. This paper aims to demonstrate the calculation of warehouse space by considering the material requirements from production.

Vise is important tool to support finishing process such as cutting and grinding. Vise consists of several parts such as base, right clamp body and handle. These parts require different production processes and different materials. As the result, to calculate the warehouse space for vise manufacturing, material requirement planning from production need to consider [3]. Planning of raw materials relates to the calculation of the volume of materials, time for material delivery and cost of material [4]. Planning of raw materials is very important and must be aligned with the company's

production plans. This paper demonstrates the calculation the volume of raw materials for each process in manufacturing vise. Then this calculation is used in calculating the warehouse space.

Several models are available in the literature such as Economic order quantity and Economic order interval to support the calculation of stock quantity that are influenced by product demand, order cost, and inventory holding cost [5]. However, these models are worked under the assumption, the warehouse has enough space or area to store the raw materials. This paper focuses to calculate warehouse area based on raw material requirements so the warehouse will have enough space to store the raw materials.

2. Methodology

An experiment is used as a research methodology. Experiment is good to use when the objective of research is to investigate the impact different alternatives into system performance. In this research, experiment is conducted to investigate the impact of vise manufacturing process into the warehouse space.

2.1. Research Process

To achieve the aim of the research, this research has been divided into four stages. First stage focuses on observing and collecting material removal rate date for each process in vise manufacturing. Then, the material removal rate data is used to calculate the raw material requirement for each part in second stage. In third stage, the research focuses on converting the raw material requirements from kg to unit of raw material. Then, this is followed by final stage that is focused on calculating the warehouse space based on material requirements.

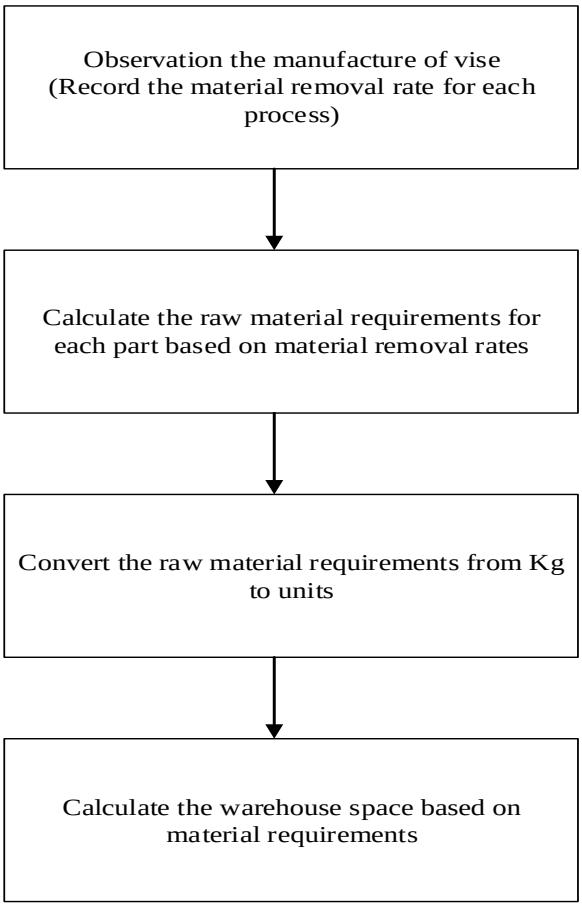

Figure 1. Research Process.

This research used material removal rate to calculate the raw material required for each process. Material removal rate (MRR) is the amount of material removed per time unit. In roughing operations and the production of large batches, this needs to be maximized. However, in finishing operations, it is a factor to be put on hold, bringing roughness and precision to the forefront. For low roughness, usually low cutting speeds and feed per tooth are both applied, as MRR is usually very low for finishing. In this research the material removal rate data is calculated from the manufacture of vise in laboratory of manufacturing process, Faculty of Engineering, Universitas Sumatera Utara. Material removal rate is calculated by dividing weight of waste material from each process with processing time. Table 1 shows the material removal rate for each process.

Table 1. Material removal rate data

No.	Machines	MRR (gr/s)
1	*Drilling*	0,0625
2	*Milling*	0,2746
3	Grindstone	0,0352
4	*Tap and Dies*	0,0614
5	Lathe	0,033
6	Scrap	0,03

3. Result and Discussion

3.1. Raw Material Requirement Calculation

The calculation of raw material is implemented by multiplying processing/operating time with material removal rate. Backtracking process was implemented to calculate raw material. It means the calculation starts from the last process to beginning process in making part of vise. For example, to make part base, the last process is milling process. Operating time for milling process is 475 seconds. Total material removed during milling process is 0.13 Kg (475 * 0. 2746). Table 2 displays the example calculation of raw material requirements for base part.

Table 2. Calculation of material requirements for Base Part

Processing order	Processing	*Output* (Kg)	*Operation Time* (*Seconds*)	*Input* (Kg)
8	*Milling*	6	475	6.1153
7	*Drilling*	6.1153	300	6.1303
6	*Drilling*	6.1303	300	6.1453
5	Scrap	6.1453	300	6.1525
4	Scrap	6.1525	300	6.1597
3	*Drilling*	6.1597	420	6.1822
2	*Drilling*	6.1822	420	6.2047
1	Grinding	6.2047	660	6.3694

For the next part, the calculation in table 2 can be used in the same way to obtain the amount of input materials required for one part. The following table 3 summarizes the number of inputs required for each part of vise.

Table 3. Raw Material Requirements for Each Part of Vise

No	Part	Type of materials	Input (kg)
1	Base	Steel ASTM 1	6.3694
2	Clamp Body Left	Steel ASTM 2	1.71932
3	Right Brace Agency	Steel ASTM 2	1.6180
4	The clamp jaw Left	Steel ASTM 4	0.80261
5	Right Clamp jaws	Steel ASTM 4	0.8137
6	Players Board	Steel ASTM 3	2.30832
7	Lahar Agency	Steel ST37	1.4339
8	Handle	Steel ST37	1.0761

3.2. Calculation of Number of Raw Materials

At this stage, the calculation of the number of raw materials is conducted. The calculation is implemented based on the dimension and weight of raw materials available on Indonesian markets. Table 4 displays the specification of raw materials used for producing vise.

Table 4. Specification of vise material

No	Parts	Materials	Dimensions (cm)	Weights (Kg)
1	Base	Steel ASTM 1	24.4x12.2x1.5	50.21
2	Clamp Body Left	Steel ASTM 2	24.4x12.2x2.8	65.43
3	The clamp jaw Left	Steel ASTM 4	24.4x12.2x1.1	65.43
4	Right Clamp jaws	Steel ASTM 4	24.4x12.2x1.1	28.04
5	Right Brace Agency	Steel ASTM 2	24.4x12.2x2.8	28.04
6	Players Board	Steel ASTM 3	24.4x12.2x4.0	93.47
7	Lahar Agency	Steel ST37	d= 3.2. h = 15	2.13
8	Handle	Steel ST37	d= 3.2. h = 15	2.13

The calculation of number of raw material required is done by implementing the following equation 1.

Number of raw material = Total unit produced per week / (Weight of Material/ weight of part) (1)

Following is the example of calculation for determining the number of raw material for part base.

$$\text{Number of ASTM 1} = \frac{273 \text{ Unit per week}}{(50.21 \text{ Kg} / 6.369 \text{ Kg})} \quad (2)$$

$$= 39 \text{ Unit}$$

Table 5 displays the calculation of raw material number for each part of vise.

Tabel 5. The calculation of raw material number for each part of vise

Part	Input	Material	Weight	Weeks	Total unit produced Per week	Number of Material
Base	6.3694	Steel ASTM 1	50.21	52	273	39
Clamp Body Left	1.71932	Steel ASTM 2	65.43	52	273	7
Right Brace Agency	1.6180	Steel ASTM 2	65.43	52	273	7
The clamp jaw Left	0.80261	Steel ASTM 4	28.04	52	273	7
Right Clamp jaws	0.8137	Steel ASTM 4	28.04	52	273	7
Players Board	2.30832	Steel ASTM 3	93.47	52	273	6
Lahar Agency	1.4339	Steel ST37	2.13	52	273	273
Handle	1.0761	Steel ST37	2.13	52	273	273

Calculation of warehouse area can be done by multiplying the number of raw materials with the dimension of raw materials. Warehouse area is the total of area required for each part and material handling area. Table 6 shows the calculation of warehouse area for vise manufacturing.

Table 6. Calculation of warehouse area for vise manufacturing

No.	Parts	Type of Material	Number of raw materials	Dimension (cm)	Size (cm^2)
1	Base	ASTM 1	39	24.2x12.2	11,514.36
2	Clamp Body Left	ASTM 2	7	24.2x12.2	2,381.44
3	The clamp jaw Left	ASTM 4	7	24.2x12.2	2,381.44
4	Right Brace Agency	ASTM 2	7	24.2x12.2	2,381.44
5	Right Clamp jaws	ASTM 4	7	24.2x12.2	2,381.44
6	Players Board	ASTM 3	6	24.2x12.2	2,083.76
7	Lahar Agency	ST37	273	3.2 x15	13,104
8	*Handle*	ST37	273	3.2 x15	13,104
9	Iron rack	-	2	200 x 100	40,000
10	Trash can		1	45 x 30	1350
11	Hand Truck Area		1	102x63.5	6477
12	Tool Cart Area		1	138x61	8418
		Total			105,576.88

4. Conclusion

This paper demonstrates the calculation of warehouse space by considering the raw material requirements from production floor. The raw material requirement is calculated for each process required for making the part using material removal rate. However, this research does not consider the level or rack system in storing the raw material. Further research is required to consider uncertainty aspects such as the volatile of demand and the different of delivery times in the calculation of

warehouse space. The use of operation research approach might beneficial in optimizing the warehouse space.

References

[1] Lacalle L N L D and Lamikiz A 2011 Modern Machining Technology
[2] Azzam A dkk. Aplikasi Perhitungan Kebutuhan Bahan Baku Produksi Buku Lks dengan Metode Material Requirement Planning (MRP) Studi Kasus pada PT. Harapan Makmur Abadi
[3] Purnomo A 2007 Perencanaan Kebutuhan Bahan Baku dan Penetapan Prioritas Pemasok di PT. Surya Mas Abadi
[4] Supriyanto and Barus T Y 2015 Analisis Perencanaan Kebutuhan Bahan Baku dengan Menggunakan Metode MRP (Material Requirement Planning) dan Metode JIT (Just In Time)
[5] Sitepu M H, Situmorang D P, and Sembiring M T 2019 Inventory Planning at Painting Section in the Indonesian Automotive Industry *IOP Conf. Series: Materials Science and Engineering*