CHAPTER IV

DATA COLLECTION AND ANALYSIS

Data is one of most important inputs to the right decision making. Collecting data as more as can provides decision makers with sufficient feedback and information to facilitate the processes and optimize the results. On the other hand, attention should also be drawn on the analysis of data for the reason that thoroughly understanding of data helps generate the better outputs, such as cost-efficient. Therefore, this chapter will analyze the relevant and necessary data being collected for this project.

4.1 Purpose of the Warehouse

The purpose of the warehouse must be principally and clearly identified owing to its guiding position in the warehouse design. As depicted above, the focused warehouse is located in the production plant and presently serves as a raw materials storage place. By researching the Company's background and developing trend, on the other hand, it is unlikely for the Company to change its business characteristic so much in the near future. For this reason, the warehouse will continue to serve as a storage area only for raw materials of steel bars.

4.2 Raw Material Data

Warehouse serves as a place to primarily conserve goods. Undoubtedly, the items being kept are the most critical ingredient of the warehouse and their values, characteristics and functions conversely influence almost all of decisions on warehouse activities. For this reason, not knowing the amount and specification of the raw materials within the present warehouse, the material-based improving activities are incapable of going forward. As a result, the data of raw materials turns itself into one of the most vital inputs to the correct decision on warehouse solutions.

4.2.1 Decision on To-be-stored Items

As mentioned in the problem statements, since nobody is dispatched to take care of the warehouse, the stock area is used as a site to conserve any stuff. Seen from the figure 1.1, various items, including the steel stock and other mechanical components like the huge gear at the back corner, are disorderly spread on the ground. Since the warehouse is specified to only keep the valuable raw materials, necessary and useful items are imperative to be sorted from unnecessary and useless things. In another word, decide what should be kept in the warehouse.

- **Raw steel bars**

Observed from various components within the current warehouse, one sort of items must be kept in the warehouse is the raw steel bars that ***have never been processed, except being cut***. (See figure 4.1) The primary reason of keeping them is that they supply as the main resources of daily manufacturing and occupy the largest amount of Company's investment on the inventory. As a result, the huge value they possess offers as the convincible reason to conserve them.

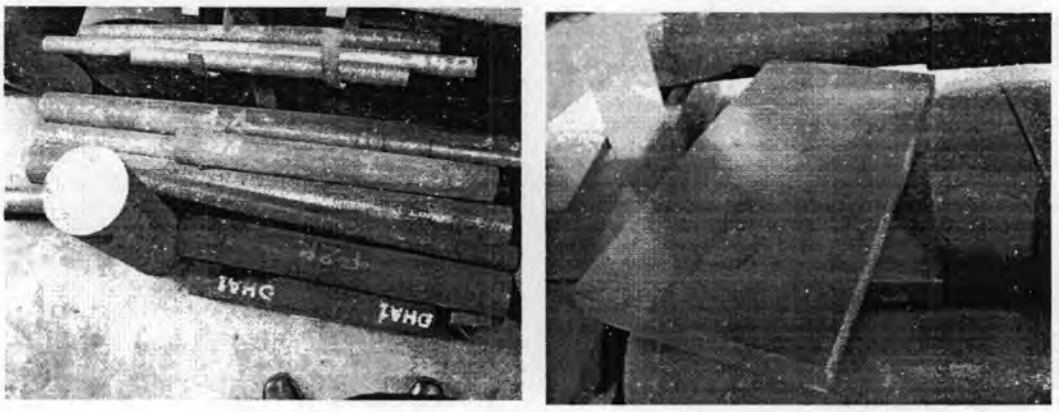

Figure 4.1: Raw steel bars

- **Ever-machined long steel bars**

Another main sort to be stored is the ever-machined long steel bars. (See figure 4.2) This represents the steel bars which have been machined, but fail to

achieve the manufacturing specifications due to the workers' mistakes or customer changing requirements. Nevertheless, they are still capable of being continuously machined to satisfy the other specifications. Take an instance. Under the lathing requirement of diameter of 98mm, one steel bar with original diameter of 100mm is carelessly lathed to 97mm, which is 1mm below the requirement. However, this over-machined steel bar has the extensive capability of being further lathed to the diametric dimension which is less than 97mm. Thus, these valuable ever-machined steel bars have to be retained.

Figure 4.2: Ever-machined long steel bars

- **Remnants**

In addition to the two main sorts identified above, the Company also decided to keep the countless tiny remnants for the reason of possible use. (Figure 4.3)

Figure 4.3: Remnants

Seen from figure 4.3, most of these items are the remaining part of the long steel bars after being cut or machined and their profiles and dimensions vary widely. Averagely, however, the length is less than 50mm. In view of the possibility that their attributes might be enough to meet the requirement of certain small products, which is able to avoid the movement and cutting of long steel bar, these remnants are saved for the potential benefits of the time- and cost- reduction.

4.2.2 Classification of Raw Materials

After the decision on necessary items being made, it is wise and essential to classify them into several groups according to certain factors or criteria. This is because that the classification helps the raw materials arrangement as well as feeds back the information for other relevant decisions.

Based on the Company's business, thus, the to-be-stored items are generally classified into three main categories, ***round steel bar***, ***flat steel bar*** and ***remnants*** in terms of ***function*** and ***appearance***. The decision of first two categories is resulted from the raw steel bars and ever-machined long steel bars discussed previously since each of them only contains round steel bars and flat steel bars. For the third one, any components failing to achieve the criteria of raw steel bars and ever-machined long steel bars automatically fall into this category. The round steel bars and flat steel bars are further classified into sub-categories in light of the ***geometrical dimension***. This will be specifically discussed in the section of storage equipment design.

4.2.3 Geometrical Dimensions

Except the remnants, due to the relatively less complexity of the raw materials in the stock area, the shape of round steel bar and flat steel bar can be explicitly illustrated by its ***cross section view***. With the assistant of 3D software, thus, the main parameters, Diameter (ØD) and Length (L) are used to describe round steel bars (figure 4.3) whereas Width (W), Height (H) and Length (L) are utilized to depict the flat

steel bars. (figure 4.4)

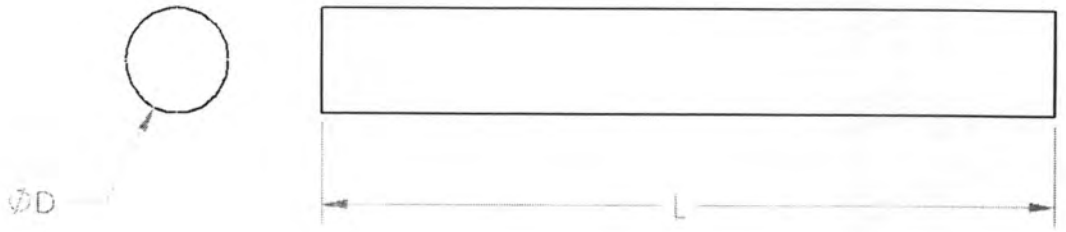

Figure 4.4: Geometrical dimension of the round steel bar

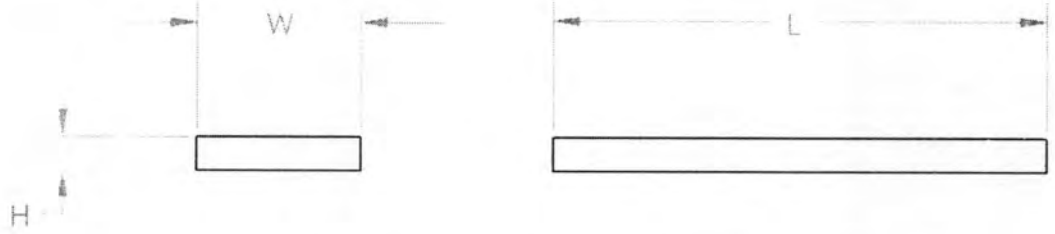

Figure 4.5: Geometrical dimension of the flat steel bar

4.2.4 Material Type

Different material types generate different mechanical characteristics. Since an extensive range of the products is demanded, the Company orders a variety of material types from its suppliers in order to fulfill different customers. Due to this fact, systemic organization of the material type is considered to be necessary since it is perceived to benefit the Company at certain aspects such as accelerating operations and avoid confusion. For this reason, statistics of the material type is conducted and the results will allow the warehouse staffs to be clear of the total amount and demand frequency of each material type so that they can prepare the systemic array of steel bars on the perspective storage equipments.

4.2.5 Weight

The weight of the raw materials must be calculated as the inputs to the proper and safe design of the storage equipments. Thus, the equation of $Weight = Density \times Volume$ is used to express the weight factor. The volume of round

bars and flat bars are calculated by the following two equations respectively. On the other hand, due to the characteristics of steel, its density is defined as 7850 Kg/m^3.

$$Volume_{Round\ Bars} = \pi \times \left(\frac{Diameter}{2} \right)^2 \times Length$$

$$Volume_{Flat\ Bars} = Length \times Width \times Height$$

4.2.6 Statistics and Analysis

Although the countless remnants make it difficult and troublesome to account, they can be roughly and approximately regarded as one certain small component which is largely different from the other two categories as well as do not influent much on the further decisions. Thus, its statistics is ignored and only current available long steel bars within the warehouse is counted in terms of their geometrical dimensions, material type, individual weight and total amount. Appendix A and Appendix B respectively display the results of the statistics of round steel bars and flat steel bars.

Summarized from Appendix A and Appendix B, there are totally 302 round steel bars and 54 flat steel bars with a variety of dimensions existing in the present warehouse. For the round steel bars, the diameter varies from 6mm to 270mm, but obviously most of them are less than 160mm. The length range extends from 128mm to 6000mm and the total weight of round steel bar is summed up to 24992.795 Kg. For the flat steel bars, the length changes from 370mm to 4900mm and total weight reaches to 2448.162Kg.

On the side of materials type, with regard to statistics of current warehouse steel bars and the historical order record (see Appendix C and Appendix D), the supplier product code and its corresponding material type which the Company frequently used are extracted and listed in Table 4.1, Table 4.2 and Table 4.3 below. Since the Company orders one type of material from different suppliers, it is better to distinguish the suppliers from one another with their product codes. The reason for the

differentiation is that the Company can easily track back to the suppliers if their materials have the problems in the manufacturing.

No.	Supplier Product Code	No.	Supplier Product Code
1	SUJ 2	9	DC 53
2	SKS 3	10	D2
3	SCM 440	11	440 C
4	SCM 415	12	8550
5	S45 C	13	3343
6	MO 40	14	2379
7	EC 80	15	2344
8	DHA 1		

Table 4.1: The supplier product code for round steel bars

No.	Supplier Product Code
1	S45 C
2	SCM 440
3	D2
4	2379
5	DC 53
6	GOA

Table 4.2: The supplier product code for flat steel bars

No.	Materials Type	Supplier Product Code	Amount for remaining round steel bar	Amount for remaining flat steel bar
1	COLD WORK 2379	D2, 2379, DC53	42	10
2	COLD WORK 2510	SKS 3	63	
3	HIGH SPEED 3343	3343	2	
4	HOT WORK 2344	2344, DHA 1	16	
5	MACHINERY 7225A	SCM 440	52	5
6	MACHINERY 7225	MO 40	10	
7	MACHINERY 7131	SCM 415, EC 80	78	
8	MACHINERY 3505	SUJ 2	15	5
9	STAINLESS 4125	440 C	8	
10	CARBON 45	S45 C, 8550	16	34
Total			302	54

Table 4.3: Material types

Concluded from three tables above, the Company totally orders 10 types of materials from various suppliers for round steel bar and flat steel bar. Some types share the similar mechanical characteristics, but with slight differences at some aspects. Thus, different number is used to distinguish them. For example, MACHINERY 7225 and MACHINERY 7131. For simplification, those types with similar mechanical character are grouped into one category such as Machinery Steel and Cold Work Steel.

With the purpose of systemically organizing the existing and future steel bars on the prospective storage equipments, it is essential to know the general occupancy rate of each group over the total amount as well. This can be done by jointly referring to the existing steel bars statistics and historical order data. For ease of explanation, the results are illustrated in figure 4.6, figure 4.7, figure 4.8 and figure 4.9

by using pie chart.

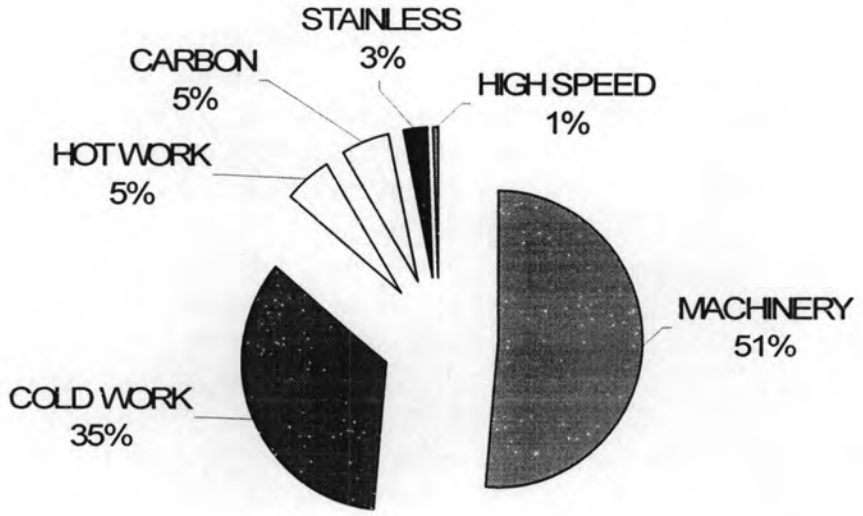

Figure 4.6: Material type share of existing round steel bars

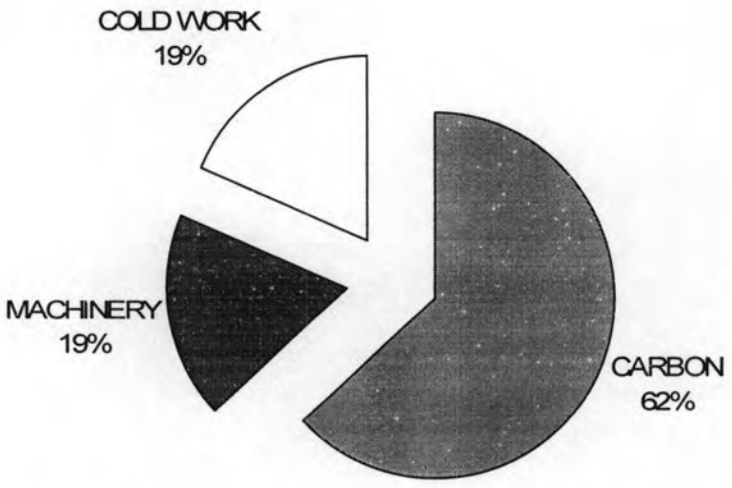

Figure 4.7: Material type share of existing flat steel bars

Observed from Figure 4.6 and Figure 4.7, in the category of existing round steel bars, Machinery Steel takes up the largest proportion of 51% and the Cold Work Steel occupies the second position with 35%. The other types jointly share the rest amount. In the category of existing flat steel bars, on the other side, CARBON Steel accounts for the largest proportion of 62% and the Machinery and Cold Work evenly share the remaining amount.

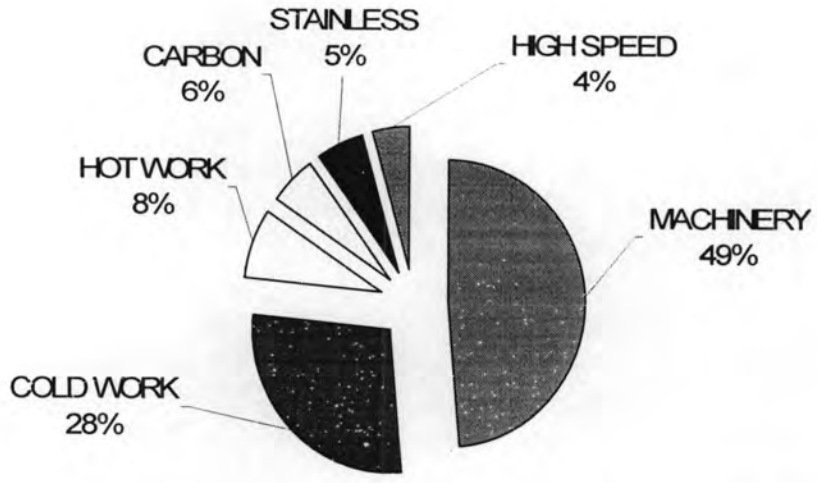

Figure 4.8: Material type share of historical round steel bars

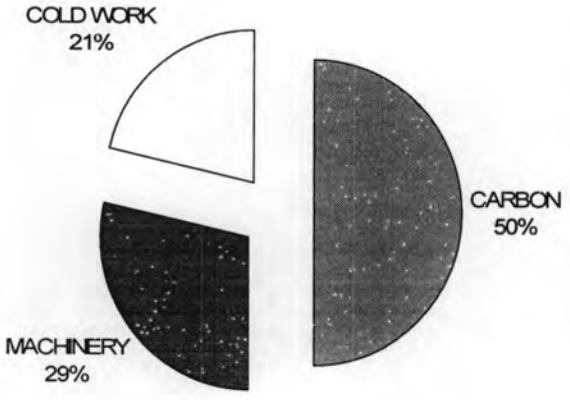

Figure 4.9: Material type share of historical flat steel bars

Judging from figure 4.8 and figure 4.9, on the side of historical order amount of round steel bars, the Machinery Steel takes the lead with 49%, which is followed by Cold Work Steel with 28%. The other groups jointly spilt the rest proportion of 23%. At the flat steel bare aspect, CARBON 45 Steel keeps the major position with 50% and Machine Steel and Cold Work Steel are the followers with corresponding proportion of 29% and 21%.

Interestingly, two sets of proportional results above are approximately identical. Additionally, the demanding frequency of each type does not fluctuate so much during the past two years. The combinative results strongly imply that the Machine Steel and Cold Work Steel, which jointly occupy between 70 and 80 percent, are main

material types the Company order for round steel bar whereas Carbon Steel, which takes up more than 50 percent, are the primary material type for the flat steel bar.

4.3 Available Resources

Although the current warehouse has been identified to be inefficient, some in-house resources are still in service and can be continuously used without replacement. Thus, in order to avoid the extra cost, the available resources with good condition should be taken full advantages as possible as can. Moreover, on the other hand, other to-be-used resources which are not current available within the Company should be taken into account.

4.3.1 Overhead Crane

The figure 4.10 below shows the Company's overhead crane. Its working area covers the whole warehouse and, in the daily warehouse operation, it shoulders the main responsibility of moving the steel bars. The crane's capacity is limited to 3 tons and it has been working in good condition since it was installed. However, the periodical maintenance and checkup are still required to avoid the potential risk and guarantee the safety. Since the crane could only sustain maximum workload of 3 tons, before the crane working, the weight of steel bars to be moved must be carefully measured in order to avoid the accident during the movement.

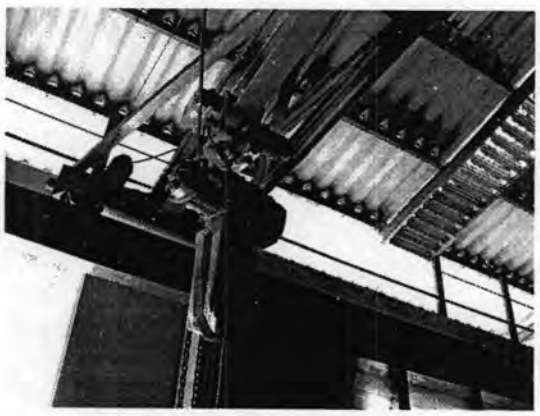

Figure 4.10: Overhead crane

4.3.2 Cutting Machine

A cutting machine partly shown at the right edge of figure 1.1 is specifically displayed in figure 4.11 below. It plays an indispensable role in the operation and employed to cut the long steel into pieces to satisfy the manufacturing requirement and easy delivery.

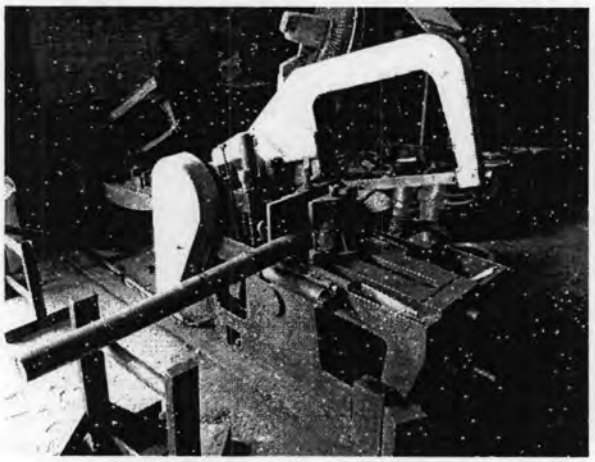

Figure 4.11: Cutting machine

4.3.3 Constructive Material

As analyzed previously, the raw materials storage equipment obviously needs to be redesigned and made. Thus, available constructive materials for perspective storage equipments have to be considered at this stage. After searching the local suppliers and balancing the cost and load capacity, the open and close square bar come into horizon. They are specifically discussed in the coming sections.

- **Open square bar**

Figure 4.12 and figure 4.13 respectively illustrate the 3D appearance and 2D specification of the open square bar. The size of the section profile is decided by height (X"), width (Y") and thickness (Z mm). The length (L mm) is able to vary, depending on the requirements. Table 4.4 shows the usual selected dimension standard of open square bar.

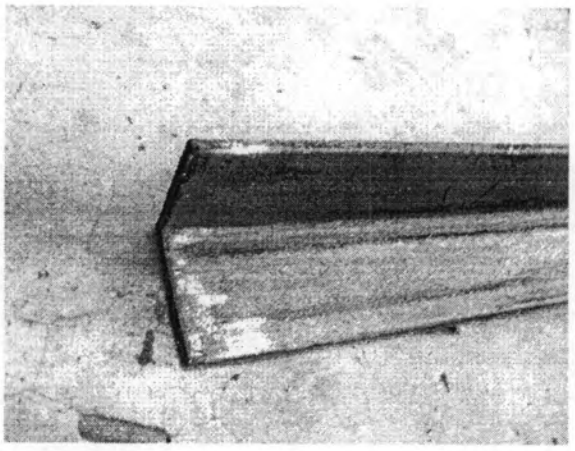

Figure 4.12: Open square bar

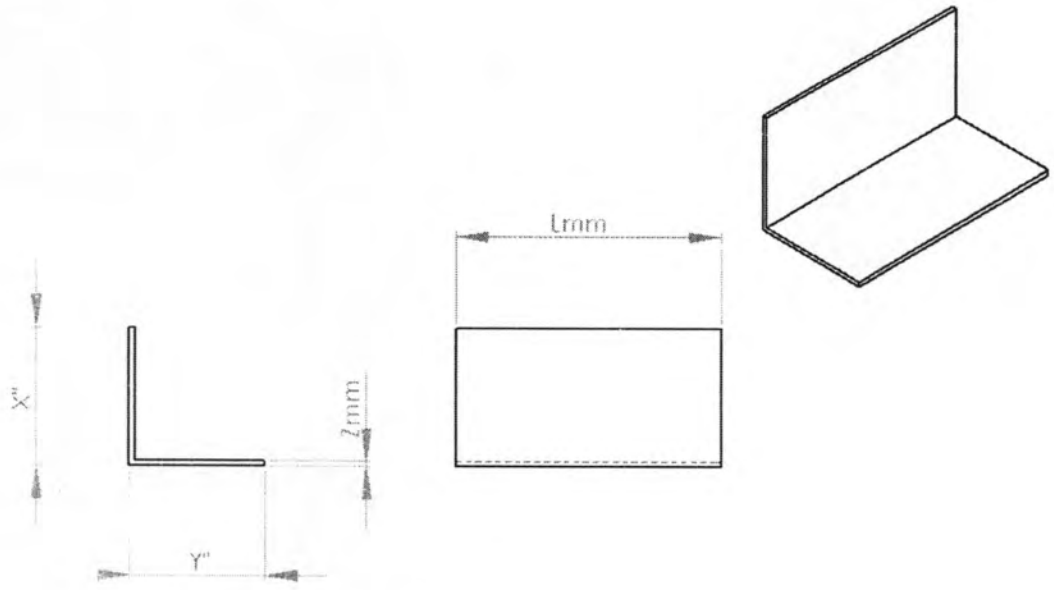

Figure 4.13: 2D specification of open square bar

No.	X"	Y"	Z mm
1	2	2	2
2	2	4	3

Table 4.4: Available dimension standard of open square bar

- **Close square bar**

Close square bar, as the name indicates, is the square bar with the close profile. Its structure is basically identical to open square bar, but it has more load capacity in comparison to its counterpart. The 3D appearance and 2D specification of close square bar are respectively illustrated in the figure 4.14 and figure 4.15. Table 4.4 displays some available standard dimensions.

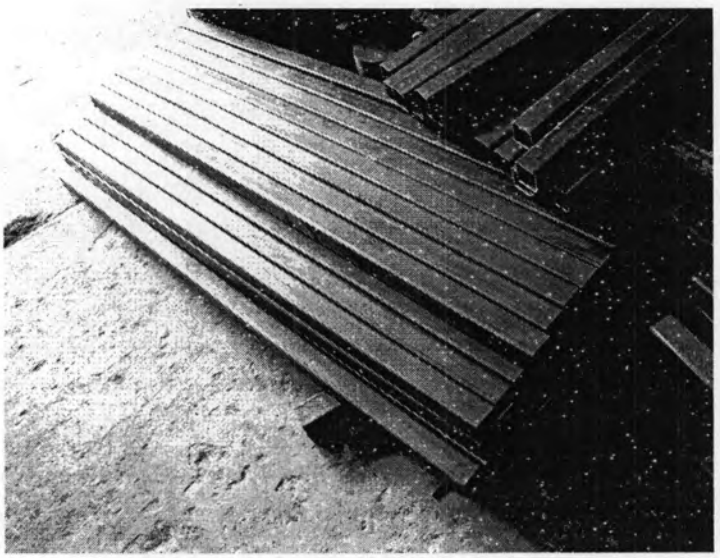

Figure 4.14: Close square bar

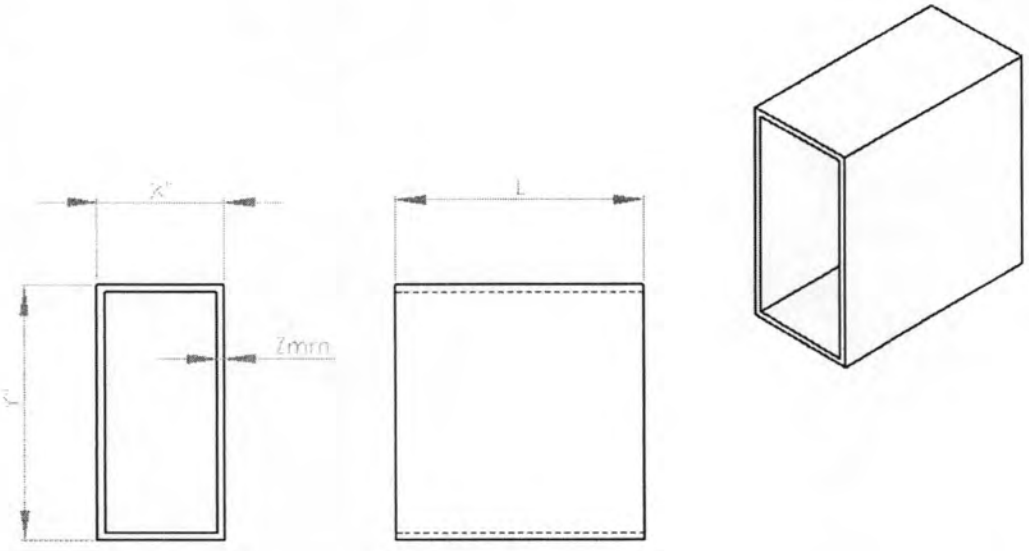

Figure 4.15: 2D specification of closed square bar

4.6 Demand Forecast

The demand forecast is required to analyze for the sake of warehouse capacity decision and it can be done with reference of the past two years' customer order data. According to the Appendix C and Appendix D, the demand trend of past two year for round steel bar and flat steel bar is illustrated in figure 4.16.

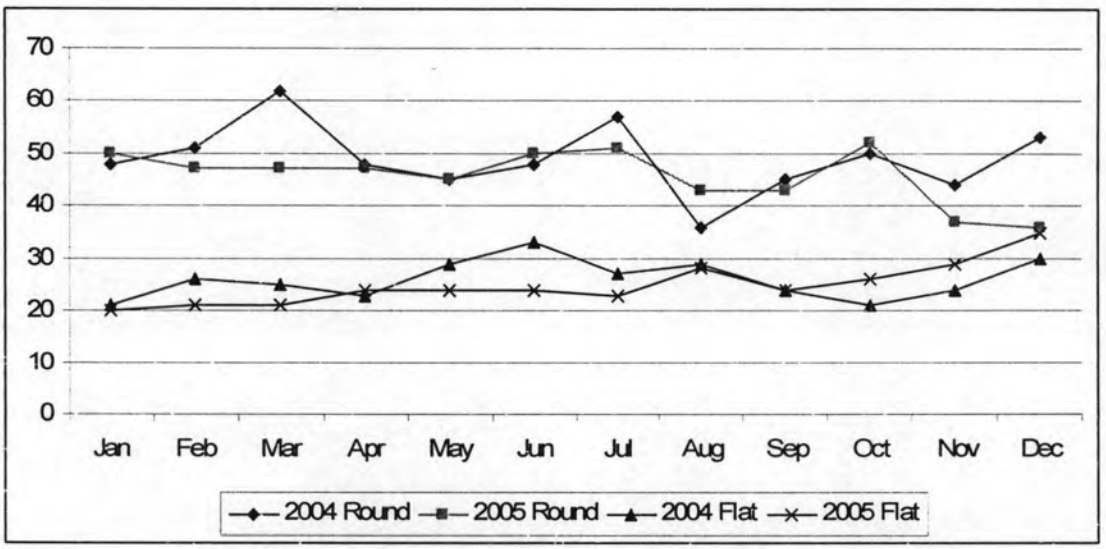

Figure 4.16: Trend of raw materials order in the past two years

Seen from figure 4.16, the customer demand across Year 2004 and Year 2005 did not fluctuate too much. The trend pattern is quite similar for each category and the changing is smooth. The round steel bar order quantity varies from 36 to 62 and flat steel bar from 20 to 35. On the assumption of stable Thai economics, there is no doubt that the demand trend will keep unchangeable in the coming years. In addition, Machinery Steel, Cold Work Steel and Carbon Steel are still expected as the high demand and the rest are the low demand.

No.	X"	Y"	Z mm
1	2	2	2
2	2	4	3
3	4	6	4

Table 4.5: Available dimension standard of close square bar

4.4 Size of Current Warehouse

The length and width of the current warehouse is measured as 10m each. Based on this, the full utilizable space within the current warehouse is calculated as $100m^2$ by multiplying the length by the width. On the other hand, however, the overhead crane is only capable of being operated within this area to move the heavy steel bars. As a result, the warehouse layout and location of all material storage equipments should be confined within this area.

4.5 Floor Strength

The floor strength has to be measured to assure whether the floor could hold so heavy raw materials. After consulting the manager, the floor strength is calculated as 5 tons per square meter. Since the warehouse is 100 square meters big, the warehouse floor strength is computed as 500 tons by multiplying 5 tons per square meter by 100 square meters. On the other hand, the weight of total current raw materials is summed up to around 27.5 tons. Comparing with the total floor strength, it is much smaller. As a result, the warehouse floor has extensive capability to uphold the load of current and future raw materials and the storage and handling equipments.