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DEVELOPMENT OF SORTING SYSTEM IN THE PLYWOOD GRADING LINE: EVALUATION OF SYSTEMS PERFORMANCE

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ABSTRACT

The main focus of this study is on the sorting method of graded plywood in the grading line. The plywood grading line is the final process in the production line. Due to the inefficiency of the sorting method, this line has low productivity, high labor usage and defective problem due to improper sorting of the plywood by the operator. The collected statistics were analyzed and the output analysis deals with drawing the comparison between the existing grading line and the built model. This study has eight aspects measured in order to achieve the objectives. They are; time study, production rate, labor cost, labor productivity, capacity utilization, defective rate, investment cost and downtime. Overall comparison for sorting graded plywood between existing system and proposed systems (pneumatic and hydraulic systems), shows that, the sorting time was reduced to 20.3% using pneumatic sorting system whereas 10.9 % using hydraulic sorting system Hence increasing the production rate by 38.9% and 32.5% accordingly.

1.0 INTRODUCTION

The slowdown in the Malaysian economy during the second half of 1997 has affected the performance of Mentiga Corporation Berhad's group. The Group recorded a turnover of RM114 million in 1997 against RM127 million in 1996, a decline of 10.2 percent. The decrease in turnover was mainly due to depreciation in world market prices of plywood. Plywood product substitute such as OSB, MDF, fibre cement and other complimentary products are gaining larger market share (Mentiga Corporation BerhadAnnual report, 1997).

In view of the unfavorable developments and difficult conditions, the Group recorded a lower turnover of RM66 million in1998 against RM114 million in 1997, a decline of 42%. Accordingly the group suffered a loss of RM 18 million

after taxation in 1998 compared to profit of RM1 million in 1997. The decrease in turnover was mainly due to stagnant market for wood namely plywood (Mentiga Corporation Berhad Annual report, 1998).

Indeed, the year 2000 has been another difficult year for the Group and the Company. The economy downturn of 1997, which had not recovered fully during the financial year, continued to affect the performance of the Group. The decrease in operating revenue achieved by the Group was mainly due to lower contributions from the manufacturing division in sale volume and lower selling prices. This is caused by the availability of cheaper plywood produced from other tropical countries like Indonesia and Brazil (Mentiga Corporation BerhadAnnual report, 2000).

According to the company daily, and monthly production report the graded plywood production rate is below the target of the company. The output rate per day is 239 pieces while the target is 351 pieces per day. It is 32% below the target. In addition, I found that the company has very high labor usage for sorting graded plywood. The average cost of these laborers per day is RM265.59 and per hour is RM33.21.

By improvising the sorting method of the system, it is the researcher's hope that the productivity will be increased and the price of this plywood product could be reduced in order to compete with other plywood product substitute and cheaper plywood produced from other tropical country.

The main focus of this study is more on the sorting method of graded plywood in the grading line. The plywood grading line is the final process in the production line. The data from the existing plywood grading line in the factory will be collected, studied and analyzed. Then several proposed methods will be developed to compare with the existing methods. The important of the study are as the exploitation of the existing system techniques in order to make an improvement for the company.

1.1 Existing Process and Problem Identification

The existing plywood grading line is used to sort the plywood into four grades. The finished plywood is firstly placed on a hydraulic platform by a forklift. There are one operator grading the plywood manually with a chalk and two other operators waiting to push the graded plywood onto the conveyor. This plywood will move along the conveyor and then pushed again by another operator to their graded line and stacked. There are six operators waiting at the grading line coded as grade 1, 2, 3 and 4. If the plywood is not graded as 1, 2 or 3 it is automatically graded as grade 4 and straight away carried towards the grade 4 stations. These six operators have to identify their graded plywood and then pushed them on to the graded conveyor line and automatically stack them (refer Figure 1). Problems identified through the existing grading line are:

1. Low productivity due to the inefficiency of the sorting method
2. High labor usage for sorting graded plywood.
3. Defective problem due to improper pushing of the plywood by the operators.

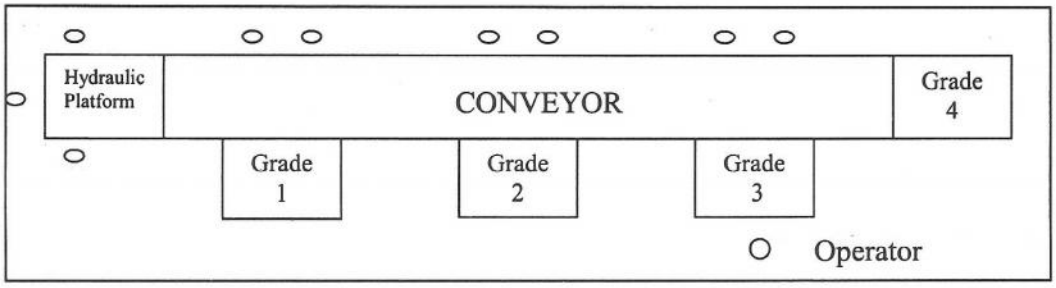

Figure 1 Grading Line Schematic Diagram.

1.2 The evaluation factors

Implementing systems for grading can be relatively complex. In a study on grading system for Malaysian pineapple by Dreyer (1970), he considered a few factors to be considered amongst them were point of grading (physical location of the grader or graders), method of loading, method of feeding, proper utilization and system maintenance. He also suggested for implementing of a system we must consider the ease of construction and repair, standardization, durability, cost, suitability that is determine by test. He also suggested that design details should be drafted after a model test. Meanwhile according to Marcus Syn (2003) the criteria that should be considered in developing a systems for grading include total cost, time, labor requirements, work in process, space requirement, quality, utilization rate, ease of operation, initial investment cost and payback period.

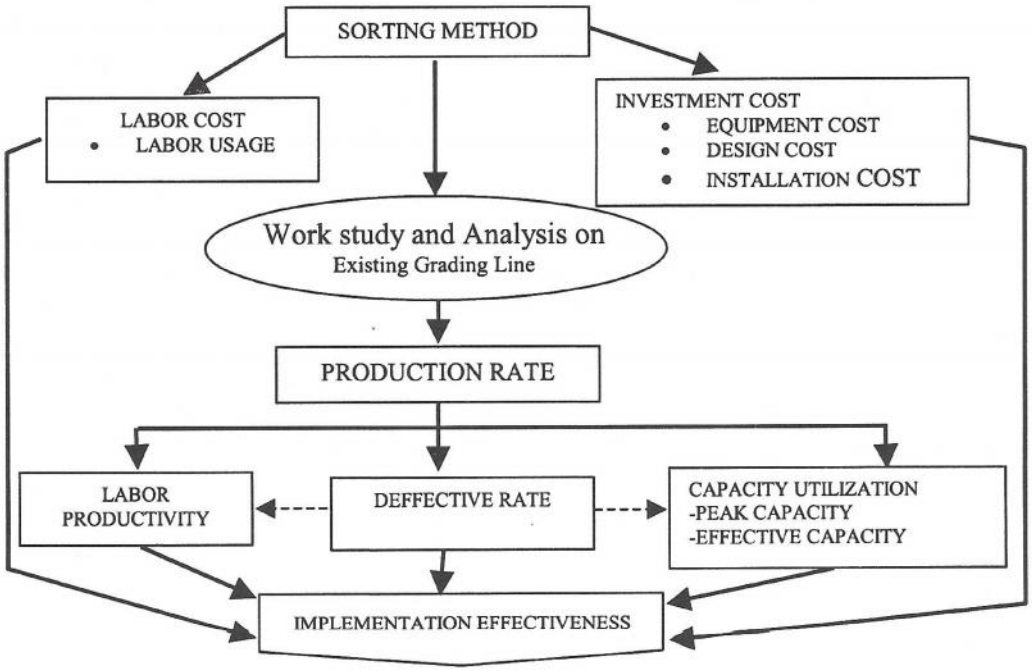

Figure 2 Evaluation factors in developing of sorting system in the grading line

After considering the factors mentioned by Dreyer (1970) and Marcus Syn (2003), Figure 2 is developing for the study. The first stage in system implementation is to choose the sorting type and develop a sorting method. The values of all of the factors mentioned in the Figure 2 will reflect the effectiveness of the system.

2.0 THE DESIGNING FACTORS OF A GRADING SYSTEM

Changeover from one type of production to another can be relatively complex decision for organization. One of the biggest factors to consider is initial investment cost. It can cost a company a great deal of money to restructure their entire plant in order to start this type of process (Marcus Syn, 2003).

A recent study at a Mississippi sawmill showed an automated grading system could result in a potential 3.8 percent value uplift from correcting conservative grading. For a softwood sawmill producing $60 million of lumber annually, this would result in increased annual revenues of more than $2 million (Forest and Wildlife Research Center, 2002).

In addition to the capital investments made in machinery, Nordic Veneers whose coming out of the recession, implemented an incentive plan and bonus system based on production and recovery (Shell, 2002). They brought the crew together and gave them a stake in the success of this business, and ever since then they have been on a mission to become more efficient, productive and better meet the needs of their customers. Shell also reported that Nordic emphasizes that the bonus system truly motivates the employees to get the most out of tools and technology they are given. Arts the sales and accounting manager of Nordic Veneer emphasizes that " you can have the best technology out there, but unless the employees are motivated you won't get the results you're looking for". Nordiac always looking for better ways of doing things that are designed to increased production or make some process easier. Arts also says that ' A lot of times when we go look at a new piece of equipment we'll take our operators so they can get a feel for what the equipment does and we can talk about the potential gains or improved maintenance costs we can get". Nordic always looking to the future, the next areas scheduled for upgrade.

I found that one of the biggest or main factor to be considered in developing of the new sorting system in the grading line is the investment cost. But however the others factors which is not less important by the researcher is the point of grading, capacity of grader, type of grader, method of sorting, proper utilization and system maintenance, flexibility to be maintained, required capacity and grader capacity, ease of construction and repair of the system, standardization, durability, and suitability that should be determined.

3.0 METHODOLOGY

3.1 Data Collection on Existing System

The most time consuming of the entire steps is to gathers relevant information regarding the system to be studied. The data collected includes the company daily production report, and monthly production report and also from the daily grading and defective report of three months in a row. The total operational days for these three months were 61 and total working hours were 421, broken into hours worked per day are seven and a half hours per day.

Information has been collected through interviews with the company production engineer and production supervisor. All these information and data are then analyzed which will be discuss later in the chapter. Data for the timing of the plywood from the beginning to its grading station also will be obtained over a significant time period to provide an accurate picture of the operation.

3.2 Model development

The first step in developing the sorting system involves examining the existing system characteristics in order to determine the possible system to be developed, creating flow diagrams and process charts, and simulation. Through the literature review two models were chosen are Pneumatics (Model 1) and Hydraulics (Model 2) system.

In developing Model 1 and 2, simulation is done through the simulation software (PneuSimPro). The software shows object-oriented graphical simulation of the system. Through this software the circuit drawn can be verify the functionality. Then the steps involved were creating the logic programming (ladder diagram), pneumatic and hydraulic circuit diagram, physical design and developing steps. The ladder diagram for both models is design by using the Programmable Logic Controller (PLC) software (Fpsoft). In addition the develop model for pneumatic system is a fabricated model which shows the actual flow of the system. For the hydraulic system the model is done through the hydraulic training board, which also the movement can be simulated. Once completed, the model was run and general statistics were collected.

Output analysis deal with drawing the comparison about the existing grading line and built model. The ability to draw correct comparison from the results is essential for making system improvements.

4.0 RESULTS AND DISCUSSION

4.1 Standard Time for Distributing Graded Plywood

From Table 1 the standard time for distributing and sorting the graded plywood is cut down by 20.3% with the pneumatic sorting system and 11.7% by hydraulic sorting system. This improvement means that the sorting time has been reduced and it becomes more efficient. The reduction of the sorting time will definitely

increase the production rate of the graded plywood more than 20.3% for pneumatic sorting system and more than 11.7% for hydraulic sorting system because this system can run for nine hours straight without rest compared to the existing system. These differences in time can be seen more clearly in Figure 3.

Table 1 Comparison of the standard time for sorting and distributing graded plywood

		Proposed	System
Process / System	**Existing System (s)**	**Pneumatic System (s)**	**Hydraulic System (s)**
Sorting to grade 1 station	20.992	16.73	18.533
Sorting to grade 2 station	23.04	18.73	20.536
Sorting to grade 3 station	25.088	20.74	22.54
Sorting to grade 4 station	22.098	20.11	20.01

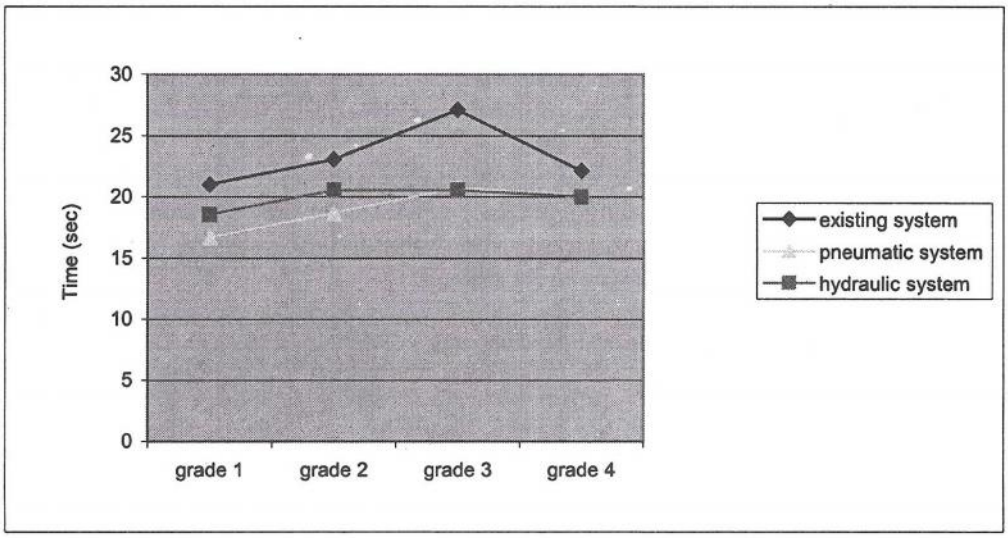

Figure 3 Comparison of the sorting time for graded plywood.

4.2 Production Rate for Sorting Graded Plywood

The sorting time has been reduced through the proposed systems. This improvement affects the production rate. According to the time study analysis, the production rate of the existing system is improved by 16.48 % with the proposed pneumatics system and 10.34% by the hydraulic system (refer Table 2 and Figure 4).

With the existing system the production rate is 20.43% below the target. With the pneumatic sorting system and hydraulic sorting system the production rate is 11.26% and 5.41% above the target.

Table 2 Graded plywood production rate on the existing and proposed systems

	PER HOUR		PER DAY		PER MONTH		PER YEAR	
	OUTPUT (unit)	TARGET (unit)	OUTPUT (unit)	TARGET (unit)	OUTPUT (unit)	TARGET (unit)	OUTPUT (unit)	TARGET (unit)
EXISTING SYSTEM	261	328	1,957	2,459	39,123	50,005	469,476	600,067
PNEUMATIC SYSTEM	304	328	2736	2,459	55905	50,005	670867	600,067
HYDRAULIC SYSTEM	288	328	2,592	2,459	5,3136	50,005	637,632	600,067

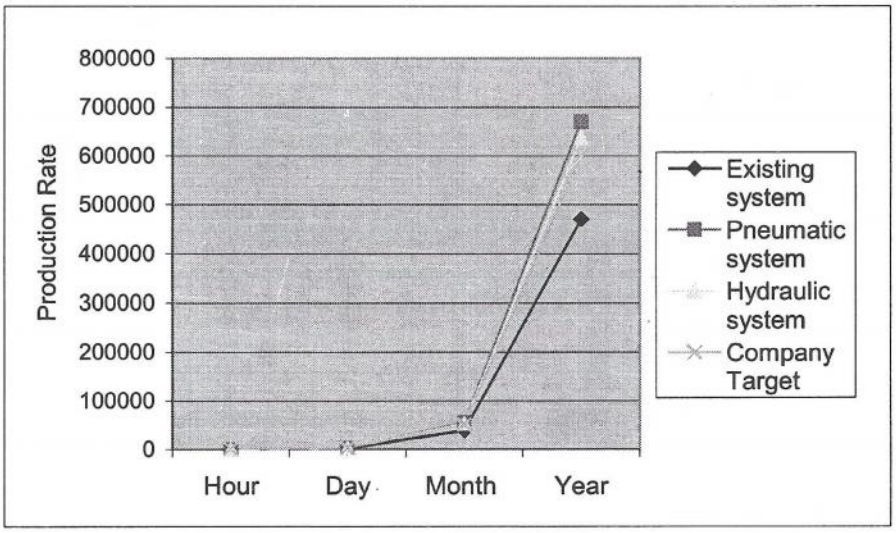

Figure 4 Graded plywood production rate on the existing and proposed systems.

4.3 Labor Cost and Labor Productivity for Sorting Graded Plywood

Through the existing system, the method of sorting the graded plywood is done manually, which involved nine operators. Through the proposed systems, only one operator is needed to do the grading and controlling the system.

The labor cost for an hour work with the proposed system is RM 3.69 meanwhile the labor cost with the existing system is RM 33.21. This shows the labor cost between existing and proposed system has been reduced at about 88.88% (refer Table 3). The company can save almost RM 57,654.80 a year of labor cost with the proposed system.

Table 3 Average of labor cost on the existing and proposed grading line.

	LABOR COST			
	PER YEAR (RM)	PER MONTH (RM)	PER DAY (RM)	PER HOUR (RM)
EXISTING SYSTEM	64,861.65	5404.50	265.59	33.21
PROPOSED SYSTEM	7206.85	600.57	29.51	3.69
COST REDUCED	57654.80	4803.93	236.08	29.52

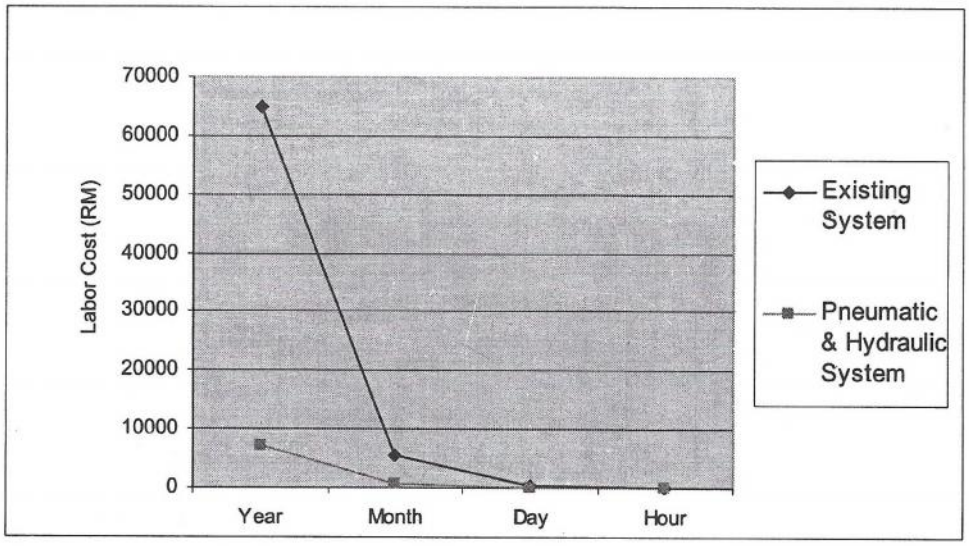

Figure 5 Labor cost on the existing and proposed models.

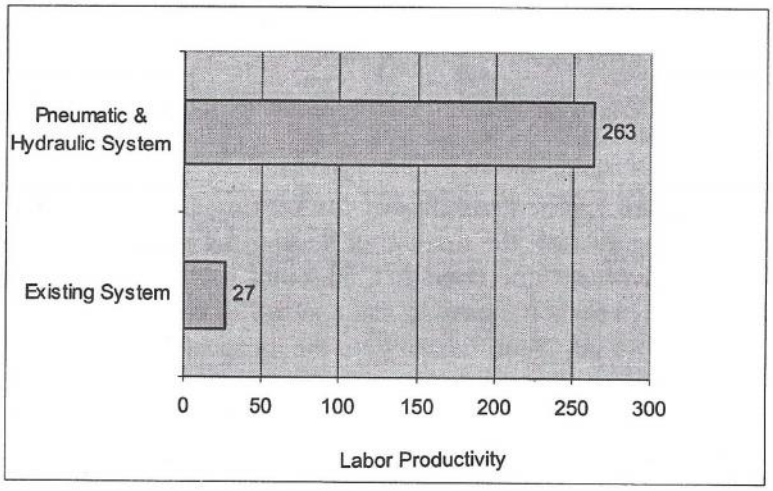

Figure 6 Labor productivity on the existing and proposed grading line.

Labor productivity is the ratio of the value of output to labor hours. The labor productivity for the existing system is 27 and 263 for the proposed system (refer Figure 5 & 6). This shows that with the proposed system the labor productivity has been increased 9.7 times compared to the existing system. Increasing of labor productivity will also increase the production rate.

4.4 Capacity Utilization for Sorting Graded Plywood

Through the existing system the peak utilization and effective utilization of the system is only 79.6% after considering that the peak capacity and effective capacity is the company's target production rate (refer Table 4). Meanwhile with the proposed pneumatic system the peak utilization and effective utilization is 111.3%. For peak utilization and effective utilization of the proposed hydraulic system is 106.4% (refer Figure 7).

Table 4 Systems Peak Utilization and Effective Utilization for sorting graded plywood

Systems	Peak Utilization (%)	Effective Utilization (%)
Existing System	79.6	79.6
Pneumatic System	111.3	111.3
Hydraulic System	106.4	106.4

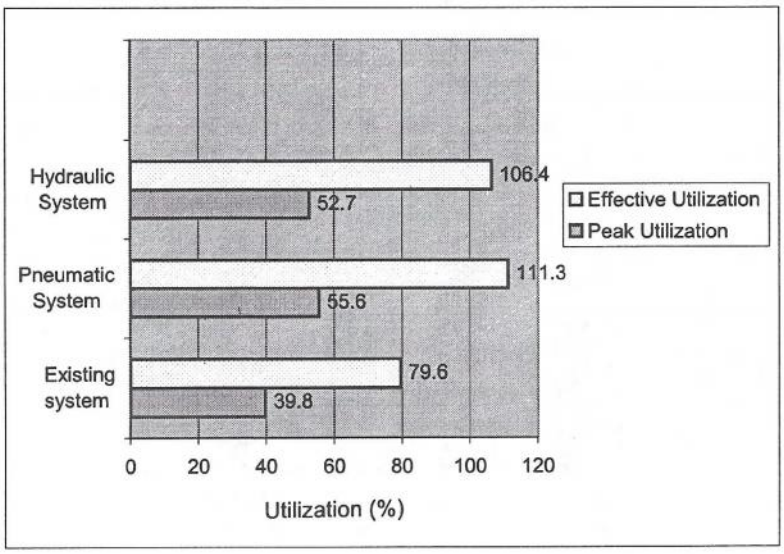

Figure 7 Peak Utilization and Effective Utilization of the sorting systems

4.5 Sorting Systems Effectiveness

Overall comparison for sorting graded plywood between existing system and proposed systems (pneumatic and hydraulic systems), is shown in Figure 8. Through the proposed system, the makespan for sorting graded plywood were reduced to 20.3% by pneumatic sorting system and 10.87 % by hydraulic sorting system. It means that the sorting time is cut short ad the sorting time of the graded plywood to their relative station is faster and more efficient than the existing system. Hence increasing the production rate by 38.91% through pneumatic sorting system and 32.45% through the hydraulic system.

Through the existing system there are nine operators needed to sort the graded plywood, meanwhile through the proposed system only one operator is needed, therefore, the labor productivity improved by 9.7 times and the labor cost are reduced by 88.88% through both proposed systems compared to the existing system.

The utilization rate indicates the need for adding extra capacity or eliminating unneeded capacity. From the proposed pneumatic system the peak utilization is improved by 31.7% from the existing system and the peak utilization for hydraulic system is also improved by 26.8%. For the effective utilization through the pneumatic system it is improved by 15.8% and through the hydraulic system it is improved by 12.9%.

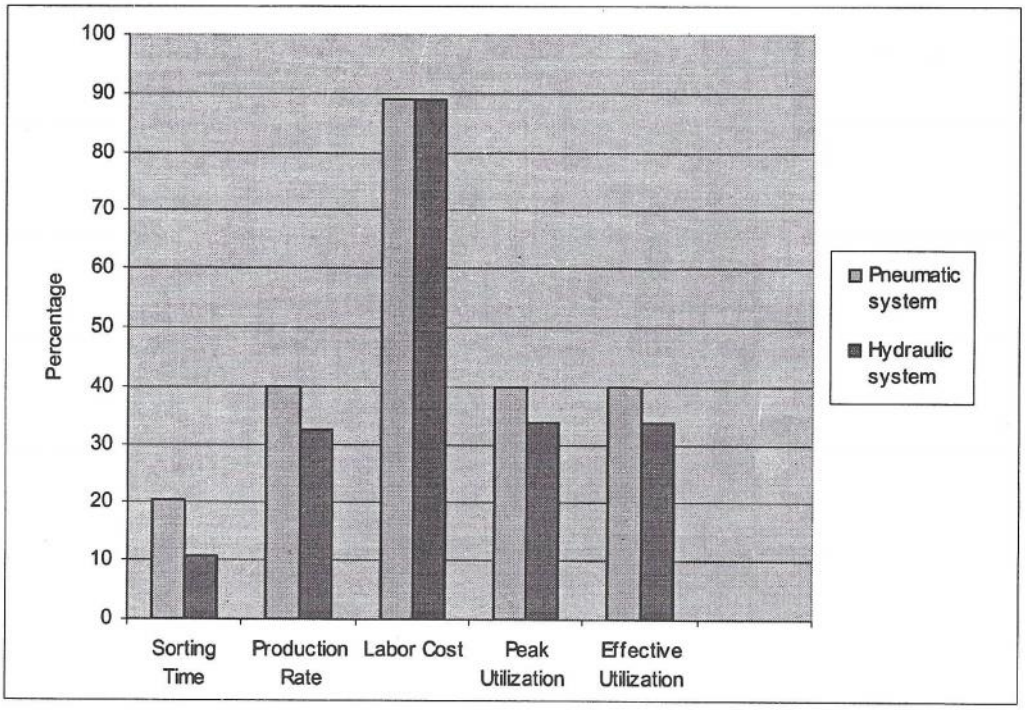

Figure 8 Overall comparison for sorting graded plywood between existing system and the proposed systems

5.0 CONCLUSION

From the study the method of sorting in the existing sorting system is outdated and not productive. It is observed that most errors occur such as denting caused by improper pushing and also fatigue allowances that affect the sorting efficiency if compared to the pneumatics and hydraulics proposed sorting systems. Another increasingly important factor in processed operations is accelerating technological change. The trend in managing processes has been an increasing emphasis on competing on the basis of quality, time, and technological advantage. Inefficiency of the existing sorting system gives lower production rate, higher labor cost, lower labor productivity, low in capacity utilization and increase in defective rate to the company.

Pneumatics proposed sorting system is the best choice for the company; the improvement in the throughput is obvious compared to the existing sorting system and hydraulic sorting system in term of the ease of construction, efficiency and safety. The investment cost is also not as high as in hydraulic sorting system and will be covered in a short term.

The way processes (production) are managed plays the key role in productivity improvement. The challenge is to increase the value of output relative to the cost of input. With the pneumatic sorting system the processes can generate more output and better quality while reducing the use resources using the same amount of input. This will end up with increase in productivity.

5.1 Recommendations and Future Research

Another study can be carried out through this grading line is the grading systems. The skill and experience worker does the existing grading system manually. This could be change by using vision base system. Then the output of the vision can be link to the automated proposed sorting system. This will make the system completely automated from the grading process to the sorting stage.

REFERENCES

1. Dan Shell .2002. Small Veneer Producer Maintains Viability, Meets New Market Needs. Panel World Magazine, May 2002. 18-23.
2. Dreyer, J.A .1970. Grading System For Malaysian Pineapple: Food Technology Research & Development Center of Malaysia.
3. Forest & Wilidlife Research Center .2002. A hybrid decision support system for automated egg grading. http:// www.cfr.msstate/fwrc.htm (August 15 2002).
4. Marcus Syn..2003. Flexible Manufacturing Systems. Industrial Automation Asia Journal: Manufacturing Automation, Instrumentation & Process Controls, Dec02/ Jan 2003, pp22-23.
5. Mentiga Corporation Berhad Annual Report .1997.

6. Mentiga Corporation Berhad Annual Report .1998.
7. Mentiga Corporation Berhad Annual Report .1999.
8. Mentiga Corporation Berhad Annual Report .2000.