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Lean Assessment in Selected Furniture Manufacturing Companies

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Abstract: Malaysian furniture industry is facing striking issues relating to raw materials supply, workforce and sustainability. Strategic practices such as lean manufacturing will help the industry to stay competitive in global markets. However, lean practices are fairly new in Malaysian furniture manufacturing industry. So, this study is intended to assess lean status of selected companies in furniture manufacturing industry. Six companies located in Johor state were chosen as case study samples. Lean assessment tool developed by Strategos Incorporation was used to assess lean practices from nine key areas of manufacturing, namely: inventory, teams, process, maintenance, layout, supplier, setup, quality, and production control and scheduling. Data from the assessment questionnaire then keyed-in to an Excel template to calculate the results. The result of the assessment then visualized into a "radar chart". The radar chart will impart the actual lean status verses the presumed lean accomplishment of the company. In general, lean is taking place in furniture manufacturing industry. From the nine keys area of manufacturing, on average, furniture manufacturing industry performs well in team approach, maintenance, setup and layout and handling. Other five key areas particularly quality and suppliers did not accomplish targeted lean status. Suggestion from this study is lean practices in furniture industry need some modifications from automotive originated lean due to distinctive character of the industry.

Keywords: Lean manufacturing, Lean assessment, Furniture manufacturing industry

1. Introduction

Furniture industry and its sub-sectors continues to be a significant contributor to the Malaysian economy. Malaysia is currently among world's top ten furniture exporters, of which 80 per cent is wood-based. By 2022, Malaysia targets to be amongst world's top five furniture exporters.

Its main oversea markets are the USA, EU, Japan, and Australia. The industry includes over 3,500 predominantly locally-owned companies that are concentrated in Johor, Selangor, and Pulau Pinang

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(MIDA, 2017). The wood & wood products and furniture & fixtures industry is moving up the value chain, diverting from focusing on primary processing activities and the production of generic products. Home-grown companies are now distinguishing themselves, by becoming Original Design Manufacturers (ODMs) and Original Brand Manufacturers (OBMs). These companies are producing high value-added furniture with exclusive and creative design aesthetics. This allows Malaysian furniture manufacturers to keep growing despite the challenge of stiff global competition.

A possible area of the industry enhancement is the establishment of a centralized furniture hub, where all industry-related activities, including designing and training, are located within nearby locality for the benefit of all industry players. Incentive could also be granted to companies adopting new technology such as automation and modernization, in preparation for Industry 4.0. These efforts aim to accelerate the achievement of the National Timber Industry Policy (NATIP) by 2020.

1.1 Research Background

In order to keep rising to the challenge of stiff global competition, Malaysian furniture industry need to implement and adapt to a number of strategic practices to enhance quality, improve productivity and to reduce costs. The use of Lean practices has proven to achieve these objectives. Lean implies production and operations without waste. In manufacturing, waste can be translated as everything that is unnecessary and add no value throughout the production and manufacturing processes of a product.

Value can simply be defined as something a customer is willing to pay to receive. If a customer is not willing to pay for it, then there is no value. Waste in production has seven types: waste from overproduction, waste of waiting time, transportation waste, inventory waste, processing waste, waste of motion, and waste from product defects. Taj (2005) claimed that most companies waste 70-90 percent of their available resources. Even the best lean manufacturers probably waste 30 percent. Interestingly, every company has to find its own way to implement the lean practices and there is no common technique that will suit to all. Even though the lean idea and concept is widespread, many companies are struggling to stay “lean”.

1.2 Problem Statements

Despite the compelling growth of the furniture industry in Malaysia, there are many evolving impediments that are already affecting the future development of the industry. Among the prominent issues are shortage of raw materials supply and workforce (Ratnasingam & Ioras, 2013; Yimie, 2017). Malaysian furniture industry also has the issue relating to sustainability. The adoption of green manufacturing is limited among furniture manufacturers as well as the raw materials of the furniture industry is not really come from environmentally certified sources. Sustainable product design also still very new concept to furniture industry in Malaysia. Of all these, it demonstrates that lack of clear vision for sustainability in Malaysia furniture industry and sustainability is not priority in furniture companies (Valipoor & Ujang, 2011).

To ensure the continuous success in furniture industry, local furniture manufacturers are encouraged to produce high value-added products such as green invention, functionality, and better design (Bernama, 2019). Furthermore, improvement in quality, reduce production time, replace low skilled job also encourage by the government. Therefore, the use of high technology, automation, and lean manufacturing can help in produce high quality product and increase competitiveness.

While, Lean Manufacturing is an approach that is prevailing in manufacturing society these days when it comes to accomplishing positively effective improvements in manufacturing operations. Therefore, lean manufacturing implementation is an effective way to manage the organization resource effectively. The use of lean manufacturing helped to minimizing costs, delivery time, and the use of resources (Nunes & Azevedo, 2018). Therefore, manufacturing companies are implementing and

adapting to a number of strategic practices to enhance quality and improve productivity to remain competitive and reduce costs. The use of Lean practices has proven to achieve these objectives.

Lean is a concept originated from automotive industry but has been widely disseminated to varoius manufacturing industry as well as service industry. Despite its extensive acceptance in numerous industries, its application in furniture industry is found to be limited (Abu, Gholami, Mat Saman, Zakuan, Streimikiene, 219). In response to the lack of lean implementation in furniture industry, this study intends to evaluate lean status of selected furniture manufacturing company in Johor. This assessment helps to investigate, evaluate, and measure nine key areas of manufacturing. The result is a deeper understanding of key issues, problem areas, and potential solutions.

1.3 Research Questions

What is the lean status of selected furniture manufacturing companies?

1.4 Research Objectives

To measure lean status of selected furniture manufacturing companies. Lean status is measured from nine key areas of manufacturing operations in selected furniture manufacturing companies. By performing the assessment, their lean status is known whereby a deeper understanding of key issues, problem areas, and potential solutions can be identified particular from the perspectives of furniture manufacturing industry.

1.5 Significance of the Study

Lean assessment is one of the practice and strategy for an organization to remain competitive on the market such as continuous improvement, cost efficiency, improving productivity and human resources. This research can help the furniture manufacturing industry to identify their lean level particularly in nine key areas of manufacturing operations. Lean assessment used in this study will calculate the difference between the actual lean and the targeted achievement level. By knowing their lean status in lean journey, furniture manufacturing companies able to plan appropriate strategies to enhance lean status.

1.6 Scope of the Study

This study involved multiple case study in which 6 companies were selected to measure their lean status. The samples for this case study were selected from furniture industry in Johor since Johor is the state where furniture industry concentrated most. Then for lean assessment, the scope of this lean assessment involved nine key areas of manufacturing operations that are inventory, teams, process, maintenance, layout, supplier, setup, quality, and production control and scheduling.

2. Literature Review

Lean manufacturing can be defined as elimination of waste or non-value adding activities that are not necessary to satisfy customers' demand (Hussain & Malik, 2016). The primary objective of lean manufacturing is to help the company to provide the product or service that are exactly need by their customer. Any potential wastages are identified and eliminated in order to achieve low production cost and high standard of product quality.

2.1 Review of Lean Assessment Tools

There are a number of popular lean assessment tools that can be traced from the literature. Ihezie and Hargrove (2009) evaluate four lean assessment tools that can be used in their study. The lean tools are compared and contrasted to justify the selection of a specific tool. The selection criteria are based

on the usability of the assessment tool, metric, familiarity, detail, and affordability. The four lean assessment tools are being considered are as follow:

(i) Lockheed Martin Lean assessment tool developed by Lockheed Martin Corp.

(ii) Throughput Lean assessment tool developed by Throughput Solutions

(iii) Shingo Prize Model developed by Shigeo Shingo

(iv) Strategos Lean assessment tool developed by Quarterman Lee at Strategos Inc.

Usability is whether the tool is easy or difficult to use. According to Ihezie and Hargrove (2009) observation, Strategos Lean assessment tool is the easiest to understand and to use.

Computer-based metric is second criterion for the tool selection. Computer-based metric is the ability of the tool to generate performance metrics as needed, as well as be computer-based. Familiarity is whether the tool is familiar to the company that implement lean program. Detail is whether the tool will cover essential areas of manufacturing operations such as inventory, processes, maintenance, quality of product, etc. Affordability is whether the assessment tool is cost-effective and affordable.

From their evaluation, Ihezie and Hargrove (2009) suggest that Strategos lean assessment tool developed by Quarterman Lee from Strategos Inc. is most appropriate tool to be used and fulfil all the criteria mentioned above. Taj (2005) also use lean assessment tool by Strategos Inc. in his assessment of lean in Chinese high-tech industries.

3. Research Methodology

This study aims to comprehend the lean status of selected furniture manufacturing companies in Johor. To measure the status, the Strategos Lean assessment tool developed by Quarterman Lee at Strategos Inc. is used. The tool contains questions of nine key areas of manufacturing operations namely: inventory; team approach; processes; maintenance; layout/handling; suppliers; setups; quality; and scheduling/control. Each area has about three to six questions. Data from the questionnaire then key-in to an Excel template to calculate the results. The result of the assessment is then visualized into a “radar chart”. The radar chart will impart the actual lean status verses the presumed lean accomplishment of the company.

Below is brief explanation of questions being ask for each area of manufacturing operations in the questionnaire.

Inventory: In lean setting, the inventory turnover ratio is should be at the value that not far of the industry average. Questions about inventory intend to measure the frequency of the inventory in the organization is sold and replaced over a period.

Team Approach: Lean practice promote teamwork. Inclusive organizations match with lean concepts. In an inclusive organization, the employees are important and valuable resource to the organization. Both employees and management work together to accomplish company goals. In this aspect, the questions asked measure the organizational culture; the working environments and connection between management and employees in the company.

Processes: In this respect, lean assessment tool intends to gage the leanness of organization’s production processes. Lean companies that manufacture many products operate best when each product or product group has its own equipment with capacity suits the production needs of that particular product or group. This is to avoid problems in changeover, scheduling, handling and quality.

Maintenance: Maintenance aspect assesses the manufacturing system maintenance methods, machine downtime and uptime and the rigorousness of preventive maintenance in the organization. In lean environment, preventive maintenance is highly emphasized upon, since losing any equipment due to unexpected downtime in a cell would result to stopping the operation in that cell which is a cost.

Layout & Material Handling: The questions in this area evaluate the space allotted to inventory, form of plant layout, and material movement around the facility. A poor factory layout and the resultant material handling can create difficulty and significant waste in a production process. Layout also reflects the effectiveness of other factors such as purchasing and the company's scheduling policy.

Suppliers: In a lean company, its supply chain uses trustworthy suppliers in long-term relations; trusted suppliers deliver high quality parts at a competitive price and on time delivery. Strategoes lean assessment assesses the kind of rapport the organization has with its supplier. More than one supplier for a single part is an indicator of lack of trust that is probably based on poor past performance.

Setup: The questions in setup dimension assess the average time taken for setting up major equipment before being used for production. This area of lean also measures the effort that has been done by management to reduce setup times and also if setup performance is taken into account by management.

3.1 Research Design

In order to achieve the objective of this research, the research is design to employed multiple case study. Findings from single case study is not enough to draw conclusion about the lean status of furniture manufacturing industry which is the population of this study. Multiple case study can provide much broad perspectives of the lean status and its trends in the industry. In this research, Furniture manufacturing industries in Johor state were selected as samples. 10 companies are selected to participate in this study. The targeted respondents are executives, engineers or managerial level from production department which typically the department that responsible to manage manufacturing operations in a company. who had lean knowledge or responsible to lean practice in the industry.

The instrument used in this study is assessment questionnaire adopted from lean assessment tool developed by Strategos. Inc. The assessment questionnaire consisted of 4 section, section A and B are question regarding demographic of company and respondent, section C is data for "strategic impact factor(SIF)". SIF is value in percentage set by the company for each nine key areas of manufacturing operations. Total SIF value for the nine key areas of manufacturing operations is 100%. Each key area of manufacturing has different priority to different companies. Bigger percentage of SIF value reflects the area is relatively important in relation to the others. Section D is questions regarding lean practices in nine key area of manufacturing operations.

3.2 Data Collection

Prior to the distribution of lean assessment questionnaire, the selected companies to participate in this study were contacted by phone call. They were brief about the objectives of this study and were asked about their willingness to participate in this study. They are convinced this research is solely for academic purposes. They were also being briefed about the lean assessment questionnaire. Total are 10 companies agreed to participate. The reason that Johor state selected as target sample is because furniture manufacturing is highly concentrated in Johor (Ratnasingam, 2017). Then lean assessment questionnaire was email to them. But unfortunately only 6 companies were responded.

3.3 Data Analysis

Upon receiving feedback from respondents, the SIF value and the answers to the questions for nine key area of manufacturing operations keyed-in into Excel template to generate a score worksheet and lean profile chart. Figure below shows the score worksheet that will generate from the assessment. The first column is the nine key areas of manufacturing operations. The second column is section point, which is the total score for each key area. Every question in each area will score from 0 to 4 points (Each area has about three to six questions). Each question will have 3 or 5 choices of answer. The first answer will score 0 point and the last answer will score 4 points. For questions that have 5 choices, first answer will earn 0 point, second answer will earn 1 point, third answer will earn 2 points, fourth answer will earn 3 points, and fifth answer will earn 4 points. While the question with three choices, the first answer will get 0 point, second answer will get 2 points and third answer will be 4 points.

Third column shows the number of question in each key area of manufacturing operations. As developed by Strategoes, Inventory has 3 questions; team approach has 6 questions; processes have 6 questions; maintenance has 5 questions; layout/handling has 5 questions; suppliers have 5 questions; setups have 3 questions; quality has 4 questions; and lastly, scheduling/control has 3questions.

The fourth column shows the section average which was calculated by dividing the section point (value in second column) with the number of questions in that section (value in third column). The fifth column show the section percentage which was calculated by dividing the section average by 4, which is the maximum possible score.

The sixth column shows the strategic impact factor (SIF) which set by the respondents based on their preference. The sum of SIF should be equal to 100 percent. The last column is section target, which was calculated by dividing the SIF with the highest percentage of a section in SIF column.

Table 1: Lean assessment score worksheet

SECTION	SECTION POINTS	# OF QUEST	SECTION AVG	SECTION %	STRATEGIC IMPACT FACTOR	SECTION TARGET
1.0 Inventory	0	3	0.00	0%	12.0%	92.3%
2.0 Teams	0	6	0.00	0%	11.0%	84.6%
3.0 Process	0	6	0.00	0%	11.0%	84.6%
4.0 Maintenance	0	5	0.00	0%	8.0%	61.5%
5.0 Layout	0	5	0.00	0%	11.1%	85.5%
6.0 Supplier	0	5	0.00	0%	10.0%	76.9%
7.0 Setup	0	3	0.00	0%	11.1%	85.5%
8.0 Quality	0	4	0.00	0%	13.0%	100.0%
9.0 Scheduling	0	3	0.00	0%	13.0%	100.0%
				SUM:	100%	
				MAX:	13.0%	

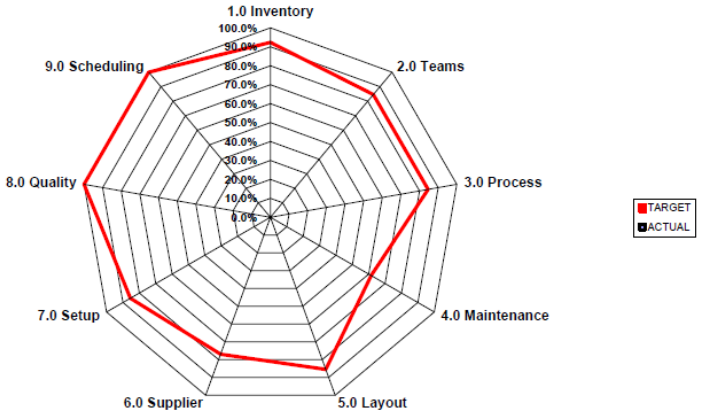

Figure 1: Lean assessment result or lean profile is visualized into a "radar chart"

4. Data Analysis and Results

As mentioned previously, 10 furniture manufacturing companies in Johor state were selected and agreed to participate is this study. But unfortunately, only 6 companies returned back the assessment questionnaire and were used for data analysis.

4.1 Analysis of respondents' position

Data from the questionnaire shows that the respondents for this research are executives (67%) and manager (33%) as shown in Figure 2 pie chart.

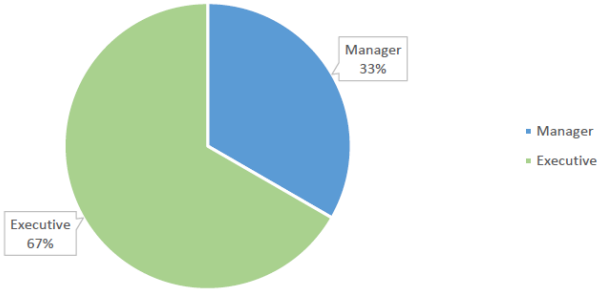

Figure 2: Respondents' position

4.2 Analysis of respondents' working experience

From the analysis of working experience, most respondents have vast working experience. None of them have below than two years working experience. Half of them i.e. 50% have 6-10 years working experience, one-third (33%) have more than 10 years working experience while the rest have about 2-5 years working experience.

Both position and working experience of respondents are important to the accuracy of answers provided in the lean assessment questionnaire. From the data, all respondents are qualified and perceived to have considerable knowledge of about lean in their companies.

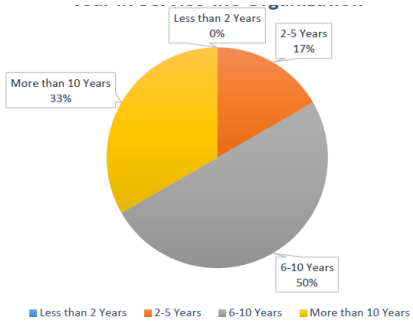

Figure 3: Respondents' working experience

4.3 Lean assessment analysis

(a) Company A

Company A is located at Jalan Kebun Sayur, Muar. Company A produces dining set, bar set, bedroom set, coffee tables, children furniture, nesting tables, living room furniture and etc. Based on lean assessment of Company A, as results shown in Table 2 and Figure 4, there are four areas of

manufacturing operations that Company A didn't achieve their target which are: inventory, process, supplier, and quality. Despite Company A placing quality as the most important aspect of its operations, quality recorded the lowest actual score which only 19% as compared to 100% target. However, there are five areas of manufacturing did Company A perform quite well, namely, team approach, maintenance, layout, machine setup, and scheduling and control. Among the five, maintenance performed very well. Further analysis of the questions asked in the assessment questionnaire, Company A rarely implement quality control tools particularly Statistical Process Control (SPC) in their manufacturing operations. This lead to their low performance in quality control. Despite its lowest score in quality, Company A is having an effective total preventive maintenance(TPM) practice which minimize machines and equipment breakdown during production.

Table 2: Score Sheet for Company A

SECTION	SECTION POINTS	# OF QUEST	SECTION AVG	SECTION %	STRATEGIC IMPACT FACTOR	SECTION TARGET
1.0 Inventory	6	3	2.00	50%	12.0%	54.5%
2.0 Teams	13	6	2.17	54%	7.0%	31.8%
3.0 Process	12	6	2.00	50%	15.0%	68.2%
4.0 Maintenance	12	5	2.40	60%	8.0%	36.4%
5.0 Layout	9	5	1.80	45%	3.0%	13.6%
6.0 Supplier	6	5	1.20	30%	14.0%	63.6%
7.0 Setup	7	3	2.33	58%	10.0%	45.5%
8.0 Quality	3	4	0.75	19%	22.0%	100.0%
9.0 Scheduling	5	3	1.67	42%	9.0%	40.9%
				SUM:	**100%**	
				MAX:	**22.0%**	

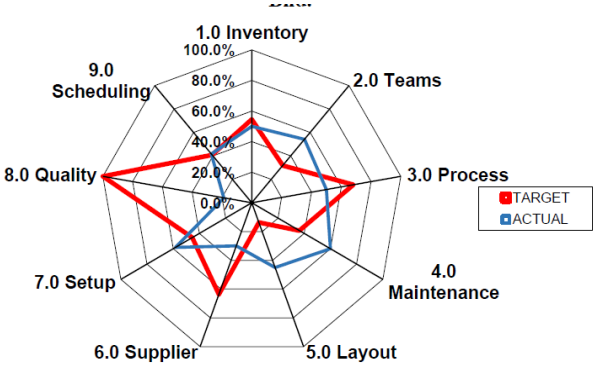

Figure 4: Lean profile chart for campany A

(b) Company B

Company B is located at Parit Sulong, Batu Pahat, Johor. This company produce TV cabinets, coffee table and other furniture. Based on the result presented in Table 3 and Figure 5, Company B did not achieve targeted lean in 5 areas of assessment which were inventory, maintenance, supplier, quality, and scheduling and control. Among these five, quality perform the worst. On the other hand, there are four aspects of manufacturing operations that achieved targeted score which were teams, process, layout, and machine setup. Teams and corporate culture scored highest. The result indicated that even though Company B put strong concern in quality (SIF value is 20%), but they didn't emphasize in SPC. SPC is vital even for manual operations and where quality is not easily measured such as in furniture industry. While, in the aspect of human resource management, Company B did a good job by providing the workers with attractive compensation, adequate training, teamwork and participative organization.

Table 3: Score Sheet for Company B

SECTION	SECTION POINTS	# OF QUEST	SECTION AVG	SECTION %	STRATEGIC IMPACT FACTOR	SECTION TARGET
1.0 Inventory	5	3	1.67	42%	20.0%	100.0%
2.0 Teams	15	6	2.50	63%	5.0%	25.0%
3.0 Process	12	6	2.00	50%	10.0%	50.0%
4.0 Maintenance	9	5	1.80	45%	10.0%	50.0%
5.0 Layout	9	5	1.80	45%	5.0%	25.0%
6.0 Supplier	7	5	1.40	35%	10.0%	50.0%
7.0 Setup	7	3	2.33	58%	5.0%	25.0%
8.0 Quality	3	4	0.75	19%	20.0%	100.0%
9.0 Scheduling	5	3	1.67	42%	15.0%	75.0%
				SUM:	100%	
				MAX:	20.0%	

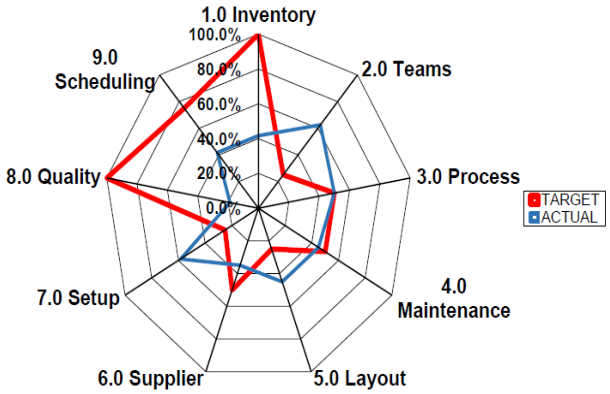

Figure 5: Lean profile chart for campany B

(c) Company C

Company C is located at Tangkak, Johor. This company produce furniture for living room, dining room and bed room. As shown in Table 4 and Figure 6, there are three areas of manufacturing in the assessment that Company C did not achieve the targeted lean namely process, supplier, and quality. Among the three, supplier had the worst score. Areas of manufacturing operations that Company C had performed quite well were inventory, teams, maintenance, layout, setup, and scheduling and control. Among the six, inventory succeeded others by attaining the highest score. Due to lowest score for supplier, Company C was facing lack of trust to its suppliers. The suppliers cannot be trusted to deliver high quality products, on time delivery and competitive price. Furthermore, highest score for inventory indicated that Company C had good inventory management. Inventory turnover is good due to raw materials, WIP, and finished goods inventory are kept at buffer level. Supplier poor performance may lead to Company C to employ low inventory approach.

Table 4: Score Sheet for Company C

SECTION	SECTION POINTS	# OF QUEST	SECTION AVG	SECTION %	STRATEGIC IMPACT FACTOR	SECTION TARGET
1.0 Inventory	9	3	3.00	75%	15.0%	60.0%
2.0 Teams	17	6	2.83	71%	5.0%	20.0%
3.0 Process	11	6	1.83	46%	12.0%	48.0%
4.0 Maintenance	14	5	2.80	70%	5.0%	20.0%
5.0 Layout	9	5	1.80	45%	8.0%	32.0%
6.0 Supplier	7	5	1.40	35%	10.0%	40.0%
7.0 Setup	6	3	2.00	50%	10.0%	40.0%
8.0 Quality	7	4	1.75	44%	25.0%	100.0%
9.0 Scheduling	6	3	2.00	50%	10.0%	40.0%
				SUM:	100%	
				MAX:	25.0%	

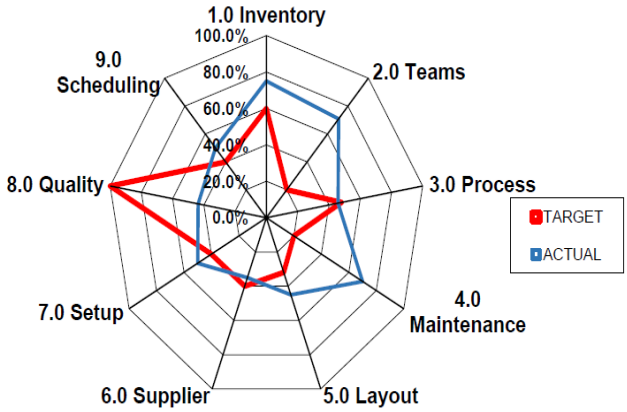

Figure 6: Lean profile chart for Company C

(d) Company D

Company D is located in Skudai, Johor. This company design and produce office furniture for their customer. Lean assessment results for Company D is shown in Table 5 and Figure 7. Inventory, process, maintenance, layout, supplier, quality, and scheduling and control were seven parts of manufacturing operations of Company D did not achieve lean target. Among the seven areas, suppliers got the lowest score. As the same case with Company C, Company D was experiencing poor past performance by its supplier which lead to lack of trust to its suppliers. While in the area of machine and equipment setup, Company D performed the most. The set up time for major machines and equipment in Company D is relatively low which was below than 0.5 hour. The machine operators were given proper training relating set up time reduction and their performance is measured by achievement of set up time reduction.

Table 5: Score Sheet for Company D

SECTION	SECTION POINTS	# OF QUEST	SECTION AVG	SECTION %	STRATEGIC IMPACT FACTOR	SECTION TARGET
1.0 Inventory	7	3	2.33	58%	12.0%	75.0%
2.0 Teams	14	6	2.33	58%	5.0%	31.3%
3.0 Process	11	6	1.83	46%	15.0%	93.8%
4.0 Maintenance	12	5	2.40	60%	13.0%	81.3%
5.0 Layout	9	5	1.80	45%	8.0%	50.0%
6.0 Supplier	6	5	1.20	30%	13.0%	81.3%
7.0 Setup	8	3	2.67	67%	9.0%	56.3%
8.0 Quality	5	4	1.25	31%	16.0%	100.0%
9.0 Scheduling	5	3	1.67	42%	9.0%	56.3%
				SUM:	**100%**	
				MAX:	**16.0%**	

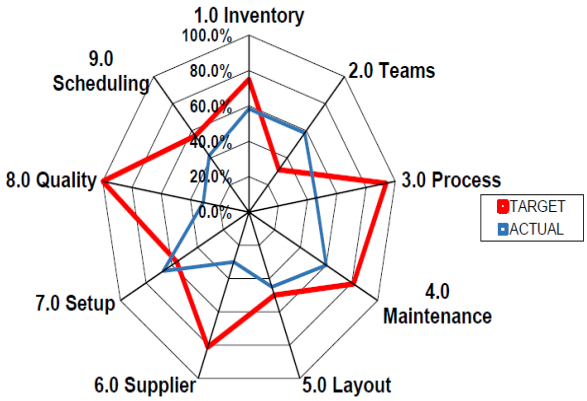

Figure 7: Lean profile chart for Company D

(e) Company E

Company E is located in Batu Pahat, Johor. This company produce wooden bedroom set and is among the largest bedroom set manufacturers in Malaysia. Results for lean assessment for Company E is shown in Table 6 and Figure 8. Five areas of manufacturing operations didn't achieve targeted lean status. The areas were process, layout, supplier, quality, and scheduling and control. Among the five, supplier had the poorest achievement. Company E had problems with supplier similar problems faced by Company C and D. However, Company E's actual lean was above target lean area of inventory, teams, maintenance, and setup. Among the four, maintenance had the best performance. Company E was good in their total preventive maintenance activities.

Table 6: Score Sheet for Company E

SECTION	SECTION POINTS	# OF QUEST	SECTION AVG	SECTION %	STRATEGIC IMPACT FACTOR	SECTION TARGET
1.0 Inventory	8	3	2.67	67%	10.0%	62.5%
2.0 Teams	16	6	2.67	67%	8.0%	50.0%
3.0 Process	9	6	1.50	38%	14.0%	87.5%
4.0 Maintenance	16	5	3.20	80%	10.0%	62.5%
5.0 Layout	10	5	2.00	50%	9.0%	56.3%
6.0 Supplier	7	5	1.40	35%	13.0%	81.3%
7.0 Setup	8	3	2.67	67%	10.0%	62.5%
8.0 Quality	9	4	2.25	56%	16.0%	100.0%
9.0 Scheduling	6	3	2.00	50%	10.0%	62.5%
				SUM:	**100%**	
				MAX:	**16.0%**	

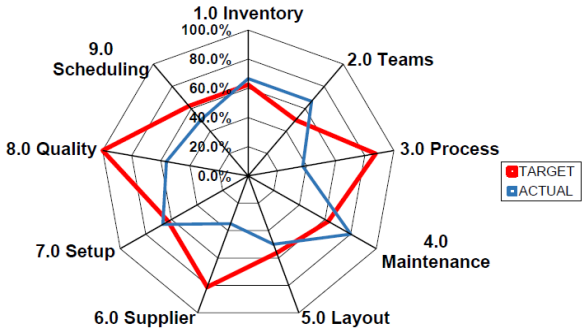

Figure 8: Lean profile chart for Company E

(f) Company F

Company F is located at Muar, Johor. The main product is dining set. This company also carry out research and development activities to enhance their competitiveness in the market. Based on result shown in the Table 7 and Figure 9, Company F achieved targeted lean for seven areas of manufacturing operations which were inventory, teams, process, maintenance, layout, machine setup, and scheduling and control. Among the seven areas, maintenance gained the highest score. By the way, only two areas did not meet targeted lean which were supplier and quality. For Company F, quality is their top priority as compared to other area of manufacturing operations (SIF=30%). Company F were rarely used SPC as a tool in their processes. In addition, company F also facing problem with their suppliers. Poor past performance of suppliers contributed to lack of trust towards their suppliers.

Table 7: Score Sheet for Company F

SECTION	SECTION POINTS	# OF QUEST	SECTION AVG	SECTION %	STRATEGIC IMPACT FACTOR	SECTION TARGET
1.0 Inventory	6	3	2.00	50%	12.0%	40.0%
2.0 Teams	14	6	2.33	58%	8.0%	26.7%
3.0 Process	10	6	1.67	42%	10.0%	33.3%
4.0 Maintenance	13	5	2.60	65%	7.0%	23.3%
5.0 Layout	10	5	2.00	50%	5.0%	16.7%
6.0 Supplier	6	5	1.20	30%	10.0%	33.3%
7.0 Setup	7	3	2.33	58%	8.0%	26.7%
8.0 Quality	8	4	2.00	50%	30.0%	100.0%
9.0 Scheduling	6	3	2.00	50%	10.0%	33.3%
				SUM:	**100%**	
				MAX:	**30.0%**	

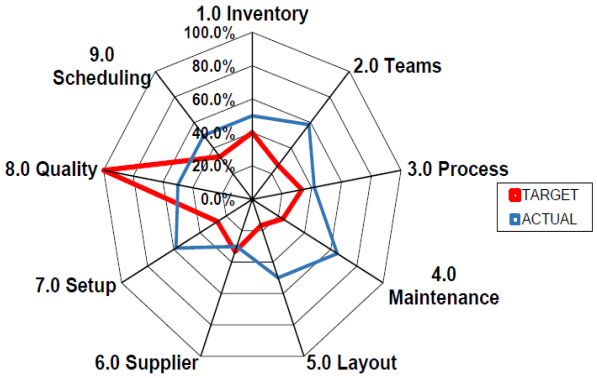

Figure 9: Lean profile chart for Company F

4.4 Average Actual and Targeted Lean Score for Nine Key Areas of Manufacturing Operations of Studied Companies

Table 8 shows the average score for actual and targeted lean. On average, four areas of manufacturing operations which were team approach, maintenance, layout and handling, and machine set up. While other five areas namely inventory, process, suppliers, quality, and lastly scheduling and operational control. Among areas which actual lean were above targeted score, team approach actual lean was far above target. For manufacturing areas that did not achieved desired lean, quality was the poorest because the gap was huge. Actual score far behind targeted.

Table 8: Mean of Actual lean score and Targeted achievement in nine key areas of manufacturing of studied companies

Area	Actual lean score (Mean %)	Targeted lean score (Mean %)	Remark
Inventory	57.00	65.33	Target is not achieved
Team approach	91.83	30.80	Target is achieved
Process	45.33	63.74	Target is not achieved
Maintenance	63.33	45.58	Target is achieved
Layout and handling	46.67	32.27	Target is achieved
Suppliers	33.33	58.25	Target is not achieved
Setup (machine)	59.67	37.67	Target is achieved
Quality	36.50	100.00	Target is not achieved
Scheduling and operational control	46.0	51.33	Target is not achieved

5. Discussion and Conclusion

Based on six case studies of lean assessment in furniture manufacturing industry, lean manufacturing is taking place in furniture industry. Abu et al. (2019) argued that lean manufacturing is fairly new concept in Malaysian furniture industry. Abu et. al. (2019) study found that most companies in wood and furniture industry implementing 5S which is the most fundamental in lean practices. The study also realized that the reasons for the industry to implement lean are to increase efficiency, utilization of space, tidiness and organized workplace.

From the six case studies, quality is the area of lean which companies in furniture industry do not show satisfactory accomplishment. Lean assessment tool developed by Strategos Inc. emphasizes Statistical Process Control (SPC) to measure quality dimension. 4 out 5 questions in quality area in the assessment are relating to SPC. Nature of furniture industry is product-oriented that deals with low-volume, high-variety production which also called job shop, or intermittent production (Heizer and Render, 2017). The definition of quality in furniture industry may vary from those industries like automotive, electronics, etc. Design, workmanship, esthetic are important quality dimensions in furniture industry. Accordingly, this may cause furniture industry not to use SPC as an important tool in their quality control.

Suppliers is another aspect of manufacturing that furniture industry faces big challenges. Base on the average calculated score, most studied companies in this assessment did not achieve targeted lean in suppliers. Raw materials supply is the most critical issue in Malaysian furniture industry (Yimie, 2017; Ratnasingam, 2017). Furniture industry is severely reliant on wood particularly from natural forest timber for raw materials. Ever since the world develops into more environmentally friendly, natural forest timber is confronting strict ruling to preserve the sustainability of the forest (Valipoor & Ujang, 2011; Akademi Sains Malaysia, 2018). This is among the factors that contributes to underperformed suppliers of furniture industry.

Instead of serious work force problem in furniture industry, teams and corporate culture aspect gained good achievement in the assessment. According to Abu et al. (2019), lean companies in furniture industry perceive that employee-related issues are the major obstacles to lean implementation such as lack of labor resources, lack of know-how skills, and employee reluctance to change. One of the ways to handle these problems is furniture companies have to be participative organizations, focus on teamwork and collective work cultures. This concept works best with lean concept.

In conclusion, Malaysian furniture industry is its way to implement lean manufacturing. The adoption of lean practices has proven to increase resources' efficiency, reduce costs, enhance quality and improve productivity. However, lean implementation in furniture industry need some adaptations from the traditional lean which originated from automotive industry due to the different industry nature. The implementation of lean manufacturing will provide Malaysian furniture industry with sustainable practices to confront with stiff global competitions.

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