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# The implementation of lean manufacturing and ergonomics in Small Medium Enterprise – Case study

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**Abstract.** Productivity can be increased by eliminating of all wastes. The objective of lean manufacturing is to eliminate wastes. Commonly, there are seven wastes known as transport, inventory, motion, waiting, over processing, overproduction and defects. However, ergonomics is a process to improve the working posture by designing or arranging a workplace, system and material handling. The aim of this study is to improve the productivity through the integration of basic lean manufacturing and ergonomics in the food company. The walkthrough and distribution of questionnaire have been conducted in this company. Each activity was observed to identify non-value-added activity and work related muscular skeletal disorder (WMSD) that affect the productivity by using questionnaire, motion study and Rapid Upper Limb Assessment (RULA). The questionnaire result has shown that the most of wasted motion is in weighing and measuring activity. In addition, all workers in this process were affected by the musculoskeletal disorder at their neck and shoulder. All movement were simulated through Delmia software. The RULA score shows that the worker had experienced pain at the arm and wrist. The score also suggested that the process should be changed immediately. The changes might reduce the worker's pain and increase the productivity.

## 1. Introduction

As a developing country, Malaysia is rapidly growing in various industrial sectors. One of the sectors involved in driving the Malaysian economy is the food industry. The food industry in Malaysia is predominantly owned by Malaysian small and medium enterprise (SME) [1]. It is expected the food industry will grow very fast especially on halal food. Therefore, Malaysian SMEs are encouraged to prepare and ready with the challenges of halal food. SME is categorised based on a company which has 200 permanent workers or sales turn over less than RM50 million [2]. Most of the SMEs are lack of capital, skills, expertise and resources [3]. They are concentrating and focusing more on production activity, did not aware much on ergonomics factors [4]. As a result, the workers might become disable due to prolong affected of musculoskeletal disorders [5]. It is considered the most common work-related problem in SME due to working posture and design of workstations. Most of the work done in SME are stills carried out manually due to the lack of technology capability [6]. Therefore, issues of work related musculoskeletal disorders (WMSD) and injuries of the workers are great concern. The risk of the workers in this industry exposed to WMSD is very high [7]. WMSD definitely will affect worker productivity and efficiency. Besides, SMEs also do not apply the good manufacturing practice [8], thus both of the problems were affecting the productivity of the company. Productivity is the most valued aspect of all companies including SME. It is a measurement to determine the company performance



based on production volume compared to the provided inputs. The integration of basic lean manufacturing and ergonomics could enhance worker productivity. Both of the systems are concerned on wastes which due to availability of non-value added activities. Non value added activity is anything not add value to the product. The common non value added activities are motion, inventory, defects, over processing, over production, waiting and transportation [9]. It is including of poor handling due to body movement or posture [10]. The effectiveness of lean manufacturing implementation is complemented by the ergonomic features such as the employee interface with tools, parts, and environmental factors in the workplace [11]. This study aims to propose the integration of basic LM and ergonomics in the case study company.

Lean manufacturing (LM) and ergonomics concerned are working towards free of wastes. The objective of LM is to eliminate all possible wastes whereas ergonomics is to enhances workplace health, safety, and work design issues. The integration of these two systems will give better performance to the practitioner compared to a single practice. The workers will feel comfortable with ergonomic working zone and safe to work in a long duration. Hence, the organization could improve labour productivity through the efficient system and proper handling. Among the LM tools and practices could be implemented in SME are 5S, continual improvement, reduce set up time, visual display and value stream mapping [12]. These tools and practices are considered easy to be implemented and less investment. In addition, 5S is a basic tool and must be implemented before other tools can be implemented. Lack of human factor in the organisation will decrease productivity due to pained and fatigued. Indirectly it could increase the absenteeism among the workers. Therefore, it could affect the efficiency and productivity. In other words, the demands of LM and ergonomics must be balanced to achieve high productivity. 5S is the most used tool in the LM discipline. This tool also can be implemented universally through any field of work due to its simplicity and easy to be implemented. 5S is generally focusing on the tidiness of the workplace that helps increasing the agility of worker but it is not included one aspect of safety.

Ergonomics comes from the old Greek word of 'ergo' and 'nomos' that means work and natural law respectively. Ergonomics is a discipline of the usage of scientific principles, methods, and data drawn from a variety of discipline for the development of systems in which humans play a significant role. The field also extends from a single person of a simple tool to multi-person with complex machine and organisation [13]. Musculoskeletal disorder (MSD) is affecting the human musculoskeletal system due to exposing to the ergonomics risk factor. Upper limbs (the hand, wrist, elbow and shoulder), the neck and lower back are particularly vulnerable to MSDs. Lower limbs and the upper back may also be affected [14]. Work-Related Musculoskeletal disorder (WMSD) tends to decrease the productivity of the worker due to the MSD disease. The employee absenteeism will be increased if the MSD is not controlled effectively [15].

Rapid Upper Limb Assessment (RULA) is one of ergonomics assessment tools available for evaluating the risk level of WMSD. The tool referred to body posture diagram that provides evaluation criteria for exposure to the risk factor. The assessment was divided into three stages which focusing on the desired placed that want to be assessed. As an example, RULA is conducted to investigate the risk based on the results of the questionnaire that lead to the upper limb body part. DELMIA software is used to evaluate the RULA score of body movement through a simulation.

6S is the extension of 5S, with the addition of another 'S' which known as Safety. The rest of 'S' still the same i.e. sorting, set in order, shining, standardise and sustain. It is aiming for creating a safe workplace for the employees from injuries due to repetitive work. MSD is a disease that developed by time due to exposing of ergonomics risk factor and could affect worker health. Thus, in the long term, this symptom will affect overall productivity. Therefore, through the integration of lean manufacturing and ergonomics, an organisation could enhance productivity through the elimination of waste which due to non-value added activities including poor posture movement. 6S in the new perspective is to create and maintain organisation in clean, safe and efficient that enables the highest level of value-added performance. The awareness of worker safety from MSD disease also part of 6S.

The 6S methodology is a progressive expansion of traditional 5S which design to reduce damages, accidents and optimize productivity in the workplace. The safety in 6S is a way of ensuring the worker and workplace are safe which free from accident, injuries, fatigue and pain [16].

## 2. Methodology

The methodology of this study comprised of three phases. Firstly, the questionnaire is distributed to the workers. The questionnaire used in this study is a Nordic Questionnaire. The main purpose of this questionnaire is to evaluate the musculoskeletal disorder in the perspective of the ergonomics context and for occupational healthcare service [17]. The workers were asked to rate their musculoskeletal symptoms based on the provided questionnaire. They are encouraged to ask on any unclear information for clarification. Only three workers were evaluated with the range of age between 19 to 53 years old. Similarly, Fazi et al. also conducted an ergonomic study in food company with three workers [7]. Total working postures evaluated comprised of 11 processes. The researcher also observed and identified an awkward posture. RULA assessment was selected for this analysis because most of the workers were discovered upper extremity MSD. Then, Delmia software was used to generate an assessment score. All movements were simulated according to the real workers' movement in their working area. The simulation was followed exactly based on recorded movement which was taken by the video recorder. Before recording, the workers were informed to work as usual without interruption. Total score will determine whether the job needs an immediate change to reduce MSD risk. Table 1 shows the reference of RULA assessment for level of MSD risk.

**Table 1.** RULA Score [13]

Score	Level of MSD Risk
1-2	Negligible risk, no action required
3-4	Low risk, change may be needed
5-6	Medium risk, further investigation change soon
7+	Very high risk, implement change now.

However, the walkthrough was carried out to observe any wastes incurred in this company. Any abnormal movement, process or activity were recorded for improvement.

## 3. Result

The main objective of lean manufacturing is to eliminate waste. The observation shows that all of the workers were felt pain to their body due to uncomfortable while performing the job. As a result, they have to stop frequently for a rest about one to two minutes. Table 2 shows the questionnaire result of pain gained by the workers. The effect of the awkward posture has caused productivity low. In average they were operated 77 minutes for 50 packs per cycle which in total 150 packs per day. Three workers were working here, two female and one male. All of them were having the same pain at their neck and shoulders since the last 12 months. However, only one worker had pain at her wrist since last 12 months, especially when performing the heavy lifting (HL).

**Table 2.** Questionnaire Result

Sex	Height (cm)	Weight (kg)	Neck	Shoulder	Wrist
M	167	67	Yes	Yes	No
F	158	57	Yes	Yes	Yes (HL)
F	161	60	Yes	Yes	No

\*Note: M=Male; F=Female

The Delmia simulation analysis shows the details of the score as in table 3.

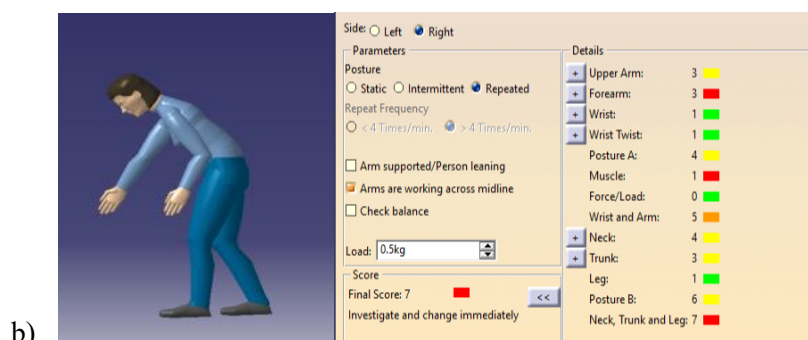
**Table 3.** The RULA Scores by using DELMIA Software

Process	Arm and Wrist Score	Neck, Trunk and Legs Score	Final Score	Risk level
Weighing and Measuring	5	7	7	High
First Rolling	7	2	5	Medium
Second Rolling	5	3	4	Low
Boiling	5	2	4	Low
Cooling	6	3	5	Medium
Packaging	7	2	5	Medium

Table 3 shows RULA assessment and risk level for every process. The highest score is 7 for weighing and measuring. This score means high risk which needs an immediate change of current working posture. It was due to the worker need to bend their body at 90 degrees while weighing and measuring as shown in Figure 1(a). Figure 1(b) is based on Delmia simulation. The worker continues to bend for a long period with frequently has a short period of break. It was observed that this working posture has influenced the neck and trunk due to bending and twisting while filling for the weighing process. This working position is classified as an awkward posture. The increasing level of fatigue might effects productivity. The worker agreed that they were discovered mild pain at their neck and back.



a)



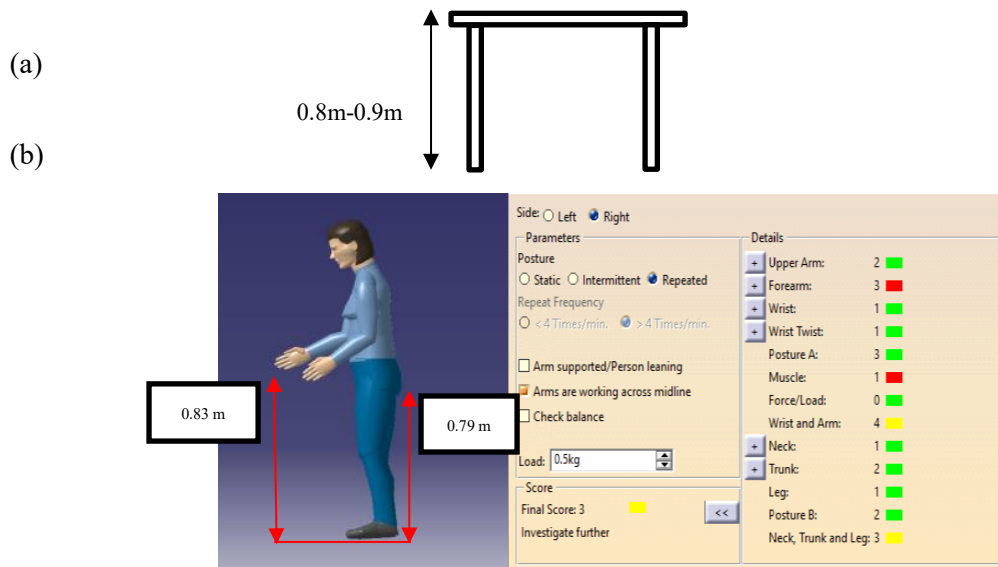
b)

**Figure 1.** (a) Real working condition for weighing and measuring (b) Delmia Simulation of Weighing and Measuring processes

Whereas three processes, first rolling, cooling and packaging were classified as medium risk. These processes need to be carried out further investigation as an effort to increase productivity. Other two processes second rolling and boiling were categorised as low risk. Although this level is considered safe

for the worker, it still has a tendency to increase the risk level if the worker keeps using the same method, especially on boiling. As for safety and health precautions, the bending posture could be avoided through the development of jig or use table with a recommended height of 0.8m to 0.9m for weighing and measuring [18]. Figure 2(a) shows the sketch of a suggested working table.

The suggested working table height was simulated in the DELMIA software as in figure 2(b) and the result shows positive with the final score of 3. The height of the table should be around 0.8 m to 0.9 m below to the average of worker elbow height or suitable with the worker working height according to guidelines that may vary [19].



**Figure 2.** (a) Suggested working table height (b) DELMIA analysis with a suggestion of table height

The study also identified non-value-added activity which known as scooping up the flour and weighing the noodle. These processes consume too much time to get the right weight. It took about 20 minutes for every batch. It was due to manually filled in without using any standard container. Therefore, this study has suggested to the company to use the right scoop with almost the right weight as needed compared to the current process which requires repeating process before getting the right weight. Due to time constraint, this study is limited to the suggestion for improvement only.

#### 4. Conclusion

The integration of basic lean manufacturing and ergonomics could enhance company performance. Some companies especially SME are lack of expertise in lean manufacturing and ergonomics. Therefore, in this case study, the research has concentrated on how basic lean manufacturing system and ergonomics could be implemented in SME-food's company. The research has discovered the problems on ergonomic and lean manufacturing which are awkward working posture and non-value added activities. After the investigation carried out thoroughly, the safety and working condition has been proposed to a better working posture. The RULA evaluation has proved that the current working position for weighing and measuring need to change immediately. As in this study, the working posture can be improvised by using a table with a proper height between 0.8 m to 0.9 m. The simulation has validated the immediate change of working height that could reduce RULA score from 7 to 3. It is expected that the improvement of working posture could enhance company performance by reducing the lead time to less than 77 minutes for 50 packs. It could be achieved once the non-value activity on bending too long is eliminated. As overall production, this company is predicted to produce more than 150 packs per day.

Embedding ergonomic features in lean manufacturing implementation will lessen mistakes, improve productivity and reduce WMSD risk factors.

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### References

- [1] MITI. 2016. Food industry in Malaysia. Retrieved from Ministry of International Trade and Industry: [www.miti.gov.my/miti/resources/11.\\_Food\\_Industry\\_.pdf](http://www.miti.gov.my/miti/resources/11._Food_Industry_.pdf)
- [2] <http://www.smecorp.gov.my> accessed by 20th June 2019
- [3] Rose A N M, Deros, B M. and Rahman, M N A. 2013. Lean manufacturing practices implementation in Malaysian's SME automotive component industry. *Applied Mechanics and Materials* **315** 686-90
- [4] Siong V Y et al 2018 Ergonomic Assessment in Small and Medium Enterprises (SMEs). *Journal of Physics: Conference Series*
- [5] Kelli D. Allen 2017 Musculoskeletal Health: Addressing the Leading Causes of Disability *N C Medical Journal* **78** 5 306-9
- [6] Radzi N M, Shamsuddin A and Wahab E 2017 Enhancing the Competitiveness of Malaysian SMES Through Technological Capability: A Perspective; *The Social Sciences* **12**(4) 719-24
- [7] Fazi H M, Nik Mohamaed N, Ab Rashid M F and Rose A N M 2016 Ergonomics study for workers at food. *MATEC Web of Conferences* **90**
- [8] Anthony J and Kumar M 2005 Six sigma in small and medium sized UK manufacturing enterprises *International Journal of Quality and Reliability Management* **22**(8) 860-74
- [9] Ohno T 1988 The toyota production system. English translation *Productivity Press*
- [10] Suryoputro M R, Sari A D, Burhanudin R, Sugarindra M 2017 Lean production design using value stream mapping and ergonomics approach for waste elimination on buffing panel upright process *IOP Conference Series Material Science Engineering*
- [11] Kim I J 2017 The Function of Ergonomics in Lean Manufacturing Design and Control *Journal of ergonomic*, **7**(5) 1-3
- [12] Rose A N M, Ab Rashid M F F, Nik Mohamed N M Z and Ahmad H 2017 Similarities of lean manufacturing approaches implementation in SMEs towards the success: Case study in the automotive component industry *MATEC Web of Conferences* **87**
- [13] Elbert K H A 2018 *Ergonomics: How to Design for Ease and Efficiency* Third Ed. (Academic Press)
- [14] Yusuff R M and Abdullah N S 2016 Ergonomics as a lean manufacturing tool for improvements in a manufacturing company *Proceedings of the International Conference on Industrial Engineering and Operations Management* 581-88
- [15] Deros B M, Daruis D D I and Basir I M 2015 A Study on Ergonomic Awareness among Workers Performing Manual Material Handling Activities. *Procedia - Social and Behavioral Sciences* **195** 1666 –73
- [16] Gautam V S, Shah A R, Parmar A N, and Kedariya V D 2014 Study of 6S Concept and its Effect in Industry *International Journal of Emerging Technology and Advanced Engineering* **4**(10) 272-77
- [17] Kuronika I, Jonsson B, Kilbom A, Vibterberg H, Biering-Sorensen F, Andersson G, and Jorgensen K 1987 Standardise Nordic questionnaire for the analysis of musculoskeletal symptom *Applied Ergonomics* 233-37
- [18] <https://ergo-plus.com/rula-assessment-tool-guide/> accessed by 20th June 2019.
- [19] Department of Occupational Safety and Health Malaysia 2002 *Guideline of Occupational Safety and Health for Standing at Work* Department of Occupational Safety and Health Malaysia