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**ERGONOMICS STUDY ON MUSCULOSKELETAL  
DISORDERS (MSD) RELATED PROBLEMS AMONG  
WORKERS IN ELECTRONICS ASSEMBLY LINE**

**(KAJIAN ERGONOMIK DALAM MSD BERKAITAN  
MASALAH YANG MELIBATKAN PEKERJA-PEKERJA  
ELEKTRONIK DI BAHAGIAN PEMASANGAN**

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**Ergonomics Study On Musculoskeletal  
Disorders (Msd) Related Problems Among  
Workers In Electronics Assembly Line**

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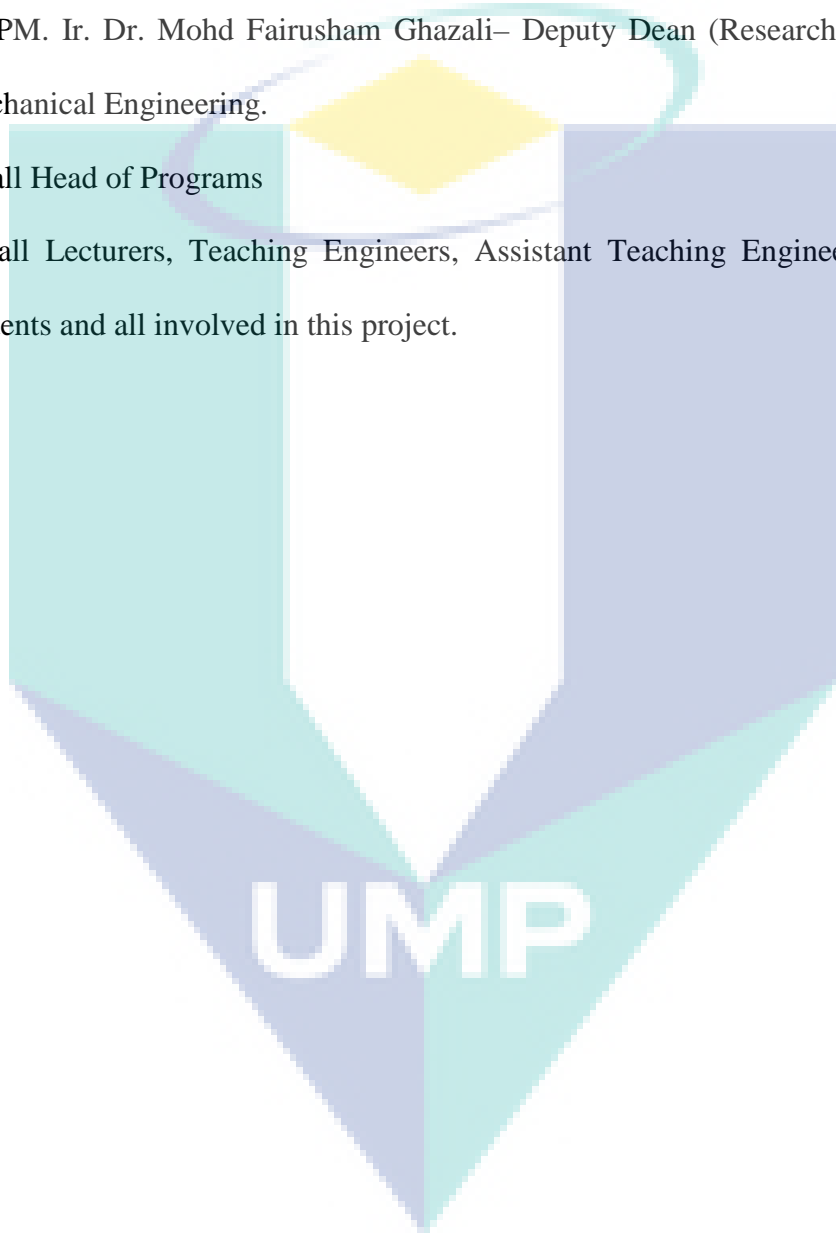
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## ABSTRACT

### ERGONOMICS STUDY ON MUSCULOSKELETAL DISORDERS (MSD) RELATED PROBLEMS AMONG WORKERS IN ELECTRONICS ASSEMBLY LINE

*(Keywords: Ergonomic, electronics components, assembly line)*

Work-related musculoskeletal disorders (MSDs) are one of the most prevalent occupational health problems, affecting millions of workers every year. Ergonomics is important because our body is stressed by an awkward posture, extreme temperature, or repeated movement which affected the musculoskeletal system. The body may begin to have symptoms such as fatigue, discomfort, and pain, which can be the first signs of a musculoskeletal disorder. Thus, this study aims to analyse the data obtained from electronics company based on workers with manual material handling that involved in the production line. Ergonomics methodology will be used to find out risk and tendency of MSD. This study will suggest improvement in production's handling by taking care of worker's safety. The problems related to the assembly and assembly processes were analysed by using WITNESS simulation software, whereas DELMIA simulation software is used to improve human factors working condition. Based from both simulation runs, the assembly line can be further improved in many ways, such as the arrangement of floor layout, workplace condition and machines handling method by the workers. All of these are imperative to improve the working condition which will directly increase the efficiency of the production line. For analysis and implementation stage, the results from the case study experiments will be carried out in the actual manufacturing condition. The main issues that were recorded from the observation and data collection was the delivery always behind the schedule. It was contributed by the human factor which increased the number of rejected parts and slows down the production line. The WITNESS and DELMIA software have successfully improved the overall efficiency of the electronic assembly line. Hence, based on the study, the continuous improvement of the layout design, ergonomic factors and training of operators are possible to be implemented in a larger scale.

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## ABSTRAK

### KAJIAN ERGONOMIK DALAM MSD BERKAITAN MASALAH YANG MELIBATKAN PEKERJA-PEKERJA ELEKTRONIK DI BAHAGIAN PEMASANGAN

*(Kata kunci: Ergonomik, komponen elektronik, barisan pemasangan)*

Gangguan muskuloskeletal yang berkaitan dengan pekerjaan (MSD) adalah salah satu masalah kesihatan pekerjaan yang paling meluas, yang menjejaskan berjuta-juta pekerja setiap tahun. Ergonomi adalah penting kerana tubuh kita ditekankan oleh sikap yang janggal, suhu yang melampau, atau pergerakan berulang yang mempengaruhi sistem muskuloskeletal. Tubuh mungkin mula mengalami gejala seperti keletihan, ketidakselesaan, dan rasa sakit, yang boleh menjadi tanda pertama gangguan ototkeletal. Oleh itu, kajian ini bertujuan untuk menganalisis data yang diperolehi daripada syarikat elektronik berdasarkan pekerja dengan pengendalian bahan manual yang terlibat dalam barisan pengeluaran. Metodologi ergonomi akan digunakan untuk mengetahui risiko dan kecenderungan MSD. Kajian ini akan menunjukkan peningkatan dalam pengendalian pengeluaran dengan menjaga keselamatan pekerja. Masalah yang berkaitan dengan proses pemasangan dapat dianalisa dengan menggunakan perisian simulasi WITNESS, manakala perisian simulasi DELMIA digunakan untuk memperbaiki keadaan kerja manusia. Berdasarkan kedua-dua aliran simulasi, barisan pemasangan boleh diperbaiki dengan banyak cara, seperti susunan tata letak lantai, keadaan tempat kerja dan kaedah pengendalian mesin oleh pekerja. Semua ini penting untuk memperbaiki keadaan kerja yang secara langsung akan meningkatkan kecekapan barisan pengeluaran. Untuk analisis dan tahap pelaksanaan, hasil dari eksperimen kajian kes akan dilakukan dalam keadaan pembuatan yang sebenarnya. Isu-isu utama yang direkodkan dari pemerhatian dan pengumpulan data adalah penyampaian sentiasa di belakang jadual. Ia disumbangkan oleh faktor manusia yang meningkatkan jumlah bahagian yang ditolak dan melambatkan barisan pengeluaran. Perisian WITNESS dan DELMIA telah berjaya meningkatkan kecekapan keseluruhan barisan pemasangan elektronik. Oleh itu, berdasarkan kajian, peningkatan reka bentuk susun atur yang berterusan, faktor ergonomik dan latihan pengendali mungkin dilaksanakan dalam skala yang lebih besar.

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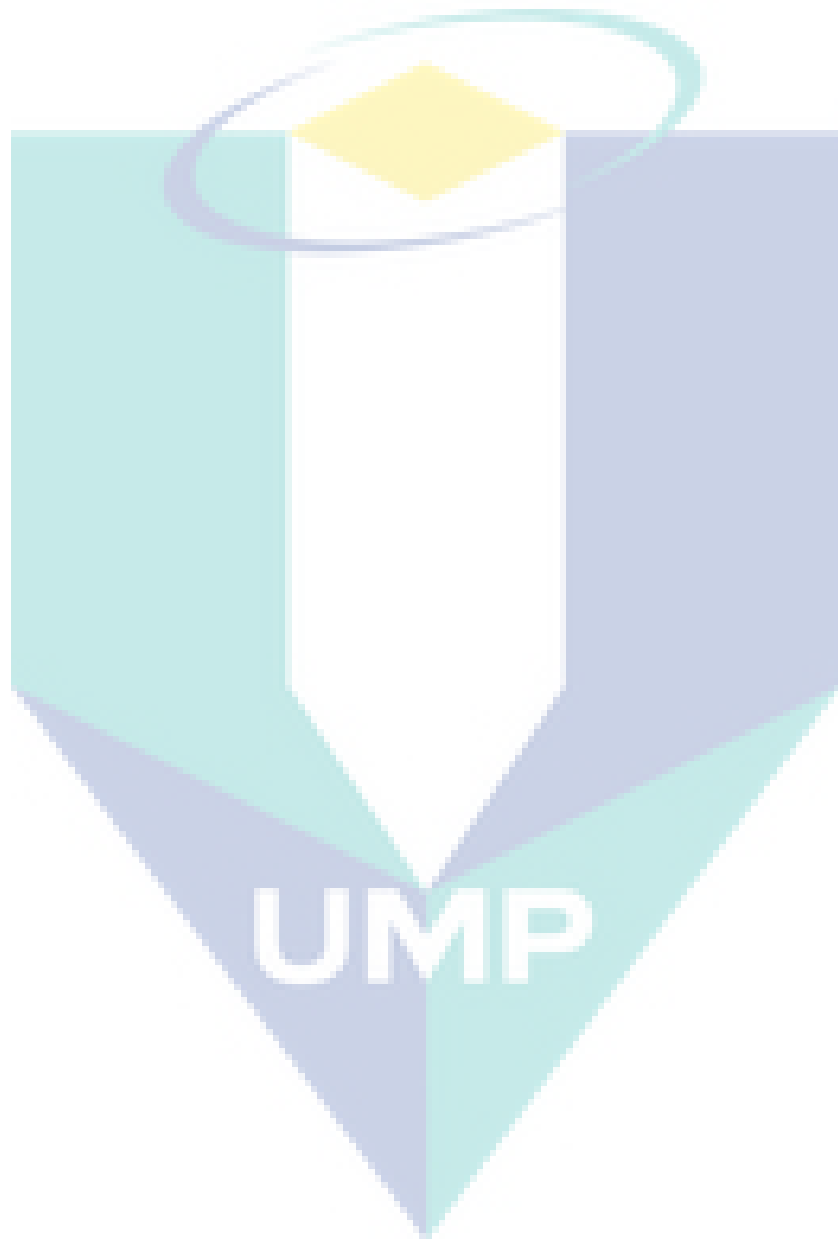
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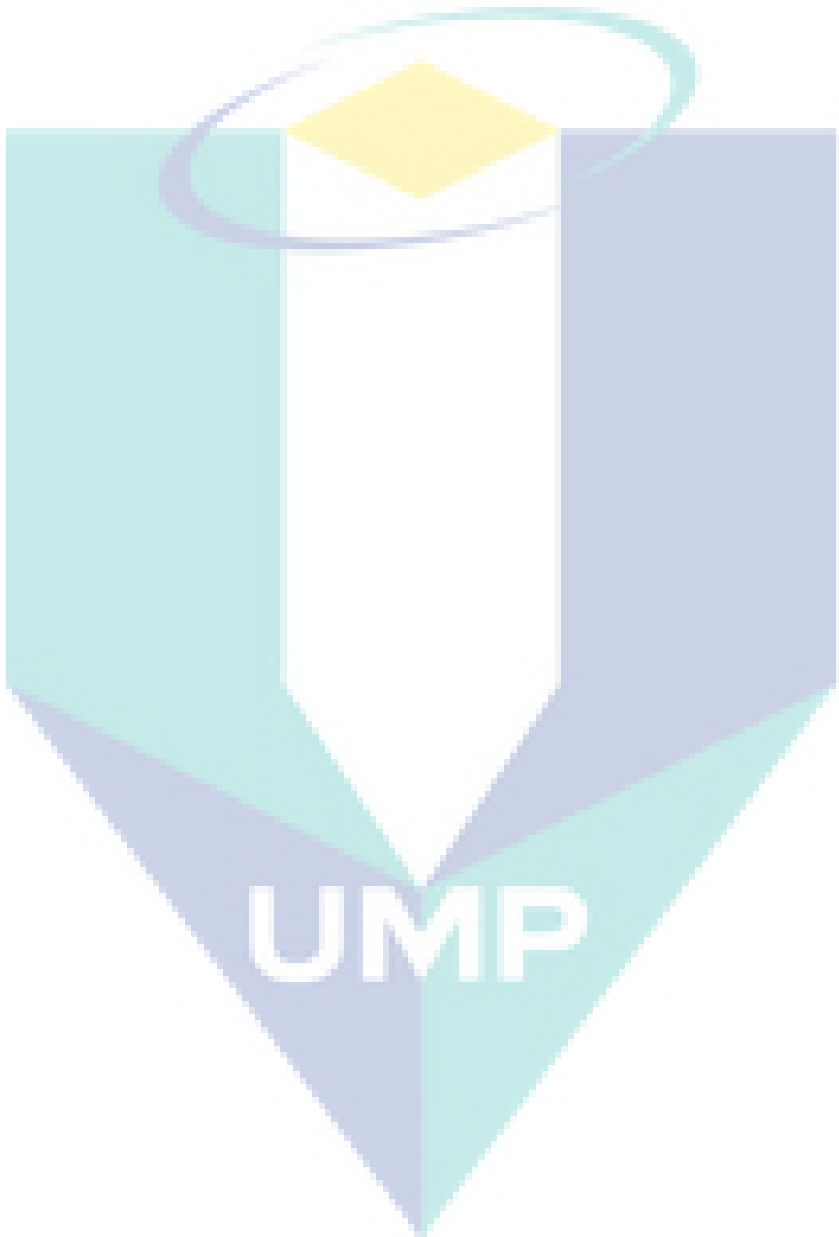
**Figure 1**      Research flowchart

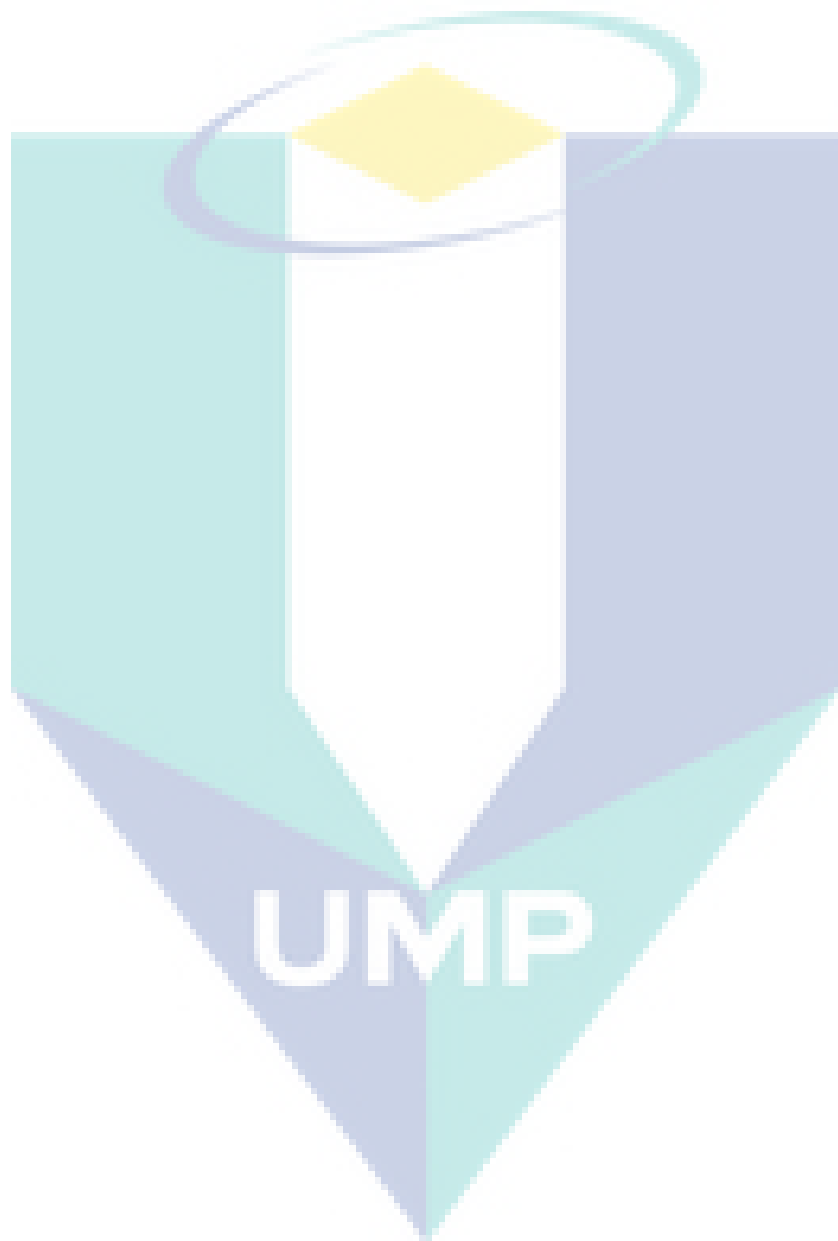
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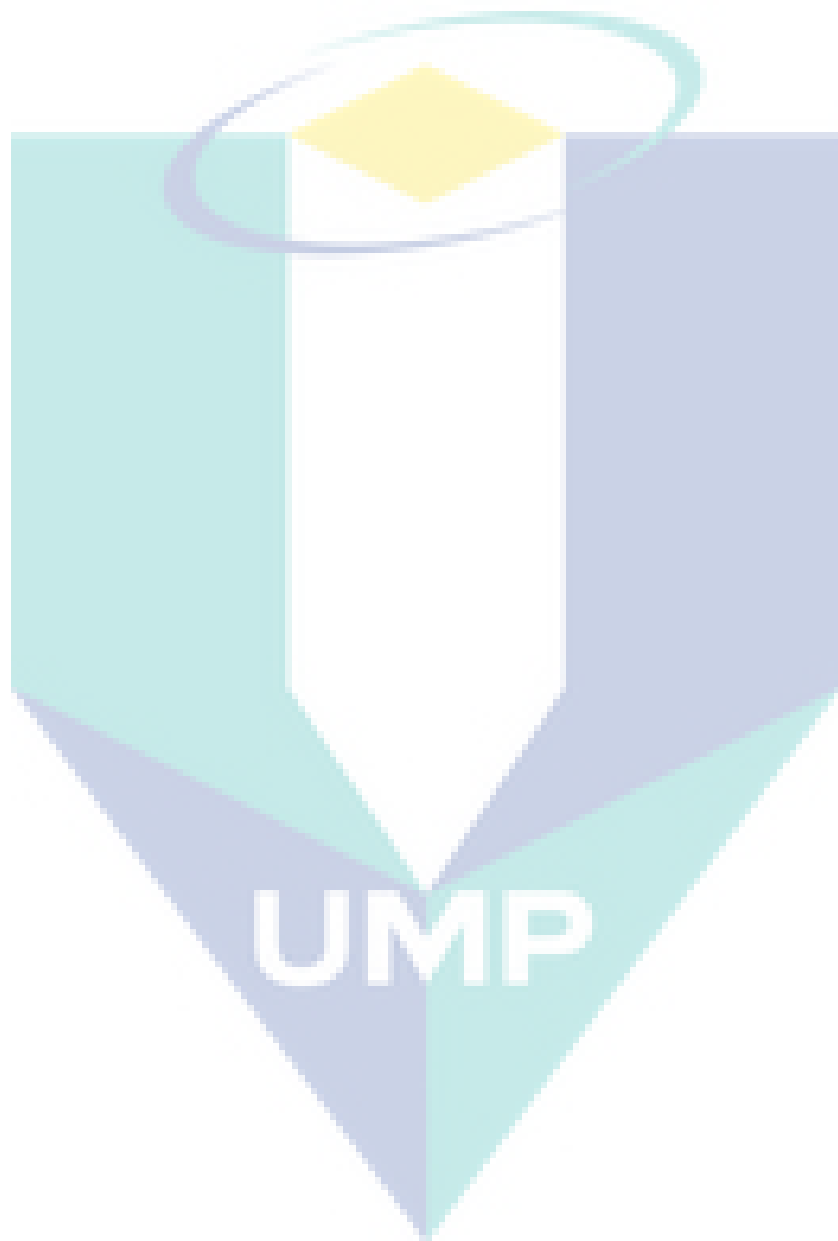
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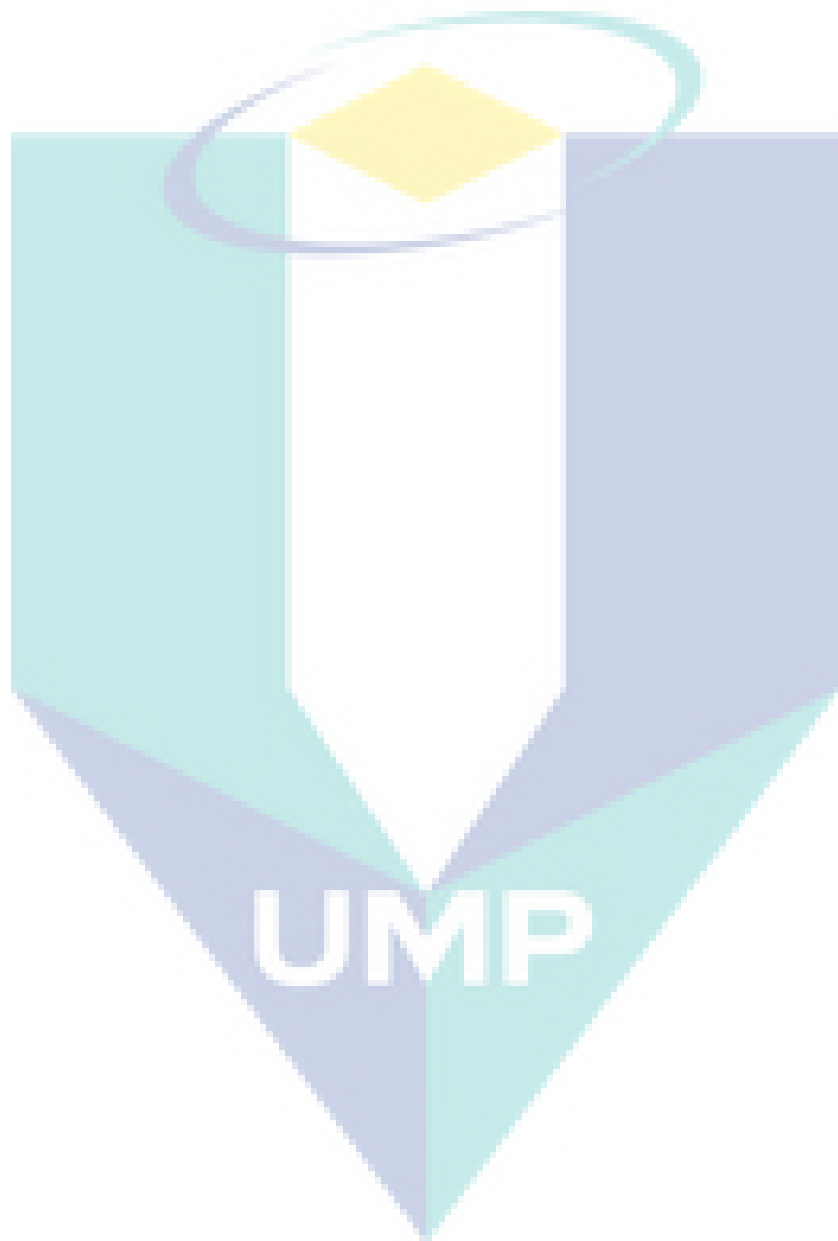
MSD                      Musculo-Skeletal Disorders











# CHAPTER 1

## INTRODUCTION

At the workplace, ergonomics is applied to the design of work equipment and tasks and to work organisation. It is often referred to as occupational ergonomics as it is an important part of occupational health and safety. As such, it aims to promote health, efficiency and well-being in employees by designing for safe satisfying and productive work [7]. Ergonomics is designing a job to fit the worker so the work is safer and more efficient. Implementing ergonomic solutions can make employees more comfortable and increase productivity [2]. Ergonomics is frequently defined as an interdisciplinary subject, dealing with adjustment of devices, tools, machines, environment and work conditions to anatomical and psychophysical properties of a human being, ensuring efficient and safe work with relatively low biological cost [2, 4, 6, 8]. Some of the definitions define ergonomics as a knowledge needed for the proper design of tools, machines, working systems and environments ensuring safe and effective work [8].

The focus of ergonomics implementation should remove barriers to quality, productivity and safe human performance by fitting products, tasks, and environments to people instead of forcing the person to adapt to the work. In order to assess the fit between a person and their work, ergonomists will consider the worker, the workplace and the job design [5]. Manual material handling, is one of the most physically demanding activities in production and logistic processes, has been a major field of research in the last 30 years [3, 9]. Based on biomechanical, physiological or psychological criteria or a combination of these a large number of various assessment methodologies have been developed to reduce health related disorders and to gain highly efficient work systems [3]. Depending on the evaluation type, existing assessment approaches and tools can be differentiated in methodologies defining recommended weight limits or long-term dosage limits and methodologies classifying the level of risk for injuries in the musculoskeletal system [11]. Work-related musculoskeletal disorders (MSDs) are one of the most prevalent occupational health problems [1], affecting millions of workers every year. Ergonomics is important because when you're doing a job and your body is stressed by an awkward posture, extreme temperature, or repeated movement your musculoskeletal system is affected. Your body may begin to have symptoms such as fatigue, discomfort, and pain, which can be the first signs of a musculoskeletal disorder [2]. (MSDs) are conditions that affect your body's muscles, joints, tendons, ligaments, and nerves. MSDs can develop over time or can occur immediately due to overload [10].

Thus, this study aims to analyse data obtained from electronics company based on workers with manual material handling that involved in the production line. Ergonomics methodology will be used to find out risk and tendency of MSD. This study will suggest improvement in production's handling by taking care of worker's safety.

## 1.1 Research Objectives

- (a) To investigate health related problems in the organization by evaluating the performance of workers.
- (b). To analyse the data obtained by using statistical analysis and simulation.
- (c) To validate the use of ergonomic measures related to musculoskeletal disorders (MSDs) among workers.

## 1.2 Scope of Research

- (a) To study the procedure for parts/components design
- (b) Study the parts/components assembly at production line
- (c) Identify problems during design and assembly stages
- (d) Data collection at the electronics industry
- (e) Analyse the data using Witness and Delmia simulation software
- (f) Data validation of consistency
- (g) Report writing & project closure

## 1.3 Methodology

### (a) Design of protocol:

Ergonomics worksheet control is possible with a validated workers data performance that captures the movement of rapid upper limb and entire body during work. This observation will also capture the processing time by each worker that explained daily routine among the employees. This study focus on the workers who being carrying manual handling manual material handling activities, and to process this study, validated collected data based on prior study in one production line of a factory will be re applied and used. The cycle time of worker was taken once the worker start doing the task and this cycle time will be stopped once activities for one piece are done. The process time is recorded for all workers which include all workstation involved in the production. Ethics of this study will be obtained from one of the production line in actual manufacturing environment. Data collection will be used and analyse using appropriate software and methods. The entry criterion for the study including employees activities measurement on the daily routine during standard employee monitoring, where desirable of production according to demand per day in the production line is being carried out. Average time recording measurement will be used to ensure accurate and consistent measurements. Minimum of three times data collection per different working hour in a day must be obtained. The data collection is recorded three times during each session; morning session, followed by afternoon and evening session. The working position also been observed together during the data collection process, hence the recorded data will be used to proceed with assessment of worker's working posture for the prevention and control of occupational musculoskeletal disorders (MSDs).

### (b) Virtual Workers and Simulation:

Developing a validated virtual simulation will be carried out using workers respective to data obtained from the prior study "Lean Manufacturing Implementation in Small and Medium Industries". There will be approximately 24 virtual workers based on that one production line created by using Witness simulations. Virtual worker's performance will be generated according to working hour per day, allowing simulating workers performance to modify process of production and specifically tailor the best improvement to the company.

(c) Data Statistical Analysis:

Baseline variables and working posture and position for each worker were compared and analysed by using Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) or any other software related to this study. RULA provides a rapid assessment of the musculoskeletal loads on workers due to posture, repetition and force. It aids in evaluating jobs or tasks that may expose workers to upper limb disorders (neck, shoulder, upper and lower arms, and hand). RULA accomplishes these goals by providing a "Grand Score" which can be compared to four action levels. REBA provides a scoring system for muscle activity caused by static, dynamic, rapid changing or unstable postures. The final REBA score provides an action level with an indication of urgency.

The flowchart of the research methodology is as follows:

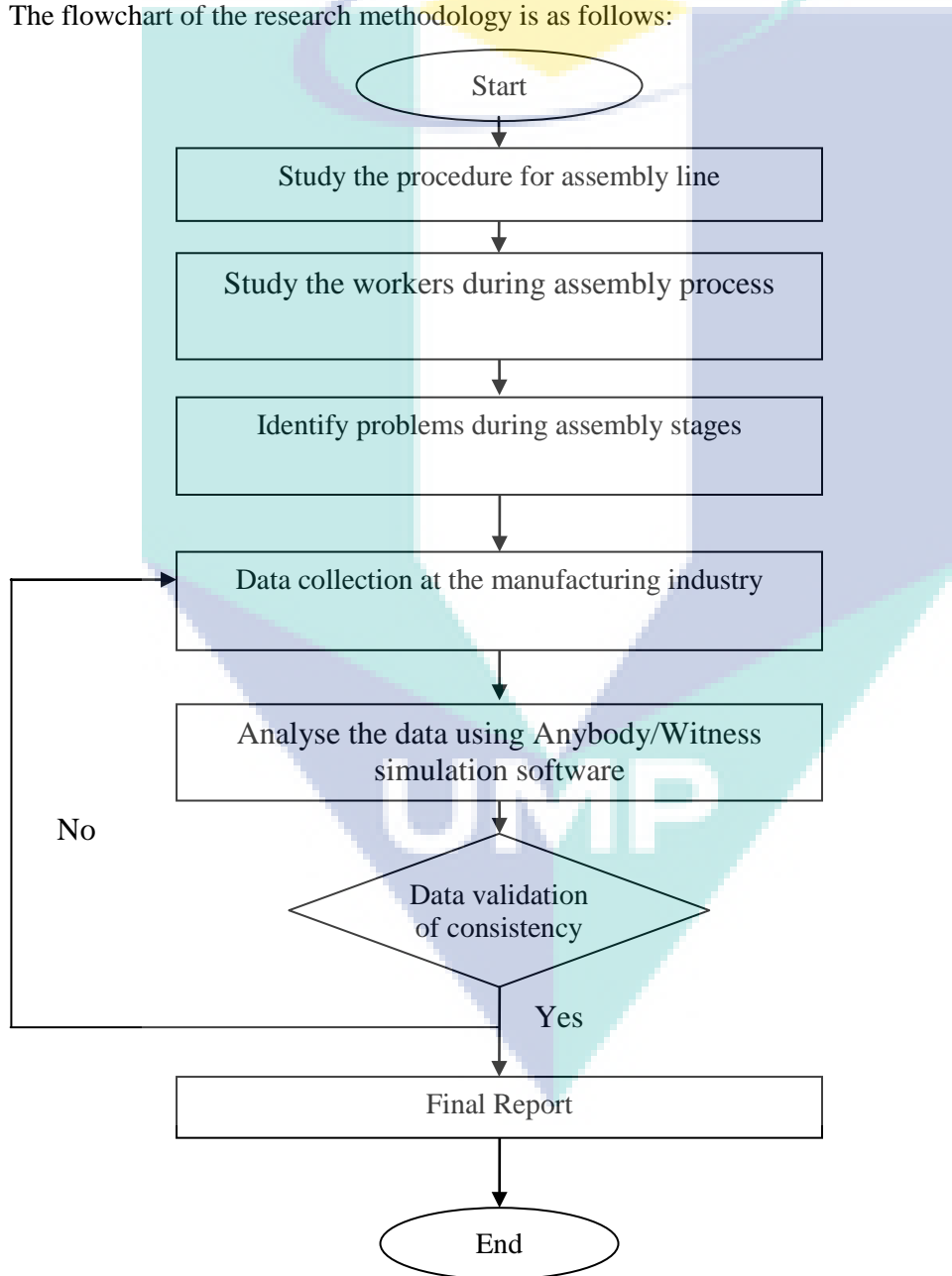
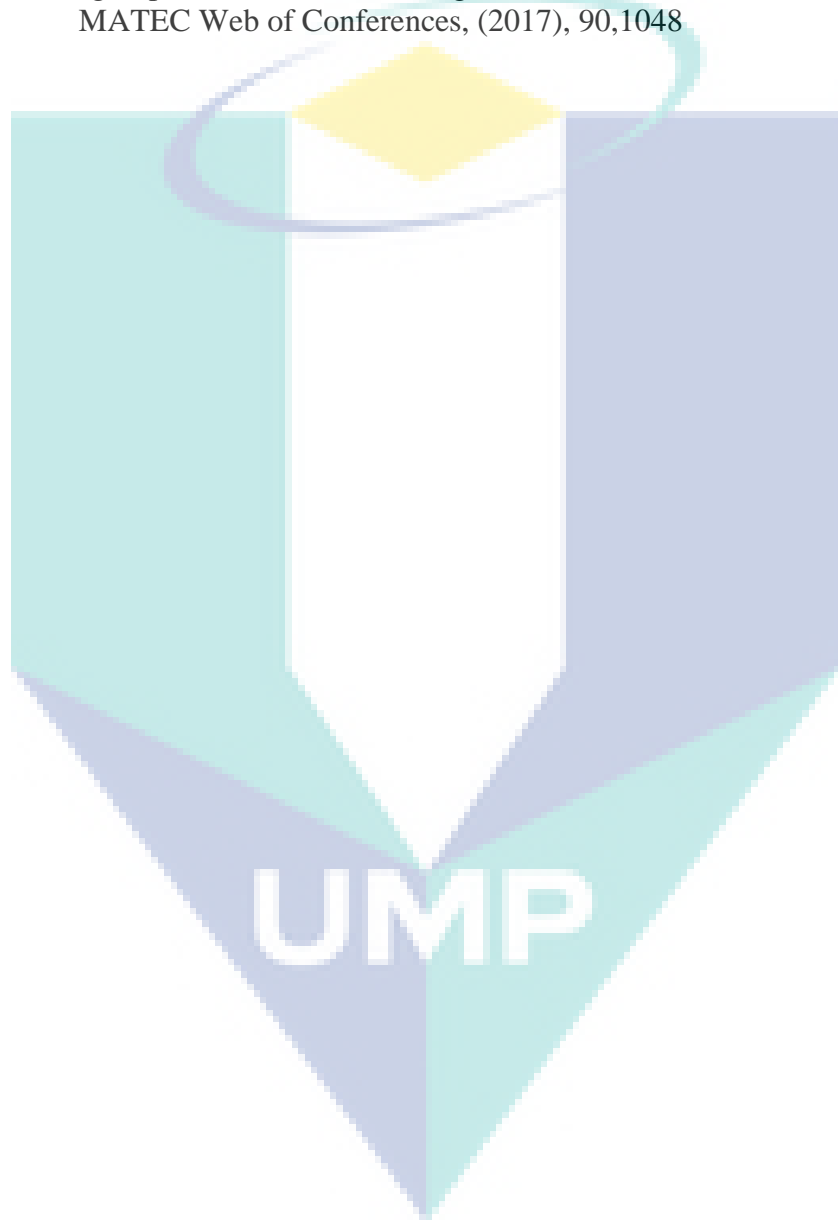


Figure 1.1 Research flowchart

## CHAPTER 2

### PUBLISHED PAPER 1

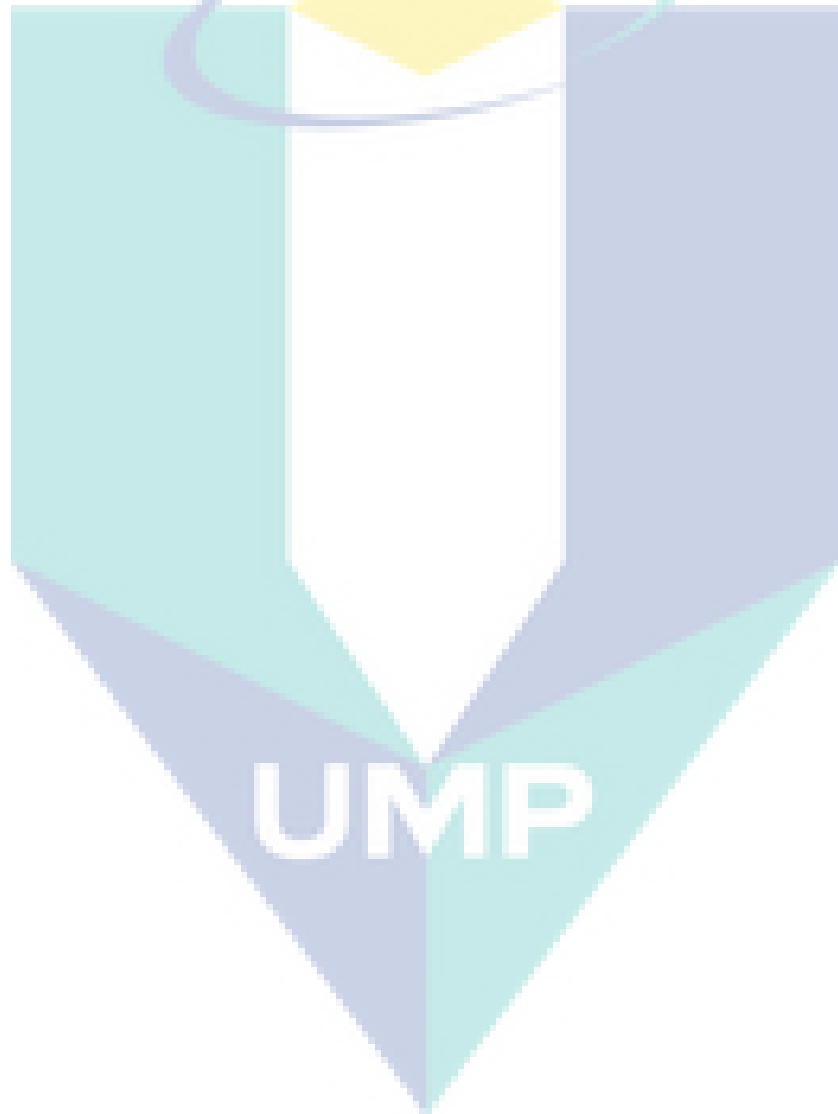
NH Zakaria, NMZN Mohamed, MFF Ab Rashid and A.N.M.Rose  
Lean manufacturing implementation in reducing waste for electronic assembly line  
MATEC Web of Conferences, (2017), 90,1048



## CHAPTER 3

### PUBLISHED PAPER 2

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Lean Manufacturing Implementation in Small and  
Medium Industry  
Advances in Smart Systems Research (2016)  
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## CHAPTER 4

### CONCLUSIONS AND RECOMMENDATIONS

#### 4.1 Conclusion

The significant of this research is the development of an ergonomics framework on musculoskeletal disorders (MSD) related problems among workers in electronics assembly line. As the worker's experience pain and fatigue at a certain point of their body, their material manual handling will become slow thus, will affect the production. Ergonomic factor did have an influence towards workers productivity and it can be used as one of problem indicator for workers performance in production but other factor such as type of workload should be consider as well. When workers were working in an ergonomic way, their performance during production will be more efficient. The framework provides assemblers with a standard set-up for assembly workers which applies ergonomics aspects. There are two important elements involved in this study, the layout and human factor. The combination of WITNESS and DELMIA software in this research has improved the efficiency of the electronics manual assembly line significantly.

#### 4.2 Recommendation

This study brings more understanding of ergonomic in production in industry, especially in finding a correct method to bring improvement in production. Recommendations that could be implemented are:-

- Toroidal winding process: The worker were having difficulties to coil the wire to the core by hand as the small gap in between two side of the core, create rough collision between the wire and hand. the hand of the workers also experienced pain to pull and coil the wire around the core. Workers could use safety glove to prevent hand injury and use material that could separate between toroidal core sides for a smooth winding.
- Epoxy process: This process require worker to see thoroughly the joint part in order to have a proper amount of adhesive and neat joint. Working table for this process should not be similar with other process. They require a proper height of working table to reduce the bending of body while doing the epoxy detailing process.
- VMI process: The process need a precise inspection before it goes to test and packaging process. For example, any minor and moderate cracks are measured to make sure that they fall within the acceptance criteria. This require a detail inspection to reduce reject fail. Thus, improving the lighting conditions could help to have a better angle of view to perform the inspection precisely.



## REFERENCES

- [1] Boschman, J. S., Frings-Dresen, M. H. W., & van der Molen, H. F. (2015). Use of Ergonomic Measures Related to Musculoskeletal Complaints among Construction Workers: A 2-year Follow-up Study. *Safety and Health at Work*, 6(2), 90-96.
- [2] Brenosa J, Cerrada P, Ferre M, Aracil R. Design Of An Ergonomic Threefinger Haptic Device For Advanced Robotic Hands Control, in: *Proceedings of the IEEE World Haptics Conference 2011*, Istanbul, Turkey, pp. 257-261.
- [3] Buckle, P.W., Stubbs, D.A., Randle, P.M., Nicholson, A.S. 1992. Limitations in the application of material handling guidelines. *Ergonomics* 35 (9), p. 955-964.
- [4] Grajewski, D., Górski, F., Zawadzki, P., & Hamrol, A. (2013). Application of Virtual Reality Techniques in Design of Ergonomic Manufacturing Workplaces. *Procedia Computer Science*, 25, 289-301.
- [5] Jaffar, N., Abdul-Tharim, A. H., Mohd-Kamar, I. F., & Lop, N. S. (2011). A Literature Review of Ergonomics Risk Factors in Construction Industry. *Procedia Engineering*, 20, 89-97
- [6] Mleko A, Kotli ski T. Interfejsy haptyczne i force feedback, *Informatyka Stosowana EAIiE AGH*, 2008.
- [7] P. Scott, K. Kogi, B. M. Phee., *Ergonomics Guidelines for Occupational Health Practice in Industrially Developing Countries*, IEA and ICOH vol. 163, pp. 12100, Aug 2009.
- [8] Seth A, Smith SS, Shelley M, Jiang Q. A Low Cost Virtual Reality Human Computer Interface for CAD Model Manipulation, *Engineering Design Graphics Journal* 2009; 69(2): 31-38
- [9] Schaub K., Steinberg, U., Bierwirth, M., Kugler, M., Bruder, R., 2012. MultiLa - a tool for the combined overall estimation of various types of manual handling tasks. *A Journal of Prevention, Assessment and Rehabilitation* 41, p. 4433-4435.
- [10] Tayyari, F & Smith, J.L. (1997). *Occupational Ergonomics: Principles and applications*. London: Chapman & Hall. (Chapter 1 & 19).
- [11] Weisner, K., & Deuse, J. (2014). Assessment Methodology to Design an Ergonomic and Sustainable Order Picking System Using Motion Capturing Systems. *Procedia CIRP*, 17, 422-427.

