PUSH AND PULL FORCE ANALYSIS FOR DESIGNING MANUAL OPERATED INDUSTRIAL TROLLEY

Submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Hons.)

By

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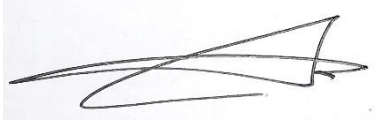

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I hereby, declared this report entitled “Push and Pull Force Analysis for Designing Manual Operated Industrial Trolley” is the results of my own research except as cited in reference.

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Hons.). The members of the supervisory committee are as follow:

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ABSTRAK

Dalam beberapa tahun kebelakangan ini, perkembangan teknologi yang pesat menjadikan kualiti hidup orang terjamin. Banyak teknologi baru telah menggantikan teknologi lama untuk menjadikan orang lebih senang. Troli adalah alat dan teknologi yang agak tradisional dan telah lama wujud. Di beberapa tempat kehidupan seharian, seperti hospital, industri dan pasar raya, dapat dilihat orang menggunakannya. Walau bagaimanapun, terdapat beberapa aduan mengenai pengalaman menggunakan troli. Kecederaan pekerjaan seperti sakit belakang dan keseleo otot sering dialami oleh pengguna troli. Sebab-sebab yang menyebabkan masalah ini adalah kerana pemegang troli tidak dapat disesuaikan mengikut keperluan pengguna dan pekali geseran yang rendah pada pemegang troli, memaksa pengguna menggunakan troli dalam keadaan canggung. Objektif kajian ini adalah untuk mengetahui bagaimana antropometri peserta mempengaruhi kekuatan kekuatan dengan postur badan yang berbeza dan merancang reka bentuk troli baru. Untuk mencapai objektif kajian ini, seramai 47 peserta dari pelajar UTeM telah menjemput dan terlibat dalam kajian ini untuk mengumpulkan dimensi antropometrik dan daya tarikan dan tarikan. Hasil kajian ini, kekuatan daya tarik lebih kuat daripada daya tolak. Selain itu, postur untuk melakukan aktiviti mendorong dan menarik juga mempengaruhi hasil kekuatan daya, kekuatan yang lebih kuat menarik ketinggian siku dengan kedudukan kaki kekuda. Dengan hasil yang diperoleh, reka bentuk troli pemegang baru dirancang.

ABSTRACT

In recent years, the rapid development of technology has made people's quality of life insured. Many new technologies have replaced the old technologies to make people more convenient. The trolley is a tool and relatively traditional technology that has been around for a long time. In some places of daily life, such as hospitals, industries and supermarkets, can be see people using them. However, there are several complaints about the experience of using the trolley. The occupational injuries such as low back pain and muscle sprain are common suffer by the user of trolley. The reasons that cause this issue are because the handle of the trolley can't adjust according to the user needed and low coefficient of friction on the trolley handle which force the user use the trolley in awkward posture. The objective of this study is finding how the anthropometric of the participant effect the strength of force with different body posture and designing a new design of trolley. To achieve the objective of this study, a total of 47 participants from UTeM student has invited and involved in this study for collecting the anthropometric dimension and the pushing and pulling force. The result of this study, the strength of pulling force is stronger than the pushing force. Besides that, the posture to perform pushing and pulling activity also effect the result of the force strength, the stronger force is pulling in elbow height with truss legs position. With the result obtained, a new design of trolley handle is designed.

DEDICATION

Only

my beloved father, Tan Yee Yam

my appreciated mathor, Ch'ng Chiew Luan

my adored sister and brother, Tan Wooi Kean and Tan Yee Teng

for giving me moral support cooperation, encouragement and also understandings

Thank You So Much & Love You All Forever

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In the name of god, the most gracious, the most merciful, with the highest praise to god that I manage to complete this final year project successfully without difficulty

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CHAPTER 1
INTRODUCTION

1.1 Background Study

Nowadays, the kknowledge development is very fast, especially in the area of science and technology. Speaking of the development of science and technology, we have to mention the industrial revolution. Technology advancement is directly related to the industrial revolution. As the technology develops faster, the bigger the industrial revolution. In the 19th century, the most advanced technology was steam, so industry 1.0 developed around steam technology. Next, the electricity replaces the vapor power and puts industry 1.0 into industry 2.0. With the development of science and technology, the computer was invented and then the industry 2.0 evolved again into industry 3.0. Industry 4.0 is the biggest revolution because in 2000 the technology began to explode growth, the most representative technology is the Internet. As long as people have access to the Internet, wherever and at any time, they can get the information they need.

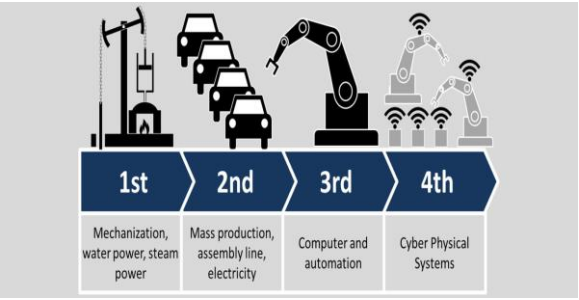

Figure 1.1: Industry revolution. (Oliver, n.d.)

Many people have misunderstood that industry 4.0 is only applied in manufacturing industry, in fact, it is not that matter. Services and business are also part of industry 4.0, and the best example is Grab. By using a smartphone, you can get the rental car you need as long as you have access to the internet. But even such advanced technology can't avoid the need for manpower in some places for manual material handling. The most common material-handling equipment is a trolley.

In fact, there have been many great men who have made many different kinds of trolley. Figure 1.2, Figure 1.3, and Figure 1.4 are showing the example of the type of trolley. Common in life is platform trolley with handle, but there is another type that more advanced is called motorized trolley. This kind of trolley is rarely used because of its limited such as high prices. Excluding motorized trolley, the rest of those trolley needs to be pushed or pulled by hand, and this action is called manual material handling. Manual material handling is accompanied by the ergonomics issue, commonly is low back pain.

Figure 1.2: Platform trolley (Flatbed trolley, 2019)

Figure 1.3: Cylinder trolley (Renegade Industrial Heavy-Duty Red Hand Trolley, n.d.)

Figure 1.4: Platform trolley with handle.

Based on the Figure 1.5, performing the manual material with inappropriate tools of action will be makes those parts of the body feels uncomfortable. By referring this report, the article stated that the risk factor that causes the muscles discomfort is the posture bending and twisting. The aim of this study is to reduce the ergonomics risk among the trolley user at the industry by redesign the handle of the trolley. This report is to study the ways to overcome those ergonomics issues that faced by the trolley user.

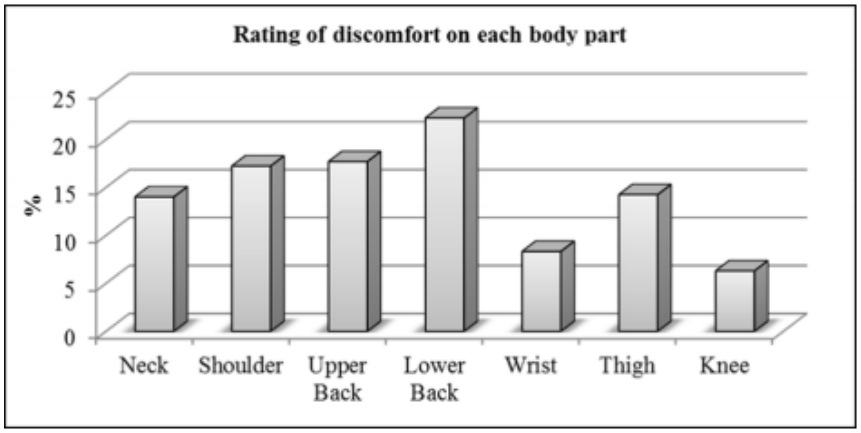

Figure 1.5: The rating of discomfort on each body part performing manual material handling in automotive industry in 2016. (Widia, Dawal, & NukmanYusoff, 2016)

1.2 Problem Statement

In manufacturing industry, many tasks involve pushing and pulling activities, for instance, handling a heavy load trolley. Excessive muscle exertion during pushing and pulling tasks is one of the prominent factors of adverse work-related musculoskeletal disorders (WMSDs) such as back pain and shoulder pain. The Social Security Organization (SOCSO) of Malaysia reported that the number of WMSDs cases and compensation costs increase from 2014 to 2017. A study pointed that 87.7% of the workers in manufacturing complained from WMSD. The workers suffering from WMSD endure pain interference with work, limiting the workers' performance and hence productivity.

Improper design of manual materials handling equipment such as the trolley is the most common cause of occupational injuries such as low back pain and muscle sprain among Malaysian industrial workers. The substandard design of the trolley such as inappropriate handle height and poor wheel design can lead to excessive muscular loads during pushing and pulling tasks.

The root causes of improper trolley design can be summarized as follow:

1. Lack of design information related to physical strength of Malaysian population including quantitative data on push and pull forces in the application of manual industrial trolleys.

2. The handle of the existing manual industrial trolleys is not designed to be adjustable. This causes mismatch of working height between the user's hands and the handle. For an example shown in Figure 1.6, a tall user tends to bend downward his or her body to push a trolley with low level handle.

Figure 1 6: Pushing a trolley with some load.

3. The existing trolley handle was designed with low coefficient of friction. This condition contributes hand slipping during pulling or pushing if the user's hands are wet or oily. Figure 1.7 showing the existing trolley handle.

Figure 1 7: The handle of trolley.

4. Difficulty in maneuvering the trolley, especially turning at a sharp corner lane. Figure 1.8 is showing that the trolley is difficult to pass through the slope.

Figure 1.8: The trolley is difficult in maneuvering.

1.3 Objective

This study is embarked to achieve the following objectives:

1. To measure the anthropometric dimensions that significantly influence the push and pull forces while performing two handed symmetrical pushing and pulling tasks among male and female adults.

2. To analyze the correlations between the anthropometric dimensions, push and pull forces in two handed symmetrical pushing and pulling tasks.

3. To evaluate the push and pull forces with different handle design of manual operated industrial trolley.

1.4 Scope

This study will be curried in the laboratory of Faculty of Manufacturing Engineering by collecting the push force and pull force data. Since the research carries in the Universiti Teknikal Malaysia Melaka (UTeM), so the participants where are the student of UTeM. More accurately, the participants were the student of Faculty of Manufacturing Engineering at fourth year for female and male. The target of number of participants is based on the sample size of total number of students. The data obtained by the help of equipment name Mark 10 Force Gauge and static object. By the way, this study is only considerer on the part of handle of the trolley. The target load that the trolley will be carry is only below 100kg.

CHAPTER 2
LITERATURE REVIEW

This chapter is mainly focused on the review of pushing, pulling task and trolley design and development that had been studied;by researchers a few years ago. The following information in this chapter was collected by many relevant resources such as articles and journal related to this project. This chapter also provides a short review on how the posture effect the forces. Besides that, this chapter also showing the overview of the design affect the ergonomic issue.

2.1 Push and Pull Force

Whether pushing or pulling force, these forces are usually used when moving things, and at the same time, this process also known as process of manual material handling. Even the technology is so widely nowadays, yet the manually material handling is needed or used in some places. According to Baba Md. Deros and his team (2010) almost all the task assigned to the worker in the automation industry including the process of manually material handling which are pulling, pushing, lifting, trunk bending, twisting and extended reach.