MULTIPLE REGRESSION MODEL FOR PREDICTING HANDGRIP STRENGTH AMONG ADULTS IN THE AEROSPACE MANUFACTURING INDUSTRY IN MELAKA

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Faculty of Industrial and Manufacturing Technology and Engineering

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A master project submitted in partial fulfillment of the requirements for the degree of Master of Manufacturing Engineering (Industrial Engineering)

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2025

DECLARATION

I declare that this master project entitled "Multiple Regression Model For Predicting Handgrip Strength Among Adults In The Aerospace Manufacturing Industry In Melaka" is the result of my own research except as cited in the references. The master project has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have read this master project and in my opinion this master project is sufficient in terms of scope and quality as a partial fulfillment of Master of Manufacturing Engineering (Industrial Engineering)

Signature : ....

Supervisor Name : ....

Date : ....

DEDICATION

This work is dedicated to the pillars of my life, mother and father.

ABSTRACT

This study aims to develop a statistical model for predicting handgrip strength (HGS) among young adults working in the aerospace manufacturing industry in Melaka. HGS is a critical measure of overall muscle strength and functional capacity, directly influencing job performance and ergonomic safety in industrial settings. The research examines the relationship between HGS and various anthropometric and demographic variables, including gender, hand dimensions, and job-specific factors. A sample of 100 participants aged 20 to 40 years from diverse occupational roles such as warehouse, layup and mechanical assembly processes was analyzed to create a robust model tailored to the aerospace manufacturing sector. Key predictors were identified using a statistical technique for choosing the best predictors, and the model's assumptions were validated through statistical assesment such as the multicollinearity, heteroscedasticity, and normality of residuals. The findings reveal significant correlations between HGS and predictors like gender, height, weight, and forearm circumference. The developed statistic model provides a practical tool for aligning HGS with job requirements, enhancing workplace safety, and mitigating risks of musculoskeletal disorders. This research contributes to the broader field of occupational health by offering an evidence-based approach to ergonomic intervention and workforce management.

MODEL REGRESI BERGANDA UNTUK MERAMALKAN KEKUATAN GENGGAMAN TANGAN DALAM KALANGAN DEWASA DI INDUSTRI PEMBUATAN AEROANGKASA DI MELAKA

ABSTRAK

Kajian ini bertujuan untuk membangunkan model statistik bagi meramalkan kekuatan genggaman tangan (HGS) dalam kalangan golongan dewasa yang bekerja dalam industri pembuatan aeroangkasa di Melaka. HGS merupakan ukuran kritikal kekuatan otot keseluruhan dan keupayaan fungsi yang secara langsung mempengaruhi prestasi kerja dan keselamatan ergonomik dalam persekitaran industri. Penyelidikan ini mengkaji hubungan antara HGS dengan pelbagai pembolehubah antropometri dan demografi, termasuk jantina, dimensi tangan, dan faktor khusus pekerjaan. Sampel sebanyak 100 peserta berumur 20 hingga 40 tahun daripada pelbagai peranan pekerjaan seperti gudang, layup, dan proses pemasangan mekanikal dianalisis untuk membina model yang kukuh dan disesuaikan untuk sektor pembuatan aeroangkasa. Peramal utama dikenal pasti menggunakan teknik statistik untuk memilih peramal terbaik, dan andaian model disahkan melalui penilaian statistik seperti multikolineariti, heteroskedastisiti, dan kenormalan sisihan baki. Penemuan kajian menunjukkan hubungan yang signifikan antara HGS dengan peramal seperti jantina, ketinggian, berat badan, dan lilitan lengan. Model statistik yang dibangunkan ini menyediakan cara praktikal untuk menyelaraskan HGS dengan keperluan kerja, meningkatkan keselamatan tempat kerja, dan mengurangkan risiko gangguan muskuloskeletal. Penyelidikan ini menyumbang kepada bidang kesihatan pekerjaan dengan menawarkan pendekatan berasaskan bukti untuk intervensi ergonomik dan pengurusan tenaga kerja.

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LIST OF ABBREVIATIONS

$UTeM$	-	Universiti Teknikal Malaysia Melaka
HGS	-	Hand grip strength
$RHGP$	-	Right-hand grip power
$LHGP$	-	Left-hand grip power
RHB	-	Right-hand breadth
LHB	-	Left-hand breadth
HB	-	Hand breadth
HL	-	Hand length
BMI	-	Body mass index
$ANOVA$	-	Body mass index

LIST OF SYMBOLS

°	-	degree
cm	-	Centimeter
kg	-	Kilogram
kgf	-	Kilogram-Force

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CHAPTER 1

INTRODUCTION

1.1 Background

Handgrip strength (HGS) is a reliable indicator of overall muscle strength and a predictor of functional performance and health status in adults. In industrial settings, HGS can be particularly relevant as it affects the ability to perform tasks such as grasping objects that require manual dexterity and force. HGS is widely used as an indicator of physical ability for work-related tasks involving manual labor, lifting, and precision as indicated by Soteriades et al. (2019).

Currently, there is a notable absence of effective tools and models tailored to predicting handgrip strength (HGS) in Malaysian workers, hindering efforts to optimize ergonomic practices and prevent injuries in diverse occupational environments. This study aims to develop a regression model that predicts HGS in young adults employed in the aerospace manufacturing industry in Melaka, incorporating various anthropometric and demographic variables.

This study also aimed to investigate the linear relationship between handgrip strength and hand anthropometric variables, gender, and ethnicity among young adults. The sample comprised 100 participants, selected from a population of 1,100 individuals in the aerospace manufacturing industry in Melaka, aged between 20 and 40 years. The participants represented a diverse range of occupational roles, including warehouse, layup, and mechanical assembly.

1.2 Problem Statement

This research aims to address the lack of task-specific predictive models for handgrip strength in the aerospace manufacturing industry in Melaka. The following key problems highlight the need for this study:

i) Inadequate Predictive Models for Handgrip Strength in Specific Industrial Processes: Existing models for predicting handgrip strength, as highlighted by Hwang et al. (2021) and Klum et al. (2012), are not tailored to specific occupational tasks, particularly in industries such as aerospace manufacturing in Malaysia. These models fail to consider task-specific anthropometric and biomechanical variables unique to workers involved in processes like warehouse operations, layup tasks, and mechanical assembly. This limits the accuracy of ergonomic interventions, compromising workplace safety, productivity, and worker well-being.

ii) Task-Related Risk of Musculoskeletal Disorders and Reduced Job Performance: Darvishi et al. (2022) and Oakman et al. (2016) identified that the absence of process-specific predictive models increases the risk of work-related musculoskeletal disorders (MSDs) for workers performing repetitive and physically demanding tasks. In the aerospace manufacturing industry, such risks are particularly prevalent in warehouse material handling, layup operations requiring precision and endurance, and mechanical assembly involving sustained handgrip strength. Without accurate task-specific models, ergonomic interventions may be ineffective, leading to injuries, reduced productivity, and poor job performance.

iii) Limited Generalizability of Existing Models Across Industrial Processes:

Hwang et al. (2021) emphasized that while developing regression models for handgrip strength is important, their applicability across diverse industrial processes remains a challenge. For Aerospace Manufacturing Industry in Melaka, ensuring that a predictive model accounts for the physical demands and anthropometric variability of workers in warehouse, layup, and mechanical assembly processes is essential. A lack of generalizability limits the implementation of ergonomic solutions that can improve worker health, safety, and efficiency in these settings.

1.3 Research Question

This research aims to develop a regression model for the handgrip strength of a young adult in the Aerospace Manufacturing Industry in Melaka. Here are three research questions that align with the stated objectives:

i) What are the key anthropometric and job-specific variables that can be incorporated into a regression model to accurately predict handgrip strength among workers in the aerospace industry's warehouse, layup, and mechanical assembly processes?

ii) How does handgrip strength correlate with task-specific performance metrics, including material handling efficiency in the warehouse, precision in layup tasks, and assembly accuracy in mechanical assembly processes?

iii) How can the developed regression model be effectively utilized to align handgrip strength (HGS) with specific job-related functions, and to what extent can its application mitigate the risk of work-related musculoskeletal disorders across the warehouse, layup, and mechanical assembly processes?

1.4 Research Objective

This research aims to develop a regression model for the handgrip strength of a young adult in the Malaysian industry. Here are three research objectives:

i) To develop a regression model tailored to predict handgrip strength among workers in the aerospace manufacturing industry, specifically focusing on the warehouse, layup, and mechanical assembly processes, by incorporating anthropometric variables.

ii) To analyze the relationship between handgrip strength and task-specific performance metrics, including material handling process in the warehouse, layup process tasks, and assembly process in mechanical assembly processes.

iii) To assess the applicability of the developed regression model in matching the HGS with work-related functions and reducing the risk of work-related musculoskeletal disorders across the warehouse, layup, and mechanical assembly processes.

1.5 Scope of Research

The scope of this research is as follows:

i) Timeframe: Define the study's time period within 1 year in order to develop recent trends and a reliable regression model.

ii) Industry Focus: Narrow down the study to a specific sector, which is the aerospace manufacturing industry in Melaka.

iii) Process-Oriented: Focusing on three processes such as warehouse, layup, and mechanical assembly.

iv) Demographic Variables: Incorporate demographic variables from age 20 to 40 years old and gender into the model to enhance prediction accuracy.

v) Anthropometric Data: Include anthropometric data from a diverse sample of adults in the aerospace manufacturing industry in Melaka.

1.6 Master Project Outline

Based on the objectives previously presented and on the approach proposed before, this master project is made up of five (5) chapters, which contents are summarized as follows:

i) Chapter 1. Introduction. This chapter presents the background of the study, research problems, objectives, scopes and significance of the research.

ii) Chapter 2. Literature review. This chapter begins with a brief overview of related studies on handgrip strength, including a summary of models and data developed by other researchers.

iii) Chapter 3. Methodology. This chapter presents the methodology used to develop a regression model of the handgrip strength of young adults in the Malaysian industry.

iv) Chapter 4. Result and Discussion. In this chapter, the handgrip strength data have been collected and verified through the regression model and the result is discussed.

v) Chapter 5. Conclusion and Recommendations. This chapter summarizes the main conclusions as well as achievements of the work undertaken in this research and suggests areas for future work.