

Design and Fabrication of Adjustable Wheelbarrow

Nurul Izatul Nuraishah binti Mazlee¹, Norsilawati binti Ngah^{1*}, Muhammad Khalil bin Zakaria¹, S. N. Azinee

¹ University College Tati, Jalan Panchur, Kampung Teluk Kalong, 24000, Kemaman, Terengganu

*Corresponding author: norsilawati@uctati.edu.my

KEYWORDS	ABSTRACT
Musculoskeletal injuries ergonomic Finite Element Analysis Adjustable Wheelbarrow	Previous studies provided evidence that young farmworkers and agricultural workers may be at risk of lower back musculoskeletal injuries. Effective interventions are needed to reduce the stressors that cause harm to minimize these risks. Since almost all work environments require manual operations, agricultural and peasant workers are very likely to bear heavy loads. Lower back pain and injury are considered one of the most common musculoskeletal diseases caused by weightlifting. However, several factors increase workers' risk, such as weight, age, gender, and height. The purpose of the current research is to study alternative forms of the wheelbarrow as an intervention for young people to transfer materials on farms. Young people helped solve this problem by innovating a simple machine called an adjustable wheelbarrow, which can transport goods from one place to another place. The research first focused on the design of the tank scissor lift. It is good to make the new design have better ergonomic through some research on the scissor lift's existing structure and materials. This project aims to fabricate the adjustable wheelbarrow used scissor lift and explore the influence of load position and force on muscle activity during the wheelbarrow task. Innovative wheelbarrow used to relieve back pain of users. Previous studies show that alternative wheelbarrow designs can reduce the awkward postures and motions during wheelbarrow tasks. Therefore, further research into the effectiveness of these interventions, including spine loading and long-term use, is necessary. The structural model was developed using computer-aided design software. Finite Element Analysis (FEA) software is performed to study the scissor lift's deflection below the tank wheelbarrow after the load was applied.

Received 30 November 2021; revised form 17 December 2021; accepted 24 December 2021

© 2021 University College TATI (UC TATI). All rights reserved.

1.0 INTRODUCTION

Human beings are faced with a lot of problems. There was a time when it is difficult to carry a load from one place to the another but as time goes on, solutions were preferred to this problem by providing a simple machine called a wheelbarrow to help transport goods from one place to another. While the result indicates that alternative wheelbarrow design can reduce the awkward postures and motion during wheelbarrow tasks, further research into the effectiveness of these interventions, including spine loading and long-term use is necessary.

Product design and development areas are the most important sector in farmers and agriculture workers. Without the design process and product development will become weak. In almost farmer and agriculture workers, wheelbarrows are used. Adjustable wheelbarrows are ideal for a multitude of jobs including moving material to facilitate transportation work and reduce the energy used. Adjustable wheelbarrows are operated with either hydraulic or manual scissor lift operations. The existing wheelbarrow on the market has various designs, some lower or high containers.

With the existence of the adjustable wheelbarrow, it does not cause problems for consumers to have it in terms of reasonable price, easy to lift material, and easy to move comparison with existing markets. The project is about the process of designing and fabricating an 'Adjustable of Wheelbarrow' which is easy to locate items at a reasonable cost.

2.0 METHODOLOGY

This section includes an explanation of the procedure, analysis, methods, and steps during the progress of this project. All the important elements that need to be considered in this project explain during this chapter. As it is indicated in the title, this chapter includes the research methodology of the dissertation. All procedures and methods that were used to achieve the objectives and to solve the problem using analysis software were presented in this section.

2.1 PROCESS OF THE FLOWCHART

The flow process is to ensure the process for this project is completed according to the time frame. This flow chart consists the steps of the project from the beginning until the end of the project in order by connecting the topics via arrows as shown in Figure 2.1 below.

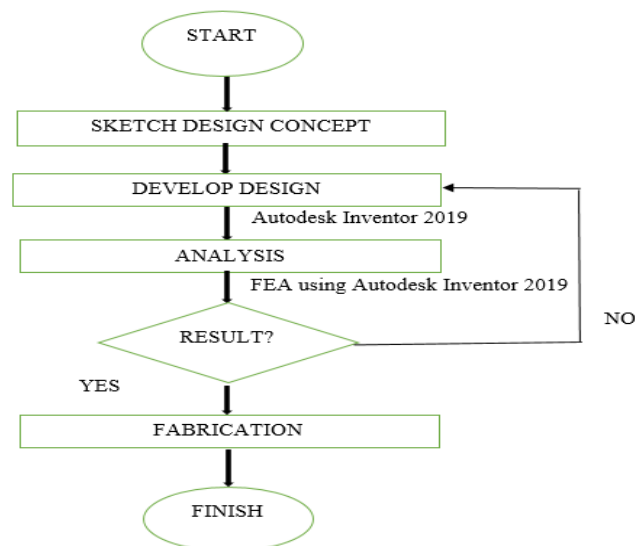


Figure 2.1: Process Flowchart

2.2 CONCEPT DESIGN

This section shows the evolution of the design concept from the first idea to the finalized idea. This will describe how the idea of product expands through study and research.

The first concept is that use a manual scissor jack. The position of the manual scissor jack is away from the tank. This is caused by a hanging and grabbed by the iron. Manual scissor jack operates by turning the handle at the manual scissor jack and order to lift the platform.

The second design concept that used a hydraulic scissor jack. The position hydraulic scissor jack is directly below the tank. Hydraulic scissor jack operates using the power source at the below of wheelbarrow by the feet with pressurized hydraulics to lift the loads.

The third design concept is the finalized design with the combination of features within design concept 1 and design concept 2. This is the most ideal and the best design of the product. It will consider its function, size, cost, and mobility.

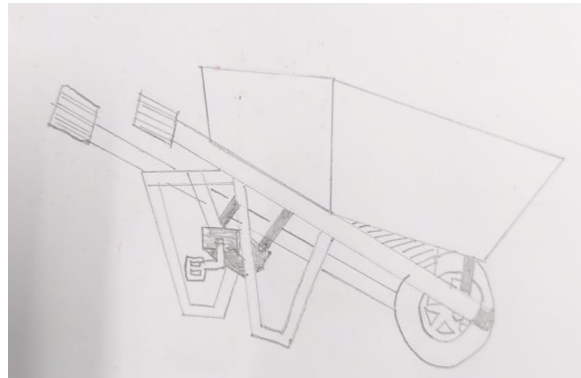


Figure 2: Design Concept 1

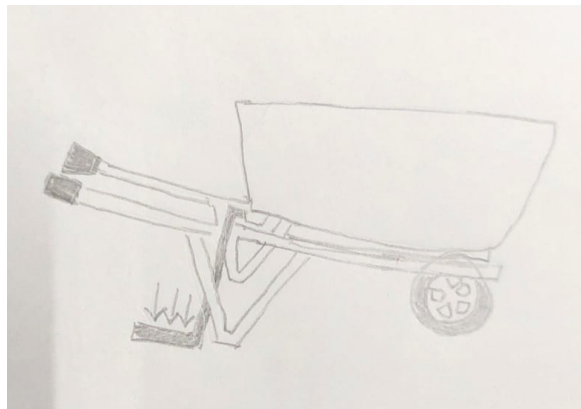


Figure 3: Design Concept 2

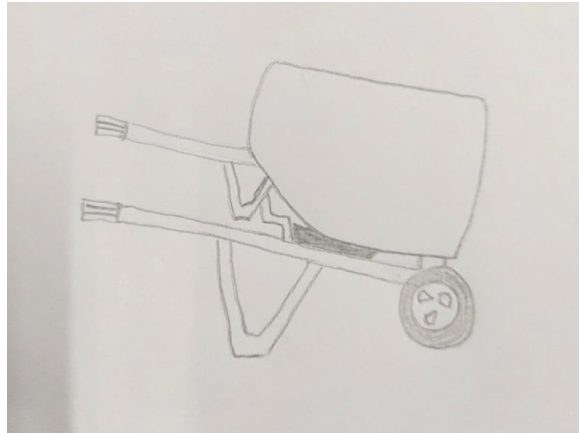


Figure 4: Design Concept 3

2.3 FINAL DESIGN

2.3.1 Isometric View

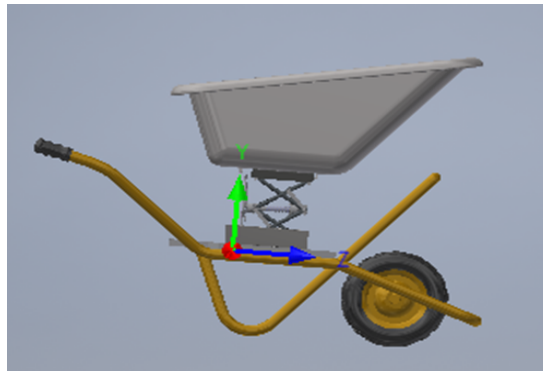


Figure 2.5

3.0 RESULTS AND DISCUSSION

3.1 FINITE ELEMENT ANALYSIS

In this section, the analysis of the structure's performance is to analyze the stress configuration. This stress analysis uses mild steel and stainless steel as materials. Figure 3.1, Figure 3.2, and Figure 3.3 show the von misses stress, displacement, and safety factor of the project by applying 686 N. The results of Finite Element Analysis were shown below (Figure 3.1) and were done by Autodesk Inventor Software.

3.1.1 Von Misses Stress

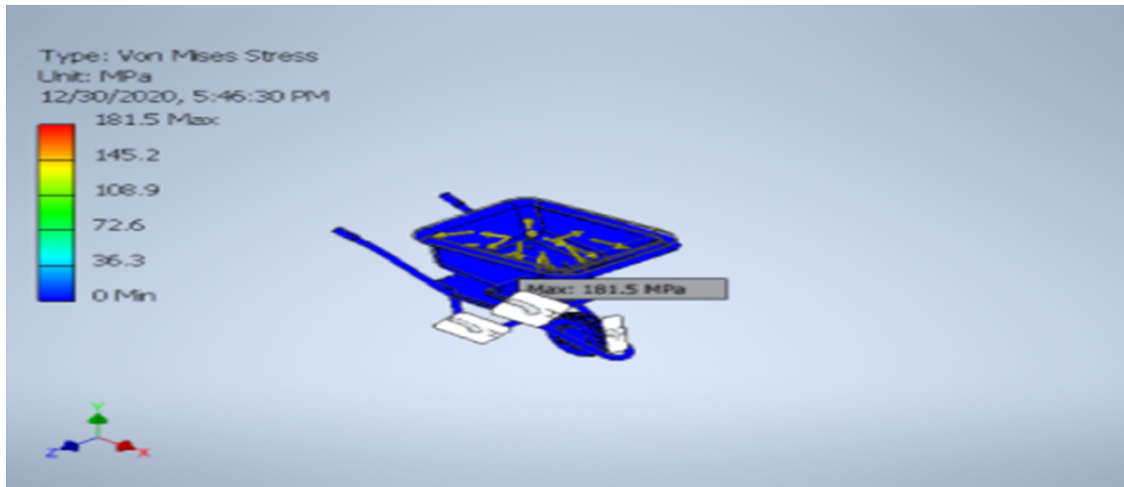


Figure 3.1: Yield Strength Analysis at Wheelbarrow and Scissor lift

The von Mises stress was used to predict the yield of materials under complex loading from the results of uniaxial tensile tests. The von Mises stress satisfies the property where two stress states with equal distortion energy have an equal von Mises stress. From the result obtained, the maximum value for von misses stress is 181.5 MPa, the yield strength of the material used is 207 MPa. This is accepted because the value generated by this stress analysis feature is lower than the yield strength of the material itself.

3.1.2 Displacement

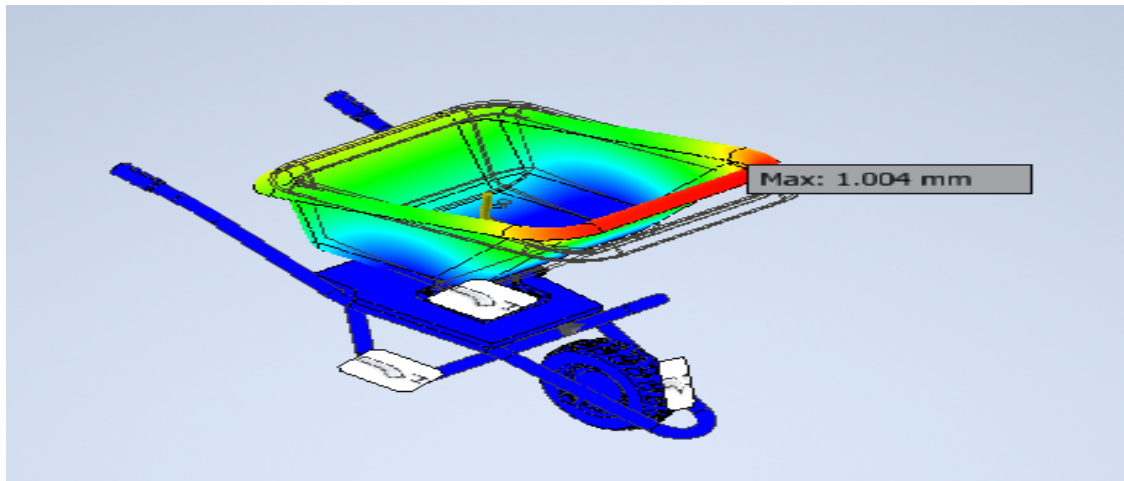


Figure 3.2: Displacement Analysis

A group displacement analysis is a process of analyzing group business based on the total value of the business and comparing it to the total value of the transient business that would be displaced if the group business was accepted. From the result of displacement analysis, the maximum value for displacement analysis is 1.004 mm. The result is accepted when 1 mm is only a small value.

3.1.3 Safety Factor

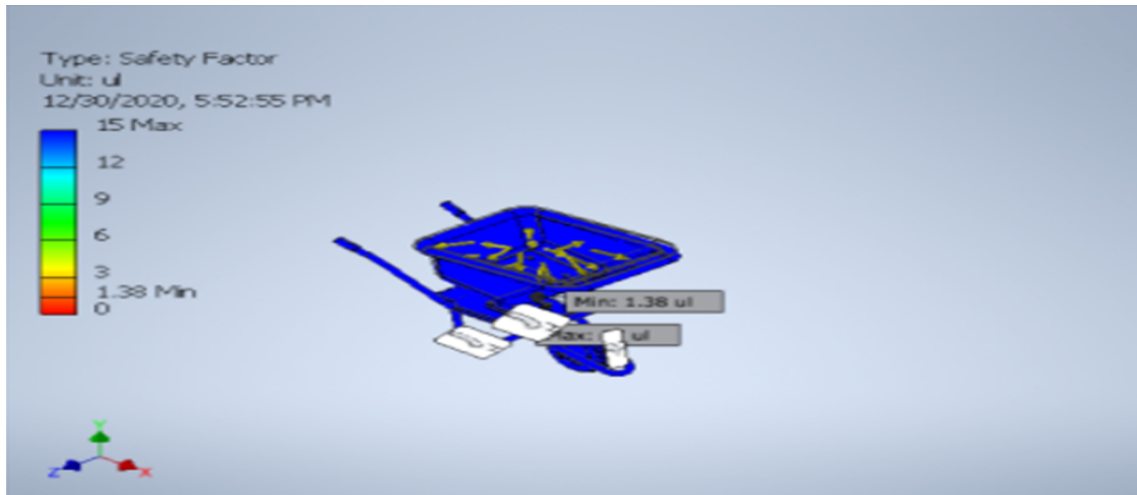


Figure 3.3: Safety Factor Analysis

The ratio of a structure's absolute strength (structural capability) to actual applied load; is a measure of the reliability of a particular design. This is a calculated value. This is sometimes referred to, for the sake of clarity, as a realized factor of safety. Based on the analysis, the result shows the maximum value for the safety factor is 15 as shown in Table 3.1.

Table 3.1: Result for Analysis

Type	Minimum	Maximum
Von Misses Stress	0 MPa	181.5 MPa
Displacement	0 mm	1.004 mm
Safety Factor	1.38	15

4.0 CONCLUSION

For this project, three objectives were achieved. The first objective is to innovate an adjustable wheelbarrow. This objective was completed by fabricating the adjustable wheelbarrow. The second objective is the design and analysis of the adjustable wheelbarrow using Autodesk Inventor 2019. Lastly, the objective is to fabricate the adjustable wheelbarrow in terms of the design concept that choices. This objective also has been achieved by fabricate the product.

In conclusion, the entire problem has a solution. With the success in developing the new design of the adjustable wheelbarrow, with the different cost compared at the market value, the product can make workers easier to put the stuff and easy to move around with compare to the current wheelbarrow, that is not ergonomic and uses a lot of energy and the last requires low maintenance in case faulty.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the technical support of Faculty of Engineering Technology, Manufacturing Department at UC TATI, Terengganu, Malaysia.

REFERENCES

- Chen, S. H., Lee, Y. H., & Lin, C. J. (2015). Effects of load position and force direction on BACK muscle loading in one-wheeled wheelbarrow tasks. *Work*. <https://doi.org/10.3233/WOR-141841>.
- Godilano, E. C., Casas, K. V., & Vargas, A. J. (2018). Design of an ergonomic wheelbarrow to reduce physiological demands of general users. 2018 5th International Conference on Industrial Engineering and Applications, ICIEA 2018. <https://doi.org/10.1109/IEA.2018.8387138>.
- Kotowski, S. E., Davis, K. G., & Waters, T. (2009). WAGR investigation of select ergonomic interventions for farm youth. Part 2: Wheelbarrows. *Journal of Agromedicine*. <https://doi.org/10.1080/10599240802612653>.
- Zhang, W., Zhang, X., Yan, C., Xiang, S., & Wang, L. (2015). A characteristic triangle method on input vectors of scissor lift mechanism and its applications in modeling and analysis. *Journal of Advanced Mechanical Design, Systems and Manufacturing*. <https://doi.org/10.1299/jamdsm.2015jamdsm0042>.
- K Nicolay – US Patent App. 10/152,752,2003 – Google Patents, US20030218305A1, https://scholar.google.com/scholar?start=0&q=adjustable+wheelbarrows&hl=id&as_sdt=0,5#d=gs_qabs&u=%23p%3DhOTWCgljS0QJ.
- David C. Winter et al, <https://patents.google.com/patent/US20090295109A1/en>.
- KH Messinger-Rapport – US Patent 6,755,478, 2004 – Google Patents, <https://patents.google.com/patent/US6755478B2/en>.