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Analysis of Simulation Results on The Design Model of Rice Loading Tools

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Abstract. Indonesia is one of largest country in the world that consumes and produces rice every year. Many rice production factories throughout Indonesia still use a plastic dustpan to fill a rice sack, therefore rice production in Indonesia is still relatively slow. The loading process can be accelerated using a rice loading tool. This design uses the concept of a lever to lift rice, intended to speed up the loading process and increase the volume of rice filled in the sack so that production efficiency can increase. The design of the shovel model that will be made has a total length of 1.8 m with the distance from the axis point to the base body is 0.5 m, the distance to the secondary handle is 1m and the distance to the primary grip is 1.3 m. The simulation process is carried out through Autodesk Fusion 360 by giving a test to the bucket in the form of a distributed load of 58.8 N and a load on the handle of 233.48 N with an angle of the force of 30 degrees because it assumes that this object will be pulled by a person placing the force on the handle that will be placed at 3 points, namely the main handle, the secondary handle, as well as pull from an extreme point in tension. The results of this design will be one of the references for further development. Keywords: Rice loading tool, product design, simulation.

INTRODUCTION)

Indonesia is the third largest rice consuming country in the world. Each year, Indonesia consumes 37.4 million tons of rice [1], with total rice production reaching 31.31 million tons of rice in 2019 [2], [3]. The data above shows that rice is the main commodity needed by the Indonesian people, with rice being a great need for the Indonesian people, it is not surprising that there are many rice factories in Indonesia. PT. Tangerang Jaya Makmur is one of the rice factories that is preparing a rice supply of 30 tons per project. The obstacle faced is the slow filling process of rice in the sack because the filling process is still using the traditional method, namely using a plastic dustpan. The ability of a plastic dustpan to fill a 25kg rice bag takes about 2 minutes on 10 fillings. If 3 workers must pack 30 tons of rice, it will take up to at least 6-7 working hours for each worker, not including the process of packing, transporting, and unloading rice. This study aims to design a device capable of helping the process of loading rice into sacks which is faster and with more volume. It is hoped that this tool will increase the efficiency of the rice loading process, help the sack transport process, and reduce costs for long-term use. The focus of the design carried out is the design of the rice shovel to fill the rice sacks.

METHOD

The method used in designing rice loading tools is a systematic method. The design begins by identifying existing problems, performing theoretical calculations, making designs, performing simulations using Autodesk Fusion 360 to obtain stress analysis, safety factor, stress, deflection, stress reactions, strain, and contact pressure on

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the shovel frame. The following is a simplification of the modeling of the rice shovel for loading that will be used [4], [5].

FIGURE 1. Design concept of rice loading tools

The material used to design rice loading tools is carbon steel SS400 or AISI 1018. SS400 carbon steel material is easily found in the market at an affordable price and has very strong mechanical properties for this design and is weldable [5], [6]. The mechanical properties of SS400 carbon steel can be seen in Table 1.

TABLE 1. Mechanical properties of rice loading tool material [5], [6]

Tensile strength	440 MPa
Yield strength	370 MPa
Modulus of elasticity	205 GPa
Shear modulus	80 GPa
Poisson's ratio	0.29
Elongation at break (in 50 mm)	15%

RESULT AND DISCUSSION

In designing rice loading tools, it is planned to use a thin steel plate ranging from 1 mm to 2 mm thick. The tool is designed to have a height of 180 cm or 1.8 m with detailed initial design data specified in Table 2.

TABLE 2. Initial data of design for rice loading tools

The mass of the shovel	25 kg
Material type	SS400/AISI 1018 Carbon Steel Steel
Load mass (rice)	4-6kg
Arm length (main)	1.3 m
Arm length (secondary)	1 m
Pivot to pivot distance	0.5 m

The working concept of a lever is the main mechanism for driving this shovel where heavy loads will be lifted by utilizing the length of the arm. For this reason, an analysis of the force that is focused on the construction of rice loading tools is needed, namely the force required to produce a moment on the shaft or pivot. Furthermore, it is necessary to analyze the deflection that will occur in the construction of the equipment if it receives a certain load. Initial calculations are carried out to calculate the moment needed to turn this lever in order to function properly. Based on preliminary data, it can be seen that the mass of rice loading tools is assumed to be 25 kg with the rice transported at 4-6 kg. Calculation is required to carry a load of 31 kg on this lever and the force required to rotate the lever, so that we can get the focus of rice loading tools [7[, [8], [9].

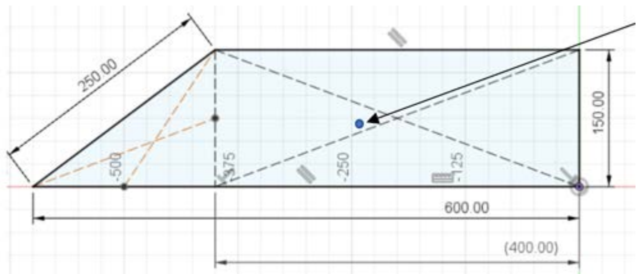
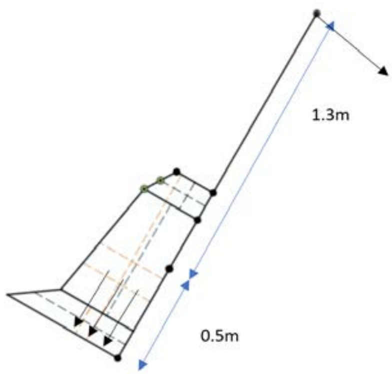


FIGURE 2. Model of weight coordinates

The next step is to calculate the force required to rotate the lever [10], [11], as shown in Figure 3. Based on the results of the calculations that have been done, the minimum force required for this rice loading tool is 233.48 N. As a validation step for the calculation results, a loading simulation is carried out using 360 fusion to ensure that the instrument can rotate.



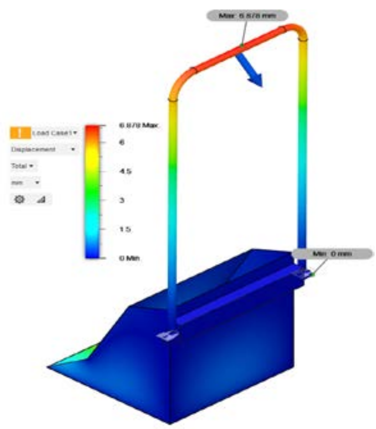
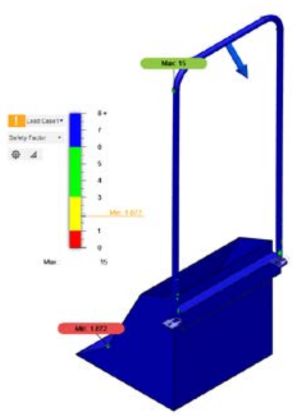


FIGURE 3. 2D Model of shovel upright position

FIGURE 4. Simulation results of applying force to the model of rice loading tools

It can be seen in the picture above that by applying a force of 233.48 N there will be a displacement or change in the model, which is around 6.878 mm. This proves that the force of 233.48 N can rotate the rice shovel when the conditions are upright. Deflection that occurs on hollow stems also cannot be considered valid, but from the results that have been obtained, at least it is noted that the deflection that occurs in hollow stems is greater than the deflection that occurs in the bucket of rice shovels. Analysis of the deflection that occurs in the model will be done using a simulation on autodesk fusion 360. The load given to the handle is the same as the force requirements as is done in the above calculation, which is 233.48 N.



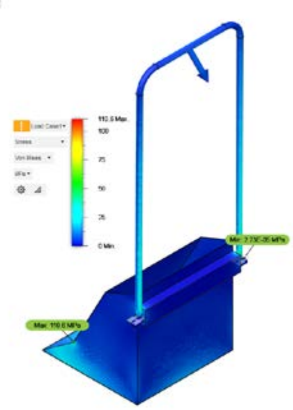


FIGURE 5. Simulation result of safety factor

FIGURE 6. Simulation result of stress

In this design, the safety factor is divided into two critical points (Figure 2). In the stem holder, the design safety factor is very safe, reaching 15, while for the rice shovel it is only 1,872. In this part of the shovel, the plate is at risk of tearing if the load received exceeds 1.87 * 6 kg or the equivalent of 11.23 kg. Meanwhile, for the right side of the image, the stresses that occur are very low, ranging from 20-30 MPa only. The critical point is that at the elbow lip of the rice shovel, where the greatest stress of 110 MPa occurs. If we look at the type of material used, namely SS400 steel, the stress resistance of this material is 440 MPa, thus it can be stated that this material is very good for the design of this rice shovel tool (Figure 6).

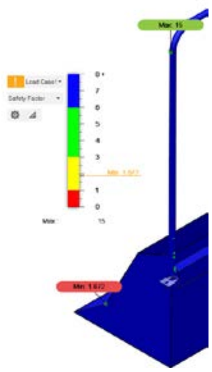


FIGURE 7. Simulation result of deflection

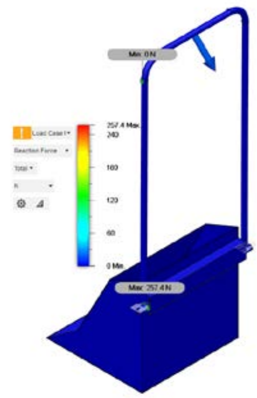


FIGURE 8. Simulation result of secondary handle stress

In this simulation, the force is applied to the uppermost point of the transport rod handle. This force can cause deflection of the stem evenly from the center to the side of the stem, which is 6.9 mm. From the simulation results, the force reaction performed by the pivot is 257.4 N. The material used in the design has a yield strength of 370 MPa which means that the shear stress that can be resisted is 370 * 0.58 = 296 MPa. With the shear stress of 296 MPa and the pivot part which has a surface area for the shaft of 6.1 mm^2, the force that can be withheld is 1.81 N, so that the load that occurs is smaller than the force that the material can withstand [12], [13].

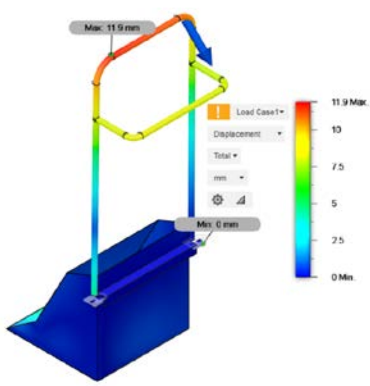


FIGURE 9. Simulation result of deflection

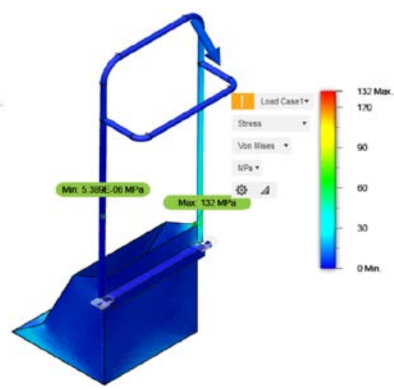


FIGURE 10. Simulation result of contact pressure

At the elbow lip of the rice loading tools there is a different strain when compared to the conveying rods. This causes stress concentration at that point because of its sharp shape. The simulation results show that the possible strain is 7.79 x 10^{-4}. This figure is very small so it can be said that the strain that occurs will not affect the performance of the tool. Based on the results of the simulation that has been done, it is obtained that the point where the greatest contact pressure occurs is at the joint between the carrier rod and the rice shovel, which is 14.46 MPa. The construction design of rice loading tools is declared safe because it can withstand loads of 110 MPa.

Meanwhile, the real load of 14.46 MPa is far below the strength of the rice loading tools. However, it cannot be ascertained that this design will be safe even though the simulation results show good results [12-14].

CONCLUSION

The design and simulation of rice loading tools has been produced. Based on the simulations that have been carried out, it is concluded that this initial design can be continued in making product prototypes. The 6 simulations that have been carried out show good results. The maximum load that may be given should not exceed 11.2 kg as this will cause damage in the form of a shovel lip tearing. The 6 kg load is a safe load to be lifted using this rice loading tool. The next step is the development of a design by paying attention to ergonomic principles so that it is safer and more comfortable when used and continued with the manufacture of product prototypes and field trials.

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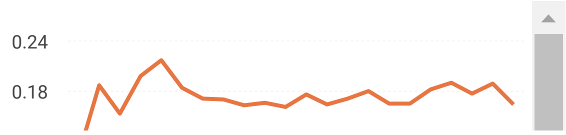

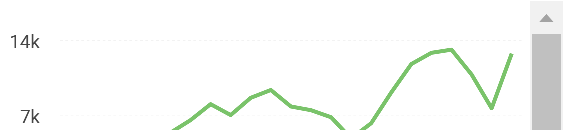

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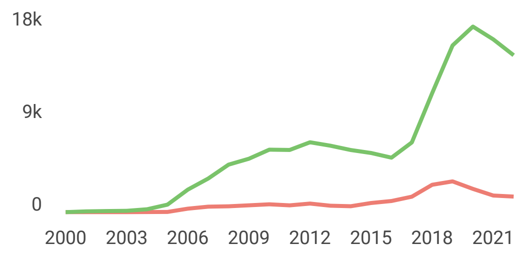

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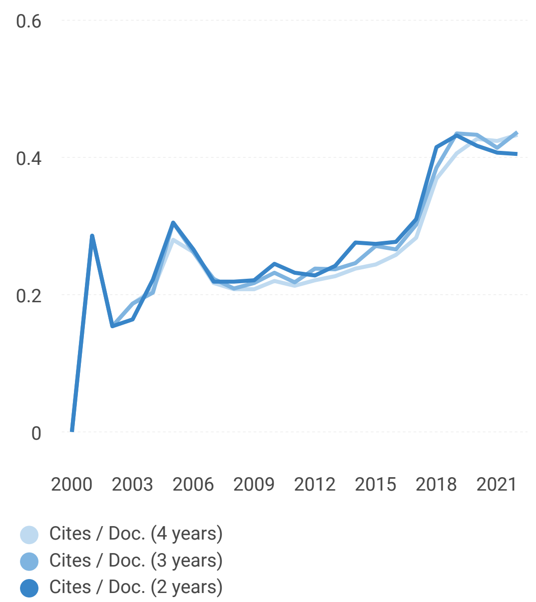

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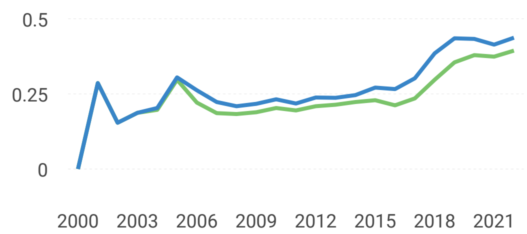

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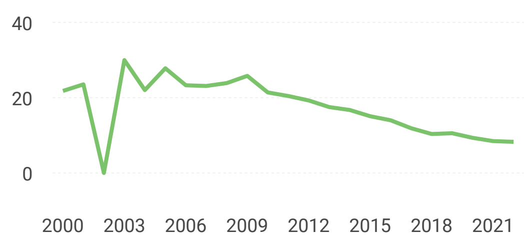

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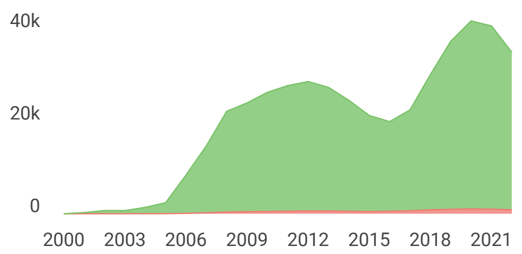

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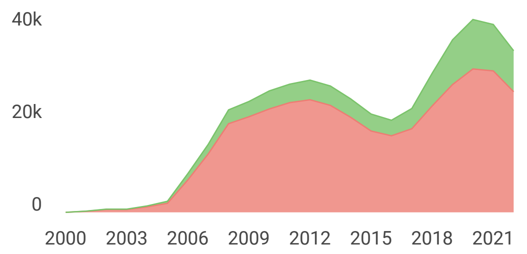

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