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Design and Analysis of Flour Sieving Machine Prototype Using Autodesk Inventor

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ABSTRACT

Small and Medium Industries (SMIs) significantly contribute to the country, especially in the Gross Domestic Product (GDP), employment, and exports. However, with the challenging external environment, SMIs must innovate to compete and survive in the business environment. Several problems can be identified in this study, such as the need to save on energy consumption and workers when operating the original Flour Sieving Machine, less productivity due to machine size, and the safety issue when the machine works at the exceeded limit of 2 kilograms (kg).Caused by that, this study aims to reduce the use of energy and labor, innovate the machine to the ideal or suitable size to save production time, and improve the safety aspects of machine operation for the safety of users and a longer life-span for the machine to operate. Therefore, researchers have conducted observations and discussions with the industry to identify and determine the elements of problems in the operation of Flour Sieving Machine through the House of Quality (HOQ) method. Next, the researchers used the information obtained from the HOQ matrix evaluation to design and innovate a new Flour Sieving Machine using Autodesk Inventor 2016 software. One of the innovations is changing the semi-automatic system to an automatic system, i.e., the press paddle to the adjusting switch, to reduce energy and labor in operating the Flour Sieving Machine. Another innovation made is increasing the width of the machine frame and flour sieve container. Apart from saving time, it can also accommodate 5 kg of flour in one sieving process compared to the original machine with only 2 kg of flour. The machine's safety characteristics may then be addressed after increasing the width of the machine's size because the machine can sustain a greater load than the original machine, making the innovation machine more durable to use in the long term. All these innovations are analyzed and simulated to obtain a new optimal Flour Sieving Machine design. The researchers discovered that the design of the Innovation Flour Sieving Machine could solve the problem of SMIs in terms of saving energy, manpower, and time, increasing the amount of flour that can be sieved at one time and increasing the comfort and safety of users and machines because the innovation machine can accommodate a larger load than the original machine as a result of the simulation. It can be concluded that there are some improvements in quality, productivity, and safety during the operation of this Innovative Flour Sieving Machine.

Keywords: Analysis, Autodesk Inventor, Design, Stress, Safety Factor

I. INTRODUCTION

In modern design, art and design have already become a part of our lives and play important roles in our society. Design is a knowledge of the planned arrangement of materials to produce a product that impacts life (Mourtzis, 2020). According to Ralphand Wand (2009), a clear understanding of what design means is important from three perspectives. From an instructional perspective, it seems obvious that any designer's education ought to include providing a clear notion of what design is. A better understanding of design will inform what knowledge such education could consist of. Besides that, from a research perspective, a precise definition will enhance construct validity in any theoretical or empirical work in which design is a construct.

Furthermore, having a clear understanding of design would make it easier to build design-related constructs like design project success. Having a well-defined definition might help establish a cumulative tradition of design research. The alternative is that different theories define design differently or do not define it explicitly. From the perspective of a (software design) practitioner, a clear definition of design can help organize, exchange, and reuse design information. Such collaborative work can help software projects succeed, and developers work more efficiently. Furthermore, understanding the design elements would help determine the issues and information that need to be considered in the design process and planning this process.

Nowadays, design decorates our society and living places, brings us a well-rounded life, and makes our lives more colorful. Design is a great benefit that would not cause any negative issues to our society. Design is very important in our daily lives because it gives people the opportunities to change their lives to become better and more fun. Besides that, it is also the basis for producing authentic products beneficial to human life and making our lives easier and more comfortable. On top of that, according to Müller et. al,. (2021), the importance of design can contribute to modern technology, social development, science, and business, fulfilling the needs of individuals and society, facilitating work through renovation, fostering the value of innovation and creativity, and opening career employment paths. The importance of design can be seen in various fields such as construction, medicine, engineering, communications, transportation, etc.

In this project, the researchers have chosen to innovate a flour sieve owned by AZ Impiana Enterprise. During this time, sifting the flour is done manually. This approach is time-consuming and exhausting. Figure 1 shows a diagram of the hand filtering process.

Figure 1.1: The traditional process of sifting flour

Then, the company decided to use a semi-automatic flour sieve by using a pedal. However, the longer it is used, the more issues it develops. Another option for resolving the problems is to redesign the machine. With this innovation, sifting flour can be done quickly and uses less workforce than previous manual and machine methods.

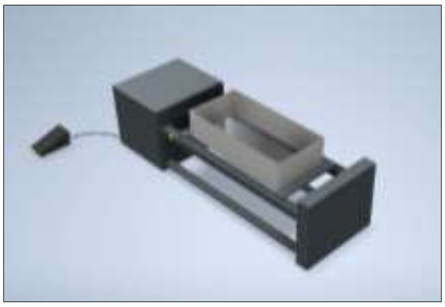

Figure 1.2 Current flour sieve design

Figure 1.3 Current flour sieve real

2. PROBLEM STATEMENT

In making waffles and Kaya balls, the main ingredient used is wheat flour. According to Tylet. al., (2019), the determination of flour quality is based on particle size to acquire uniform measurements and emphasize the quality of the flour by obtaining the particular qualities of chilled flour. The finer the flour texture, the higher the quality of the flour produced, as it improves solubility during food mixing. As a result, one of the most significant operations in producing food goods is sieve flour. Flour sieves have been used to separate foreign stuff since the dawn of humankind.(Miskelly at. al., 2017; Kumari et. al., 2021).

However, after conducting a study, the researchers revealed that dealers confront many challenges when sieving the flour. One of the issues that arise is that if a weight of more than 2 kg is added to the flour sieve machine during the sifting process, it will not perform effectively. To assure the quality of flour, a considerable force load is supplied to the flour place. As a result, the existing flour sifting machines necessitate much labor.

Next, the difficulty arises because more than 2 kg weight makes the flour sieve machine less safe to use (Olaiya et. al.,2019). This is because significant changes to the frame will quickly damage the machine.Furthermore, large amounts of flour cannot be sieved because the original sieve machine is small. As a result, merchants take excessive time to execute client orders. As a result of the problem, the researchers improved the flour sieve to make it easier for users.Indirectly, by developing a flour sieve machine, it will be able to accommodate rising consumer demand

3. METHOD

The methodology is the overall research strategy that outlines how the research will be conducted and, among other things, identifies the methods to be used (Sileyew, 2019). As described in Figure 3.1, these methods specify the methods or modes of data collection or, in some cases, how a specific result is to be calculated (Alharahsheh and Pius, 2020).The methodology seeks to exhibit our knowledge of alternative methods for indicating that the researcher made a well-considered conclusion.

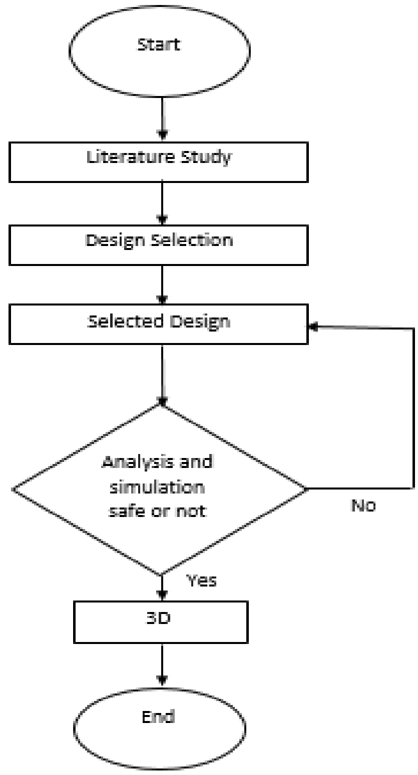

Figure 3.1 Operational Framework Research

3.1 Literature Study

The clients and the researchers discussed the observations made on the existing products. The researchers also had a discussion with the engineer and management teams about the problem that the flour sieving machine required a lot of labour to handle, the tiny size of the machine, and the issue of safety when operating this flour sieving machine.The researchersused the HOQ (House of Quality) to analyse the problem and feasibility study on the existing products so that the researchers can figured out the problems and needs from customers (Chen et. al., 2017). From there, we found the first three problems in this machine which are a thesmall size of machine, required a lot of manpower to handle the machine and the safety factor while handling the machine.

Figure 3.2 HOQ analysis of problem

3.2 Design selection

In the design selection, the researchers have used the existing product design and improved the product design according to the customer's needs. The researchers have considered the factors and efficient way the tool works, then the design planning using the Autodesk Inventor software (Telegin et. al.,2018). To plan the innovation of this product, numerous factors must be examined in terms of benefits and drawbacks for specific design enhancements. (Ahmad et. al., 2018).

3.3 Selected design

The researcher produced the overall design using the chosen design concept after obtaining an innovation for the flour sieve machine design concept, which would subsequently be analyzed and simulated.

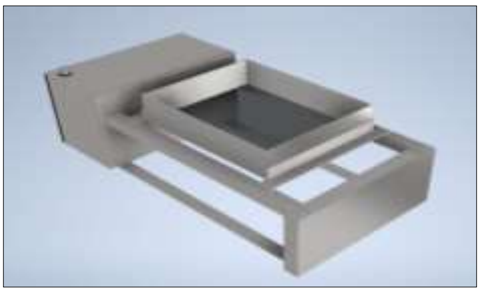

Figure 3.3 Selected Design

3.4 Analysis and simulation

Following the creation of the tool design, the design will be examined for calculations and simulations using Autodesk Inventor software(Telegin et al.,2018). The simulation tool's goal is to figure out what the design's safety factor will be. The stage will return to the design selection process if the simulation results do not meet the requirement.

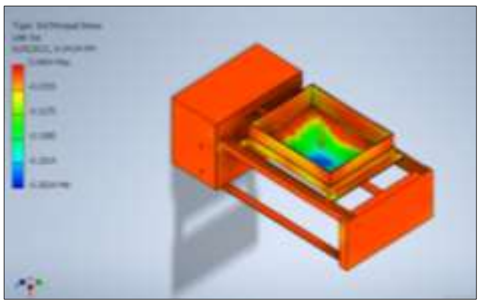

Figure 3.4 Analysis and simulation

3.5 3D Model / Prototype

After completing the design analysis and simulation, the researchers constructed a 3D prototype using stainless steel, iron ductile, plastic, and plywood for the basic components of the flour sieving machine innovation.The main components of the flour sieving machine are as follows:

NO.	COMPONENTS	MATERIALS
1.	Flour container	Stainless steel (polish)
2.	Flour container holder	Iron ductile (brush)
3.	Machine frame	Iron ductile (polish)

4.	AC power motor (240V)	Iron ductile (brush)
5.	Sieve net	Plastic
6.	Flour container cover	Plywood

Table 1: Table and specifications of flour sieving machine

4. FINDING (ANALYSIS)

4.0 Introduction

This topic includes a discussion on the analysis of thesieving machine's invention using Autodesk Inventor software and the simulation and experimental data obtained in this project. The analysis' findings will indicate the defect data for each part.Among the findings are Von Mises stress, 1st principal stress, 3rd principal stress, displacement (deformation), and safety factors. This analytical simulation applied a 5kg load to the flour sieve machine.

4.1 Von Mises Stress

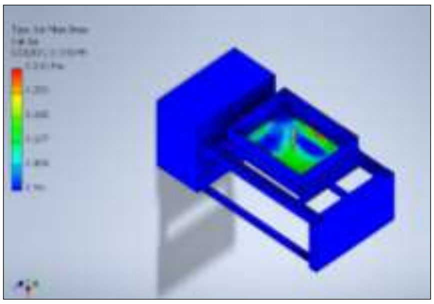

Figure 4.1: Simulation of Von Mises Stress using Autodesk Inventor

Figure 4.1 obtained from the Autodesk Inventor simulation for Von Mises Stress shows that the largest stress value is at 319.1 psi while the smallest value of Von Mises Stress is 0 psi.

4.2 1st Principal Stress

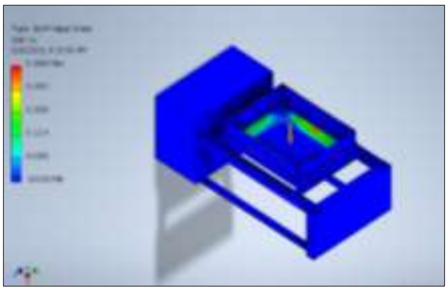

Figure 4.2: Simulation of 1st principal stress using Autodesk Inventor

Figure 4.2 obtained from the Autodesk Inventor simulation for the 1st principal stress, the largest value is at 368.8 psi while the smallest value of 1st principal stress is -43.6 psi.

4.3 Displacement (Deformation)

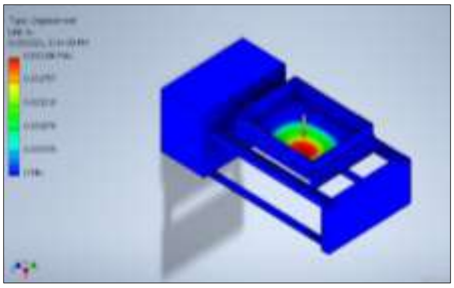

Figure 4.4: Displacement Simulation using Autodesk Inventor

Figure 4.4 obtained from the Autodesk Inventor simulation for displacement indicates that the largest value is at 0.002196 in while the smallest displacement value is 0 in.

4.4 Safety Factor

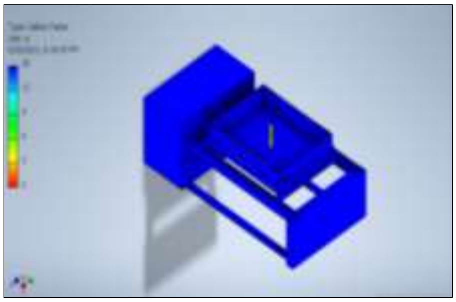

Figure 4.5: Safety factor simulation using Autodesk Inventor

Figure 4.5 obtained from the Autodesk Inventor simulation for the Safety factor. Findings show that the largest value is at 15 ul while the smallest Safety factor value is 0 ul.

5. DISCUSSION

This unique flour sieve machine fits the study's objective requirements and solves the problem statement based on the analysis findings. The following are the outcomes of the analysis-derived discussion.

Von Misses stress means the pressure at the result point. From the Von Mises stress reference, the researchers can determine the pressure value onthe flourmachine at the yield point level. The resulting point means the point at which the deformation will begin (Wibawa et. al.,2020). This is also known as the maximum power distortion failure theory. The maximum stress Von Misses stress displayed is 0.3191 kilopounds per square inch (kpsi), while the minimum is 0 when a load of 5 kilograms (kg) or 11.0231 pound-force (lb force) is applied to the flour place. It can be determined that the increase of the surface area of the tensile flour place for this innovative flour sieve machine is still in good condition and can be utilized safely.

The 1st principal stress gives you the normal stress value for the plane where the shear stress is zero. The 1st principal stress helps you understand the maximum tensile stress caused by a part due to loading conditions (Samotu et. al., 2015). In this study, the 1st principal stress analysis results after a load of 11.0231 lb force is applied, the maximum stress shows that it can accommodate 0.3688 ksi at a time and the minimum is -0.0436 ksi. This shows that this innovative flour sieve machine can handle the load and improve its function that has been imposed well (Smith et. al., 2012)

Displacement is the distance from which a node or element (beam, pole, frame, etc.) moves from its original location. The movement may be from a deflecting ray, but it may also result from an entire object moving, not distorted, such as a box sliding on a surface by friction. Displacement can be measured in terms of distance and in terms of rotation (Reza et. al., 2012). Analysis of displacement shows that the maximum change that occurs at the place of the flour sieve after a load of 11.0231 pound-force (lbforce) is applied is 0.002196 inches (in) while the minimum is 0 in. This means that only small changes occur in a place that will have a smaller impact on the functionality of the prototype flour sieve machine (Samsudin et. al., 2018).

The safety factor is how much a system can withstand in excess of the expected load or the actual load. Safety factors are often calculated by using the ratio of the main load to the allowable load for a model or structural design (Zlotnikov et. al., 2018). Analysis of the safety factor shows that, after a load of 11.0231 lb force is applied to the flour, the largest safety factor value found on this flour sieving machine prototype is 15 microliters (ul), the minimum is 0 ul. Compared to the old flour sieve machine, this new machine is safe to use when a load of 11.0231 lb is put to it.

6. CONCLUSION

In conclusion, the results of the prototype flour sieve machine analysis, which includes Von Mises stress, 1st principal stress, displacement, and safety factors,have solved the original flour sieve machine problem at SMIs. This new prototype could impact increased productivity and efficiency in production, quality of business products and material processing time, and safety while using it.

7. ACKNOWLEDGEMENT

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