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## Innovation Design Concept Of Labeling Mechanism To Improve Productivity

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### Abstrak

Proses industri harus dilihat sebagai suatu siklus yang mengupayakan perbaikan terus-menerus untuk mencapai tujuan yang diharapkan dan meningkatkan produktivitas pekerja, seperti proses pelabelan. Tulisan ini memfokuskan usulan rancangan alat pelabelan semi otomatis untuk meningkatkan produktivitas kerja proses pelabelan yang lebih efektif dan efisien. Penelitian ini menggunakan kuesioner kepada pengguna individu untuk mengumpulkan kebutuhan pelanggan. Hasil analisis menentukan acuan dalam perancangan alat inovasi dengan mengedepankan faktor-faktor seperti fungsi, kemudahan, harga, multifungsi, keamanan. Metode Simple Additive Weighting (SAW) digunakan untuk menyelesaikan pemilihan desain. Penelitian ini menemukan bahwa kombinasi material akrilik dan kayu dinilai lebih tepat berdasarkan analisis struktur. Selain itu, alat inovasi ini telah dikembangkan menggunakan rapid prototyping dan melakukan perbaikan proses yang signifikan seiring dengan peningkatan efisiensi dan efektivitas produktivitas kerja serta penghematan waktu proses pelabelan sebesar 50%.

Kata Kunci: *Desain, produktivitas, perbaikan, QFD, pelabelan*

### Abstract

The industrial process should be seen as a cycle that strives continuous improvement to achieve the expected goals and increase the productivity of the workers, such as labeling process. This paper focuses the tool design proposed for semi-automatic labelling to increase a work productivity more effective and efficient labelling process. This study uses the questionnaires to respective users to gather the customer needs. The results of analysis determine a reference in the design of innovation tools by prioritizing factors such as functionally, convenience, price, multifunctional, safety. Simple Additive Weighting (SAW) method is used to accomplish the design selection. This study found that the combination of acrylic and wood materials was considered more appropriate based on structure analysis. In

addition, this innovation tool has been developed using rapid prototyping and made significant improvement process as increases the efficiency and effectiveness work productivity of labelling process time save by 50%.

Keyword: *Design, productivity, improvement, QFD, labeling*

## INTRODUCTION

The labeling process is one of the industrial processes where the process of giving identity to the product packaging. The purpose of labeling the product is to recognize, and consumers know information about the product. Packaging is one of the important elements in a product, so manufacturers design the packaging as according to the product packaged. Mostly manual processes are unproductive activities.

Industrial process ought to be viewed as a cycle that strives continuously—continuous improvement—to meet anticipated objectives and boost productivity. The elimination of ineffective activities is one strategy for continuous improvement [1]. One of the most effective methods for cutting costs is automation, which guarantees large annual profit margins by eliminating scrap as waste, improving the performance of any machine, system, or process in any industry by reducing manpower and time, controlling quality, and improving overall performance [2]. The goal of process optimization thinking has shifted more toward making manufacturing processes work better [3]. The process optimization strategy is used to meet customer demand for the product because it helps the industry achieve its goal and increases productivity by eliminating waste [4].

This study addresses the following research questions considering the preceding background: to determine the main factors in making a sticker dispensing; to analyze the technical specifications for the sticker dispensing according to consumer needs; and to design the proposed tool for semi-automatic labelling.

Product innovation aims to meet or enhance customer requirements. Surveys, in-depth customer experience, and questionnaires (the "voice of customers") are some of the current methods for acquiring needs [5]. Every design is based on need, which can change over time. The ideal design for new product development should be meet customer requirements.

The questionnaires that were filled out by nine employees of a Chemical Company Indonesia that serves as a customer were used to collect the necessary information for the analysis. The customer's requirements for how the tools they require support the labeling process are shown in the results. The process of determining a customer's requirements for a product or service is known as customer needs analysis. Product innovation is dependent on the effective acquisition of customer needs. These needs can be divided based on the degree of difficulty and complexity. A good design draws customers to a

product, conveys its message to customer, and enhances the product's value by improving the quality of its user experiences [6].

Quality Function Deployment (QFD) is a strategy for changing over client prerequisites into plan particulars so that the final product—whether a process or a product—satisfies those requirements. QFD, which originated is utilized in the service sector as well as the manufacturing sector. In the late 1960s, QFD was created in Japan to integrate the input of the customer into the design of a product before it was made. It was successful because it cut down on startup costs and development time while also raising product quality [7]. A ceramic tile factory was used to test this framework and determine how effective QFD is in this setting [8].

With user knowledge, there are more opportunities to support the innovation idea, and users can be the source of new ideas for innovation development [9]. The process of deciding between different options for achieving a particular goal or objective is known as decision making. Simple Additive Weight (SAW) method is very relevant to solving the decision-making problem [10]. Thus, using the Tabular Additive Method with the SAW approach is useful for determining multiple selection criteria for each product being designed. Because it is based on predetermined criteria and preference weights with greater precision [11].

In developing a new product, materials and production systems have a significant impact. In the previous study, the design and evaluation tasks that make up each production system are the most important for the system's performance because each system was the result of a distinct and context-dependent development process" [12]. In most cases, a unique synergy of theoretical knowledge and data from actual experiences is required for material selection methods. All these factors prompted scientists to employ and develop selection techniques [13]. There are three stages to material selection: initial selection, development, and comparison of alternatives; finally, the best option is chosen [14, 15].

A common strategy for ensuring that products can be manufactured at the specified cost and quality is to take manufacturing aspects into consideration during the design process [16]. Products that are both comfortable and useful can only be designed with the help of ergonomic models and methods. It is widely acknowledged that employing such models in the early stages of the design process has advantages [17]. One of the most important steps in the new design product development process is prototyping [18]. Specific hypotheses, such as whether fewer parts in prototypes correlate, can be tested or prototyped to finalize product development [19]. As a result, prototyping assist in product design and increase local worker productivity by producing high-quality goods.

Conducting a product's durability test is critical when designing it. Due to their simplicity and acceptable accuracy, stress analysis of product structures frequently makes

use of simple analytical and finite element models. It is common practice to use computational three-dimensional (3D) finite element analysis to accurately predict stress fields at these locations [20].

The finite element analysis emerged from the need for analyzing complex structural analysis and elasticity problems in civil and aeronautical engineering [21]. As previously stated, the Ritz method of numerical analysis and variational calculus minimization to approximate solve vibration systems [22].

The required calculation result information can be more easily obtained during the post-processing process, and the time limit for the finite element software simulation operation samples can be effectively reduced if the input and output variables are reduced during the simulation analysis process [23].

The contribution of this research can be seen as determining the main factors in making a sticker dispensing tool, analyzing technical specifications for sticker dispensing tools according to consumer needs, and designing a sticker dispensing tool based on the formulation of the problem that has been studied. In addition, this innovation concept was developed to carry out the most of current problem faced by the mass production companies.

### RESEARCH METHODS

The method for semi-automatic labeling of design tools is shown in Figure 1.

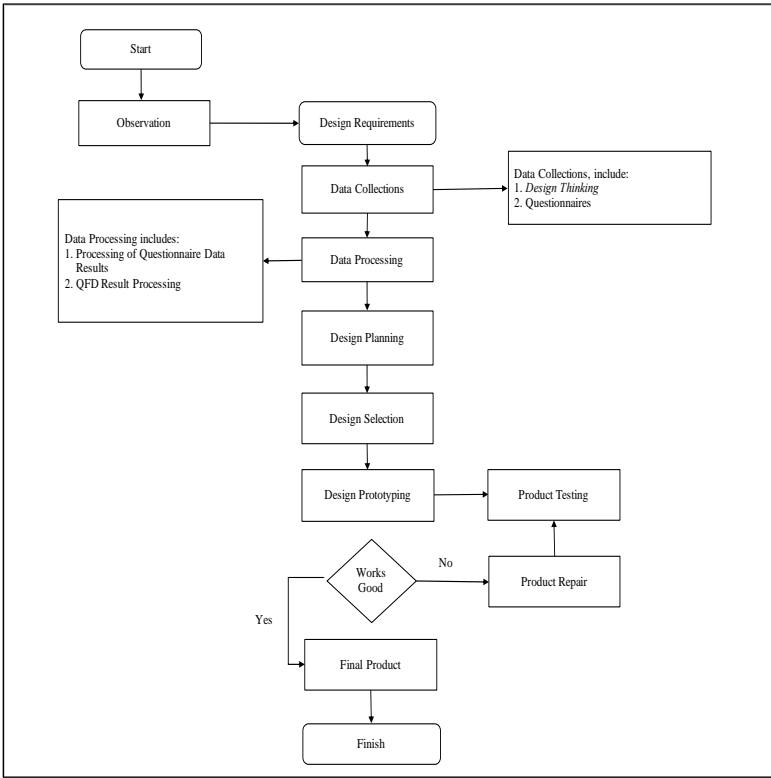


Figure 1. Methodology Diagram

# Design Requirements

At this stage use questionnaires with the target respondents being the daily users of the dispensing sticker tool. The respondents were collected from all the users who were working in this area. The instrument used to determine customer needs was a questionnaire consisting of 10 questions. In this study, the aspects of customer needs include: Functionally (Works well and is stable); Convenience (Easy to carry and easy to operate); Price (affordable prices); Multifunctional (Operations quickly, can out flexibly size of sticker, can count the number of stickers issued); and Safety (Does not use electricity).

# Design Planning

In this panning, the QFD was provided to converts the customer's voice, or expectations, into the technical requirements necessary to fulfill the identified requirements. Figure 2 shows the detail of QFD.

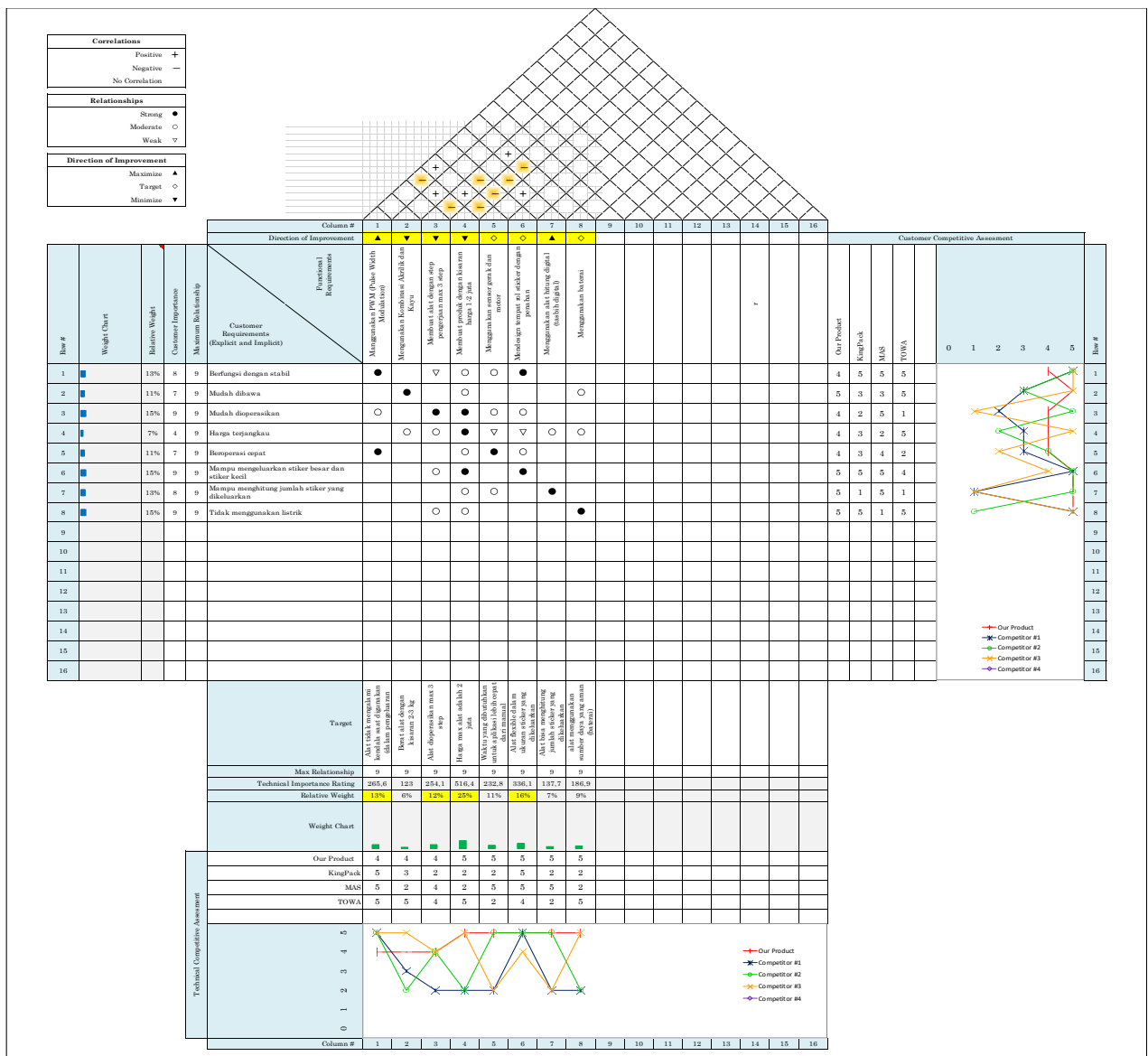


Figure 2. Quality Function Deployment

Based on the QFD matrix's findings, it is apparent that the four targets that make up most of the goals for this sticker/label dispensing innovation project were the author's top priorities. Out of the nine goals that have been established, the price of innovation tools, which can only cost around 2 million rupiahs, has the highest percentage, with 25% being the highest priority. A flexible innovation tool that can dispense stickers or labels of varying sizes was the second priority at 16% based on the relative weight.

The author's technical assessment strategy of researching competitors' products, sales, and marketing strategies aims to identify competitors through technical competitive assessment to improve strategies or do something new that no one else has done.

The innovation products, as indicated by the red line, are in a qualified position among three other competitors who share some similarities but are slightly different, such as Competitor 1, the KingPack brand, a semi-sticky dispensing tool. These results are based on the results of the author's technical competitive assessment. Automatic, which has advantages in terms of operating stability and can be used with a variety of sticker and label sizes but has a heavy weight of about 4-5 kg, a price of at least 3 million rupiahs, more than three stages of operation, cannot count the number of stickers issued (dispensed), and continues to use electricity.

It is not always the case that manual labor is overlooked or excluded without benefit. This is demonstrated by the author's Competitor 3, a manual sticker dispenser with the TOWA brand. The TOWA manual sticker dispensing tool has several advantages, including the fact that it costs less than one million rupiah, lightweight, can dispense stickers and labels in a variety of sizes, and easy to use and stable because it was manual and can be modified the power as needed, but it can be used for a long time.

The results of the competitive analysis on Competitor 2 of the MAS brand show that the dispense label tool on the MAS brand is a dispensing tool, even though it weighs approximately 5.5 kilograms, costs approximately 4-5 million rupiah, and still uses electricity. A label that closely resembles the author's product innovation's concept and design. In contrast, the MAS brand were automatic labels that can dispense stickers and labels in a variety of sizes and count the number of stickers/labels issued (dispense), of course with a faster application time speed compared to similar dispensing tools that were manually.

It is acknowledged that the author of the Brand MAS product is superior to being able to serve as a reference for ideas and designs for future tool innovations with more concern in terms of price, quality, features, resources used to produce the best innovative products, meet targets to achieve or realize consumer/user satisfaction.

## Design Selection

The Simple Additive Weight is a series of calculations used to determine the three

different design options that can be used to satisfy customers' requirements in marketing. The issue of these values is determined by considering the design outcomes of each alternative, as shown in Table 1.

Table 1. Calculation Simple Additive Weight (SAW)

Criteria	Additive Weight (W)	Alternative								
		A			B			C		
		P	Rating (R)	W x R	F	Rating (R)	W x R	V	Rating (R)	W x R
Stable Function	0,131	600	0,6	0,079	900	0,9	0,118	700	0,7	0,092
Easy to Carry	0,115	3500	0,571	0,066	500	0,8	0,092	300	0,87	0,1
Easy to Operate	0,148	4	0,75	0,111	4	0,75	0,111	5	0,6	0,089
Affordable prices	0,066	1196	0,836	0,055	1177	0,85	0,056	716	0,583	0,038
Operate fast	0,115	25%	50%	0,057	50%	1	0,115	50%	100%	0,115
Flexible (can produce small or big stickers)	0,148	100	1	0,148	100	1	0,148	100	1	0,148
Able to count the number of stickers	0,131	100	1	0,131	100	1	0,131	100	1	0,131

issued

Does not use electricity	0,148	10	1	0,148	1	0	1	0,148	1	0,148
TOTAL	1			0,79			0,9			0,8
				3			17			59

Based on Table 1 reveals that alternative A, B, and C has a final score of 0.793, 0.917, and 0.859, respectively. Therefore, Alternative B was the design that could be utilized for this innovation tool for sticker dispensing. Alternative B's design can be seen in Figure 3.

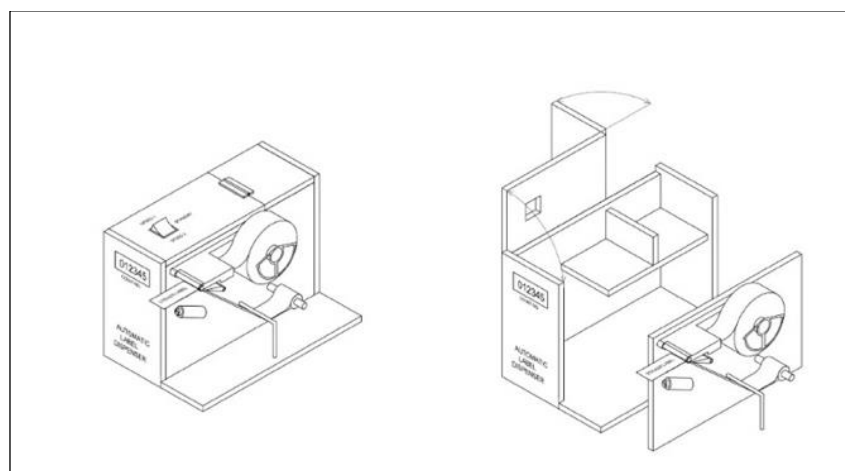


Figure 3. Alternative B Design

### Design Prototyping

Based on the results of the selection of alternative designs to be designed and developed by a prototyping. Figure 4 shows the final design to be further analysis.

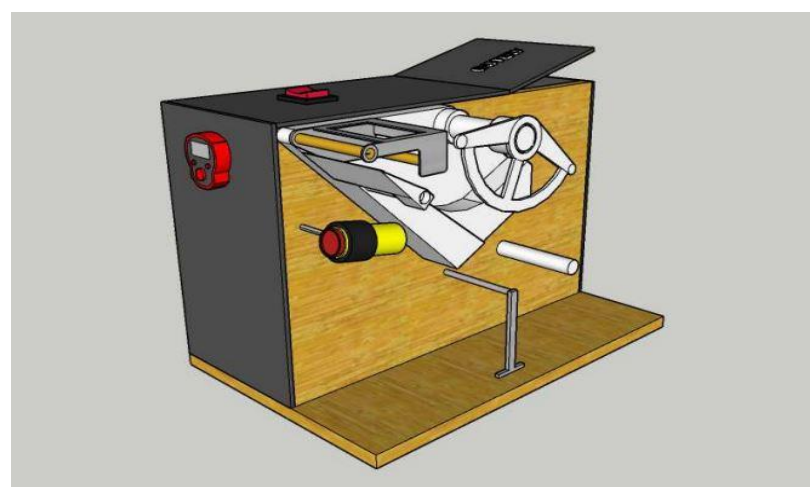


Figure 4. Prototype Design

## Product Testing

This section discusses the analysis structure used to test the durability of the designed product. In designed a product, it is important to perform a durability test. For stress analysis of product structures, simple analytical and finite element models are frequently utilized due to their simplicity and acceptable accuracy [20].

In addition to load analysis and safety factor testing, design experiments and tests were also performed. In this section, a comparison was made between the manual labeling process and the automatic labeling process using an innovative dispensing label developed from labeling samples on 30 small paint cans.

## Product Repair

The trial-and-error results of the author's automatically designed donation sticker innovation tool are enhanced in this section. The results of two trials and errors with the automatic dispensing label are listed in Table 2.

Table 2. Trials and Errors Automatic Dispensing Label

Trialz	Process	Duration	Total Sticker	Problems	Remarks	Izmpovement
1	Auto	1 Minute	20 pcs	The process of removing the sticker is not stable, the sticker is counted twice.	The infrared sensor is not strong enough, so it moves when it is used. Then it reads that there is a movement for the output of the sticker.	The infrared sensor is installed using bolts to make it stronger.
2	Auto	1 Minute	23 pcs	The tools's battery discharges quickly	Insufficient battery power.	The battery is change to 8AH.

(only 1.5 hours of use).



Trial Error and Improvement has a positive influence on the improvement process that was on this sticker dispensing machine and increases the efficiency and effectiveness of labeling in each company, particularly in this study the Chemical Company.

## RESULTS AND DISCUSSION

This section describes the results of previously stages for realize our innovation tools. It starts from comparison tools, then showing the picture of final product, and for the last was feasibility study of product such as ergonomic aspects, materials, structure analysis, feasibility, and costing structure.

### Comparison Tools

Figure 5 shows a comparison between old tools and previously innovation tools designed.

Comparison Tools			
Criteria	Old Tools	New Tools	Progress
Style			Better
System	Manual	Semi-Automatic	Better
Work Process Time	2minutes	1minutes	Better
Weight (kg)	1kg	2-3kg	
Size (cm)	10 X 5 X 20	20 x 15 x 30	

Price (million)	IDR200.000	1-2 million (Affordable prices for similar tools)	Better
Step	1 step	3 steps	
Fiture	Manual, man-skills, reliability	Battery	Better
	Dispense Sticker Only	Can be count and shown how many stickers has been dispensed	Better
	No need electricity or main power	Need main power for operate the tools	
	Non-Rechargeable	Rechargeable power	Better
	Flexible variety size of sticker dispenses	Flexible variety size of sticker dispenses	
	Stable Operations	Stable and saving time Operations	Better

Figure 5. Comparison between old tools and previously innovation tools designed

### Feasibility Study

At this point, the design of the sticker dispensing device's ergonomic features is the subject of discussion. The authors propose two aspects that can be seen from the ergonomic side of this tool based on these objectives when using a sticker dispensing tool. The tool's design height was the product of the table's height and the tool's height. The tool stands 20 centimeters tall. Therefore, it is necessary to suggest the table's height. This is done with Sitting Shoulder Height (SSH) and Popliteal Height (PH) as anthropometric measurements. As a result of the operator's sitting position and the tool's shoulder-level height when used. The design distance for the placement of the tool is the distance from the operator to the tool. The position of the tool was in front of the operator and used anthropometry data from the length of the arm span forward.

Material is something that is composed or made of material [24]. The author chose to make this innovative tool out of a combination of acrylic and wood. Based on the results of QFD and Tabular Additive Method, it was deemed to be more compatible with the existing parameters. The innovation tools that result include being user-friendly, easy to carry and operate, cost-effective, and effective. It is hoped that by utilizing the appropriate materials, such as acrylic for the case and wood for the base, it satisfied these customer requirements. Results of structure analysis (stress analysis, displacement, and factor of safety) for wood frame materials are. Figure 7 shows the result structure analysis from SolidWorks.

<b>Name</b>	Wood (Oak)	
<b>General</b>	<b>Mass Density</b>	0.76 g/cm <sup>3</sup>
	<b>Yield Strength</b>	46.6 MPa
	<b>Ultimate Tensile Strength</b>	5.5 MPa
<b>Stress</b>	<b>Young's Modulus</b>	9.3 GPa
	<b>Poisson's Ratio</b>	0.0001 ul
	<b>Shear Modulus</b>	4.64954 GPa
<b>Part Name(s)</b>	AFRIDA STRESS	

**Operating conditions**

**Force:1**

<b>Load Type</b>	<b>Force</b>
<b>Magnitude</b>	100.000 N
<b>Vector X</b>	0.000 N
<b>Vector Y</b>	-100.000 N
<b>Vector Z</b>	0.000 N

**Selected Face(s)**

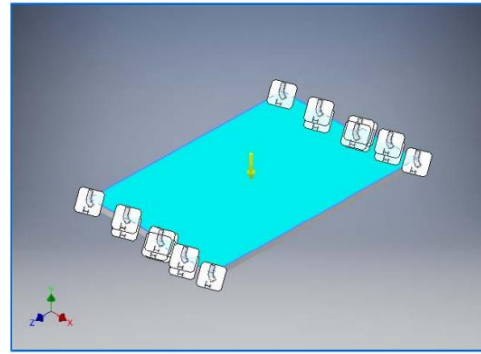


Figure 7. Structure analysis operating conditions      Figure 8. Ultimate tensile strength

Figure 8 shows the result ultimate tensile strength. The yield level of the material under loading conditions from the results of the simple uniaxial tensile test was achieved with value of 1.063 MPA.

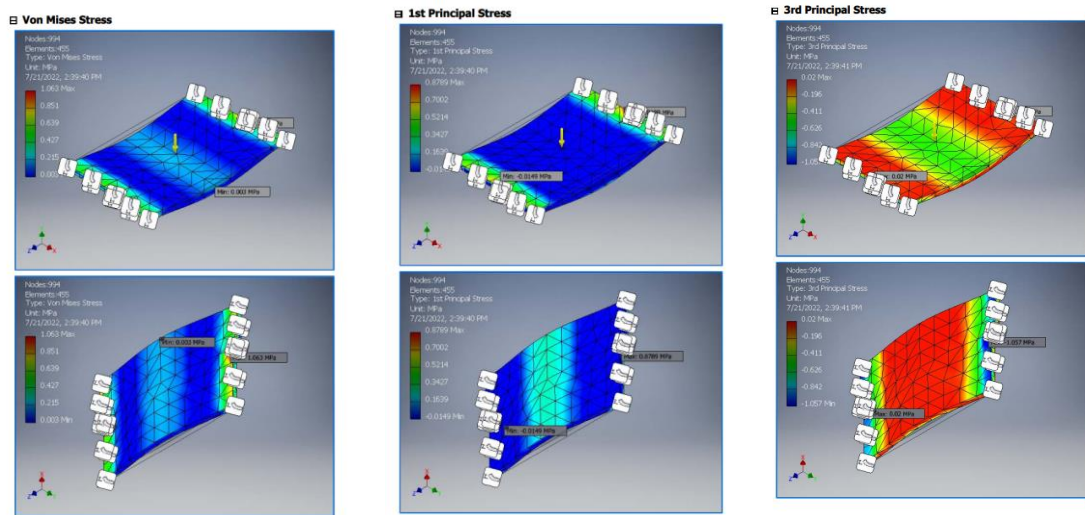


Figure 9. Principal Stress

Figure 9 shows the result principal stress of maximum tensile stress (tensile) due to loading. From the data the maximum tensile stress was determined with value of 0.89 MPA and maximum compressive stress due to pressure was achieve at 0.02 MPA. The safety factor value with a value showing the number 6, which means it was safe, where the minimum value was achieved with value of 1.25. So, it can be concluded that the use of wood material for the frame in this tool is categorized as applicable. Based on the design side and technical examiner, this economic stage.

### CONCLUSION

Innovative design concept of labeling mechanism has been developed and made a significant improved the productivity. The findings of the research lead us to the conclusion that the sticker dispensing tool was created with the intention of increasing worker

productivity during the labeling process. Functionality (works well and is stable), convenience (easy to carry and operate), price (affordable prices), multifunctional (operates quickly, can cut flexibly size of sticker, can count the number of stickers issued), and safety (does not use electricity) were the aspects of customer needs in this product development.

Based on the results, the following priority scale used in designing of innovative design concept such as price range of up to 2-million-rupiah, flexible innovation tools that can be used to dispense stickers and labels of varying sizes, the user operation step on the product or innovation tool should be limited to three stages. The other priorities were used in this study such as the speed of application time should be faster than that of manual tools, innovative tools should use battery resources; and products or innovation tools should be able to count the number of stickers or labels that the innovation's product or tool weight, which can range from 2 to 3 kilograms.

Design experiment and testing are carried out once the prototype has been determined to be feasible and completed. The results of a trial of 30 different applications for attaching stickers to small cans was tried and compared to the previous method, which required two minutes of processing time. It is found that the automatic labeling method was clearly superior. The labeling time was achieved by 50% when compared to the previous manual method because of its speed and productivity. In addition, by using this tool improves productivity at work and reduces worker fatigue.

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