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Hand dryer with sanitizer to support sustainability and ergonomic for user

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Abstract. The paper presented the design and analysis using Design for Disassembly methodology. Based on detailing material selection, use simpler materials, use environmentally friendly packaging, reduced packaging size had to be considerate for the product development. The benefit of simplified process, less production machines were used, needed energy to drive machines could be more efficient. The less amount of material used the less waste after the product life was over. The selection of material affected the recycling process. With design methods, the shorter the production process, the more energy savings, packaging could be more concise. The paper is divided into three main concepts, including 3D images with SolidWorks, material selection, and material evaluation for making it easier to analyse and determine type of material will use next. Based on the process of selection and evaluation, a new design of a hand dryer was proposed using four high density ABS, VLDPE, HDPE, and PP materials. The next step, SolidWorks to create a 3D display for a suitable hand dryer. The research focussed on the design that can support to all user even for children and disabilities, beside that it considers material to support sustainability.

Keywords: hand dryer, sanitizing hand dryer, ergonomic, sustainability

1. Introduction

Ergonomics is the science that connects humans with other elements in a system that includes human capabilities, limitations, and interactions in order to optimize it [1]. Nowadays, most manufacturing industries concern to saving production costs. Most mainly production costs come from parts, materials, and manufacturing processes. In developing new products, the methodology for the Design for Disassembly (DfD) methodology can be used because it can save the production process itself. Future needs can be prepared by making a new product or disassembling an existing product by adding or repairing it using environmentally friendly and recyclable materials. In addition, the DfD method also supports the optimization of a product in industrial processes including the lifetime and after use to support the sustainability of the environment [2,3,4].

About support environmental sustainability. Some researchers' conclusions in a more recent study about hand drying method which are more friendly in reducing gas greenhouse effect compared to other methods in preserving environmental sustainability. The electric dryer results six positive indicators, among others organic breathing, inorganic breathing, ozone layers, ecotoxicity, acidification eutrophication, and fossils fuel [5]. Moreover, research about environmental impacts with focus on global warming potential explained in life cycle assessment (LCA) concludes that high speed dryers



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have a lower environmental impact and low global warming potential compared with other kinds of method dryer [6]. The research aims to make hand dryer with sanitizer to support sustainability and ergonomic for user and environmentally friendly, easy to recycle if it not used again. The research also provides a friendly hand dryer accessible to everyone including children and children with disabilities.

2. Materials and methods

The process of selecting and analyzing materials for hand dryers is carried out at this stage. In the case of the 3D display hand dryer, SolidWorks software is used in order to design 3d model from parts and it is easy to understand and learn. This software also provides all types of material need to be analysed. Then, a systematic approach is taken to choose the best material for hand dryer applications.

Table 1 lists the selection criteria and types of existing hand dryers. The hand dryers are selected and measured into the concept of A, B, and C. Concept A is our design, concept B is common hand dryer we met on toilet, and concept C is stand hand dryer rarely we met on toilet. After getting the highest points from those three types of hand dryers, we plan for further development processes.

Table 1. Selection Criteria

Selection Criteria	Concept		
	A	B	C
Manufacturing process (easy to produced)	+	+	+
Materia Safety (Nonhazardous material)	+	-	-
Ergonomic design (friendly to used)	+	-	-
Size (Saving space)	-	+	-
Easy to install	+	+	+
Other (Cheap)	+	+	-
Sum of (+)	5	4	2
Sum of (-)	1	2	4
Net Score	1	1	1
Ranking	1	2	3
Further Development	YES	NO	NO

The next process, we decide to make several criteria in terms of easy to produce, safe materials, ergonomic design, size and affordable prices, as shown in Table 2.

Table 2. Hand Dryer Selection Based on Production, Material, Ergonomic, and Price

Selection Criteria	Weight (%)	Concept					
		Rating	WS	Rating	WS	Rating	WS
Manufacturing process (easy to produced)	30	6	1,8	7	2,1	5	1,5
Materia Safety (Nonhazardous material)	10	6	0,6	6	0,6	6	0,6
Ergonomic design (friendly to use)	30	9	2,7	7	2,1	8	2,4
Size(Saving space)	5	6	0,3	8	0,4	7	0,35
Easy to install	10	7	0,7	6	0,6	8	0,8
Other (Cheap)	15	7	1,05	8	1,2	7	1,05
Total Score	100	7,15		7		6,7	
Ranking		1		2		3	
Continue		YES		NO		NO	

Table 3 lists the collection of materials specifications that will be used as a comparison to decide what material to use when analysing using SolidWorks visualization so that a material type with good durability is produced.

Table 3. Material Properties

Spec	Material			
	ABS	HDPE	PP	VLDPE
Mass Kg	7,56683	7,06238	6,60243	6,71371
Volume m^3	0.00741751	0.00741751	0.00741751	0.00741751
Density	1,020.13	952,12	890,12	905,12
Weight N	7,41550	6,92113	6,47038	6,57944
Zero strain temperature	298 Kelvin	298 Kelvin	298 Kelvin	299 Kelvin
Tensile strength: N/m^2	3,00E+07	2.21e+07	2.76e+07	3.4e+07
Elastic modulus: N/m^2	2,00E+09	1.07e+09	8.96e+08	1,72E+13
Poisson's ratio:	0.394	0.4101	0.4103	0.3
Mass density Kg/m^3	1020	952	890	905
Yield strength MPa	20	26–33	31	6.89
Max deformation N/m^2	7,87E+08	7,33E+08	6,86E+08	7,09E+08

3. Results and discussions

The results present some ways of production using selected criteria concept, and compare of materials specification suitable and capable for user long cycle time. Figure 1 shows the design of product A. It is made to give ease to every user, drawn on CAD application Solidworks, and tried to make simplest visual with display from front and side.

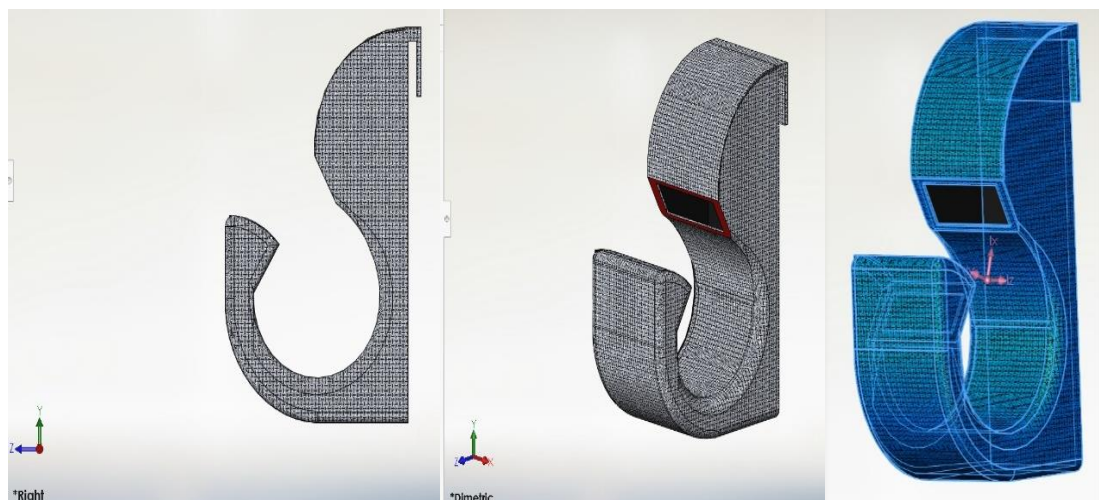


Figure 1. 3D Model

Figure 2 shows the illustration of a user-friendly hand dryer. The illustration shows a friendly product to use, even for disabilities person or children. For tall people, the hand dryer is still comfortable with its position and size. Beside ergonomic factor, the design want to know what kind of material to use and is it safe for users and environment.

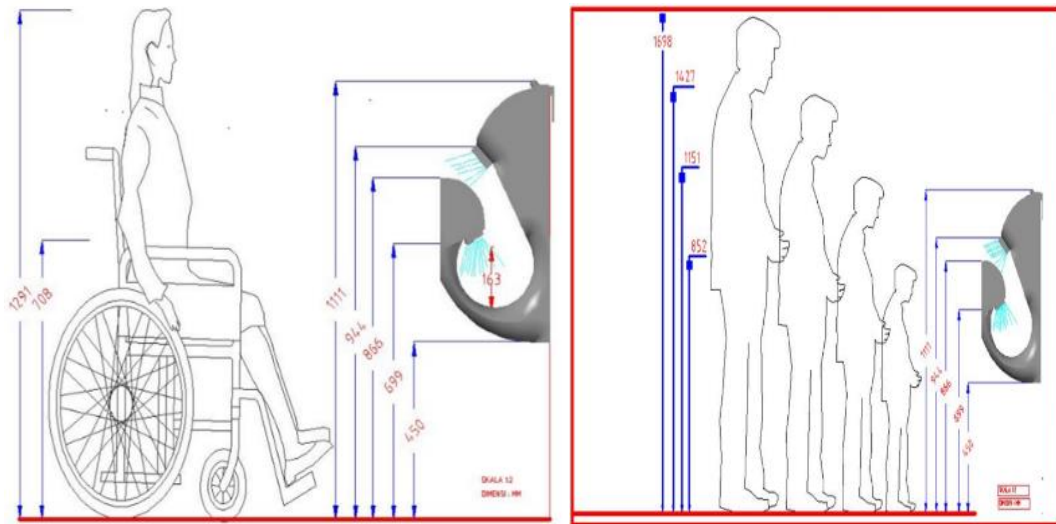


Figure 2. Posture Position

Figure 3 shows the display of maximum stress simulation. After we choose ABS for material, so it must be checked for its safety. The product with material has been analysed in Solidworks, weight material will be calculated, and also adding weight of another part like blower, hand sanitizer, and other.

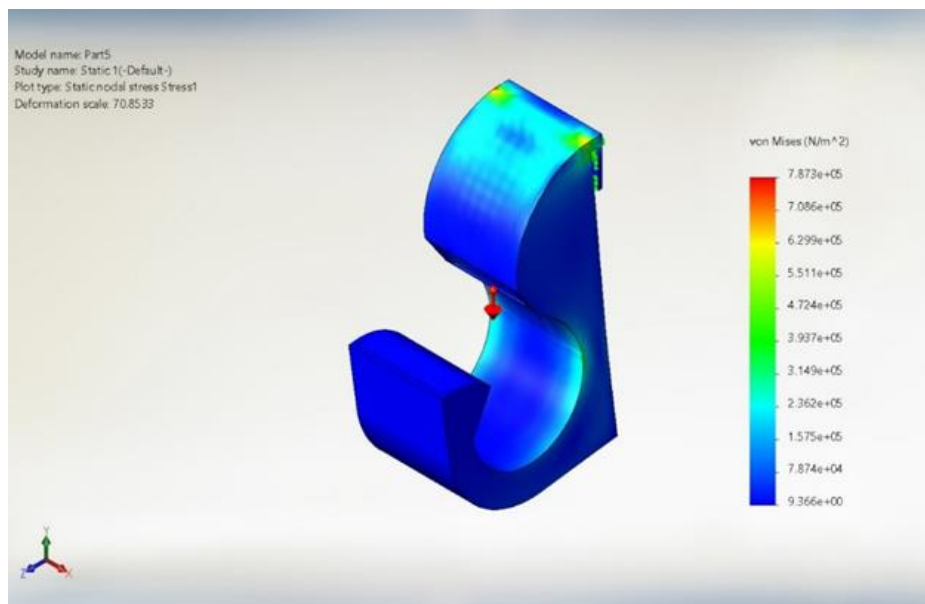


Figure 3. Simulation Result

Figure 4 shows ratio max stress vs tensile strength. Based on the result we know max stress in some point in product is Max $7.873e+05 \text{ N/m}^2$ that value is below from limit strength from material, ABS have tensile strength $3.00E+07 \text{ N/m}^2$. So the design product with material ABS is save and have good durability for user.

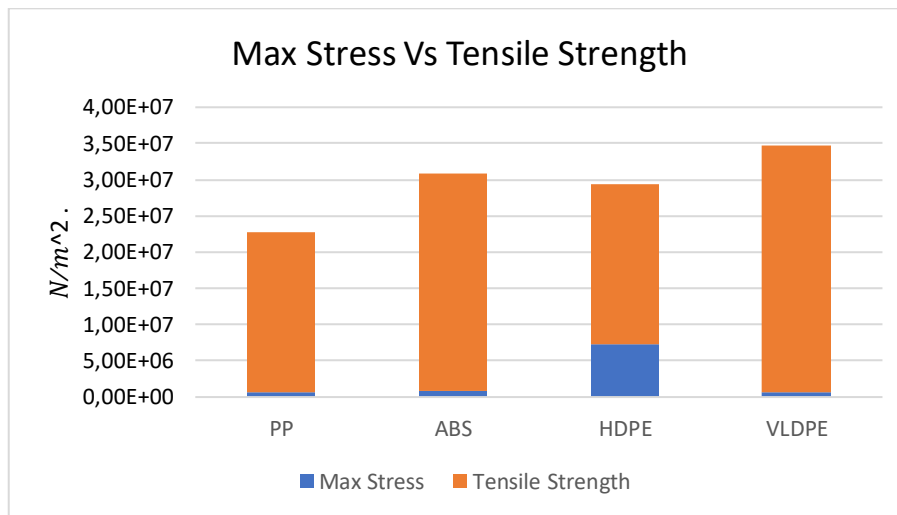


Figure 4. Materials Simulation Result

Table 4 lists the ratio between max stress and tensile strength of each materials. It can be said that VLDP and ABS is better than other, but VLDPE is rarely to have the material and ABS is easier to get material in industrial. So this material support product to be produce.

Table 4. Stress and Tensile Strength

N/m^2	PP	ABS	HDPE	VLDPE
Max Stress	6.86E+05	7.87E+05	7.33E+06	7.09E+05
Tensile Strength	2.21E+07	3.00E+07	2.21E+07	3.40E+07

4. Conclusion

Based on the data, it is important to study the stress and tensile in developing new design of hand dryer in accordance with the functions and uses that are ergonomic as well as user friendly. Because there is not much reference and research that focuses on hand dryers. The result shows the proposed design of a hand dryer with easily accessible for children, adults, and people. Furthermore, it also suits for disabilities with a comfortable body position, and an environmentally friendly hand dryer with recycled materials that have proven its durability and sustainability.

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