Modification of Chocolate Stirring Machine Using Reverse Engineering and VDI 2221 Methods

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Abstract

Indonesia is the third largest cocoa producer and exporter after Ghana and Ivory Coast. Indonesian cocoa variety has an advantage of not melting easily. Cocoa is processed using a chocolate dough mixer (melanger). Chocolate processing is divided into 3 (three) processes, namely the process of mixing, refining and conching. Further processing of yields into shape and taste can increase added value to cocoa and increase the amount of chocolate consumption in the country. However, in chocolate processing, there is no time limit for stirring the chocolate. And the capacity offered is not too large. The aims of this study is to modify the chocolate dough mixer machine. The modified design of the chocolate dough mixer machine uses Benchmarking, Reverse Engineering, and VDI 2221 methods. With the aim of improving the performance of the machine. There are 3 (three) machines that are used as benchmarking. The Premier Tilting Chocolate Refiner machine was chosen as the machine to be modified. Reverse Engineering serves to modify a new product that is superior to an existing product. VDI 2221 itself is used to meet the aspects of comfort, ease of use, maintenance, repair, security and safety. Components that are improved and added to the machine are the storage tube with an increase in tube capacity by 40%, the dimensions of the stone holder, the addition of a timer function, and the addition of a lever function. The engine performance after modification, namely the resulting mixture of particle textures is quite consistent. The results of testing data processing with the DOE (Design of Experiment) method are F0A>FTabel, F0B>FTabel, and F0AB>FTabel. So it can be concluded that there is an influence between temperature and time on the mixture of particle texture.

Keywords
Chocolate Dough Mixer Machine, Benchmarking, Reverse Engineering, VDI 2221, DOE (Design of Experiment)

1. Introduction
Chocolate product is one of the commodities produced by Indonesian plantations which is processed from cocoa beans. Cocoa has an important role in the Indonesian economy to increase foreign exchange. According to the Directorate General of Plantation, the area of cocoa plantations in 2018 reached around 1.6 million hectares. The highest area of cocoa plantation is located in the province of Central Sulawesi compared to other regions (Tempo.co and Bisnis, 2014). This is inversely proportional to the development of the domestic chocolate industry. Where, the level of chocolate consumption per person in Indonesia only reaches 0.10 kg per year (Mulato and Suharyanto, 2014). This is different from the amount of chocolate consumption per person in other European countries, such as Switzerland, Germany, and the UK as much as 9.45 to 10.55 kg per year (CAOBISCO, 2013).

To increase the level of domestic chocolate consumption, it is necessary to develop Small and Medium Enterprises (SMEs) in Indonesia. Further processing of yields into shape and taste can increase the added value of cocoa, and increase the amount of chocolate consumption in the country. There is no time limit in chocolate processing, so that the taste and texture mixture of the chocolate particles produced is consistent. Making the desired particle texture mixture requires varying time but is precise in processing, so it takes an automatic timer technology to automatically turn off the machine in running the machine. Currently the chocolate dough mixer (melanger) on the market has a capacity of 3.5L and 4L. In order to increase the level of domestic consumption, modifications to the chocolate dough mixer (melanger) are needed. To modify the chocolate dough mixer (melanger), the methods used are benchmarking, reverse engineering and the VDI 2221 method.

2. Research Methodology

The research methodology on the chocolate dough mixer (Melanger) can be seen in Figure 1.

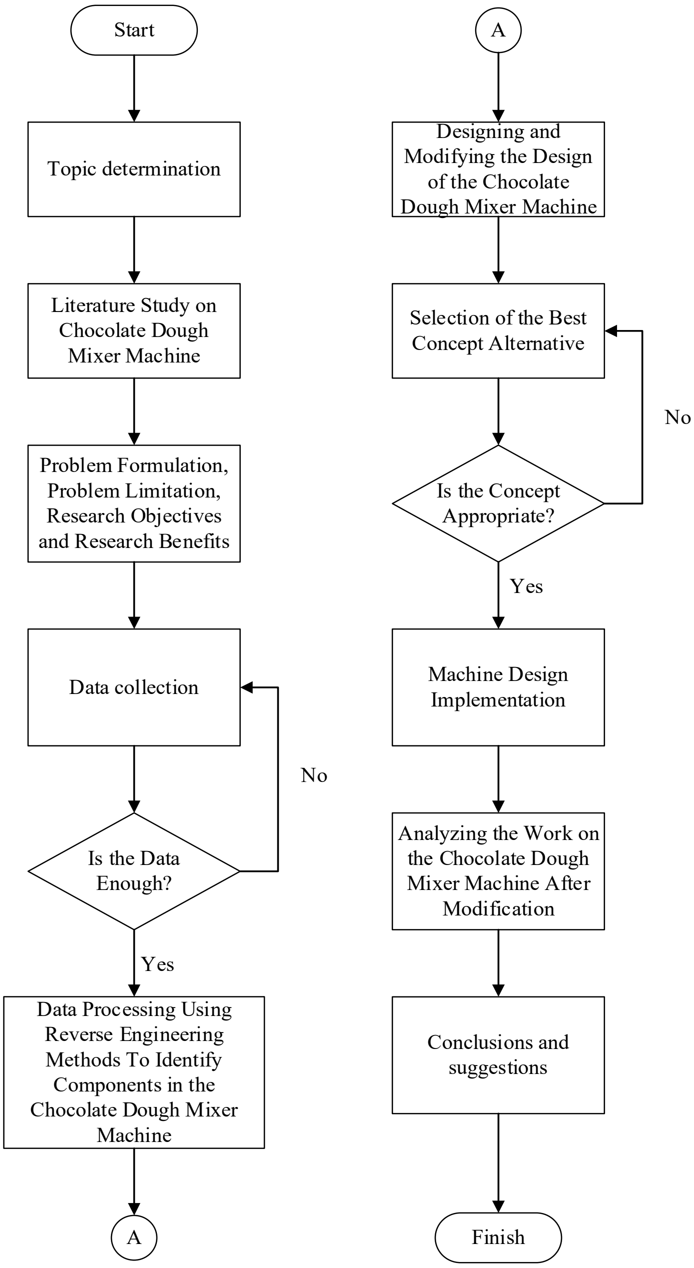


Figure 1. Flowchart of Research Stages

3. Research Methods

3.1 Benchmarking Method

Benchmarking is the process of measuring continuously and comparing one or more companies, which aims to obtain information, identify, and implement process improvements (Andersen and Pettersen, 1996). In this study, there were 3 (three) types of chocolate dough mixing machines in the benchmarking process compared to the specifications. The three machines can be seen in Table 1.

Table 1. Benchmarking of the chocolate dough mixer

No	Aspect	Premier Chocolate Refiner – 8 Lbs	Premier Compact Chocolate Melanger Refiner 11 Lbs	Premier Tilting Chocolate Refiner – 10 Lbs
1	Model			
2	Price	Rp. 3.757.221,00	Rp. 4.046.238,00	Rp. 4.479.763,00
3	Capacity	3,5 Liter	4,5 Liter	4 Liter
4	Material	Machine Outer Layer: Stainless layer Container Tube: Stainless steel Grinding Wheel: Granite stone Stone Holder: Plastic and stainless steel Tube Cover: Plastic	Machine Outer Layer: ABS plastic Container Tube: Stainless steel Grinding Wheel: Granite stone Stone Holder: Plastic and stainless steel Tube Cover: Plastic	Machine Outer Layer: ABS plastic Container Tube: Stainless steel Grinding Wheel: Granite stone Stone Holder: Plastic and stainless steel Tube Cover: Plastic
5	Dimensions	W x D x H overall machine: 28 x 28 x 36 cm Tube Height: 14 cm Tube Diameter: 20.3 cm Grinding Wheel Diameter: 10.5 cm Grinding Wheel Thickness: 3.5 cm	Tube Height: 15 cm Tube Diameter: 24 cm Grinding Wheel Diameter: 10.5 cm Grinding Wheel Thickness: 4.5 cm	Tube Height: 15.9 cm Tube Diameter: 24.1 cm Grinding Wheel Diameter: 10.5 cm Grinding Wheel Thickness: 4.5 cm
6	Power	200 Watt	300 Watt	200 Watt
7	Switch Button	Manual	Manual	Manual

Of the three chocolate dough mixing machines above, the Premier Tilting Chocolate Refiner - 10 Lbs was chosen as the machine to be modified. This is because the design and specifications of the Premier Tilting Chocolate Refiner machine are almost the same as those used in small and medium business development.

3.2 Reverse Engineering Method

Reverse Engineering is the process of analyzing an existing product as a reference for designing and designing new products by developing product components (Wibowo, 2006). Reverse engineering method is done by redesigning a machine with the performance principles of a tool and object and analyzing the structure, function and operation of the machine under study (Kezia Natalia, 2020). Reverse Engineering is the process of quoting knowledge or blueprints from machines or devices that already use Reverse Engineering methods with a focus on man-made tools (Bachman, 1988). The Reverse Engineering stage consists of several procedures (Daywin, et. Al., 2019):

1. Disassembly Product
   In the first stage, the product is disassembled with the aim of obtaining a Bill of Materials and analyzing the principles, quantities and functions of each component in the product. The results of disassembly on the Premier Tilting Chocolate Refiner chocolate dough mixer are 6 component parts, namely: tube cover, stone holder, rolling wheel, storage tube, engine body, and leg stand. An explanation of the six constituent

components of the Premier Tilting Chocolate Refiner mixing machine in the form of a Bill of Material can be seen in Figure 2.

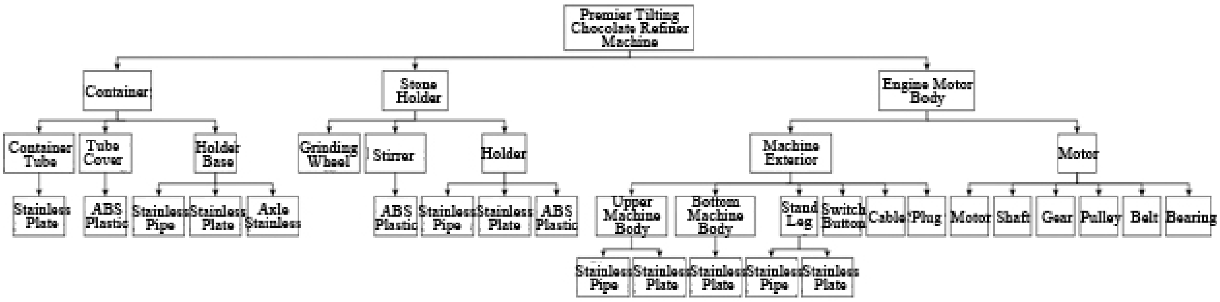


Figure 2. Bill of Materials

2. Assembly Product
In the second stage, the product is reinstalled with the aim of obtaining an Assembly Process Chart (APC) and knowing the level of ease or difficulty in dismantling or installing the product. Assembly Process Chart (APC) can be seen in Figure 3.

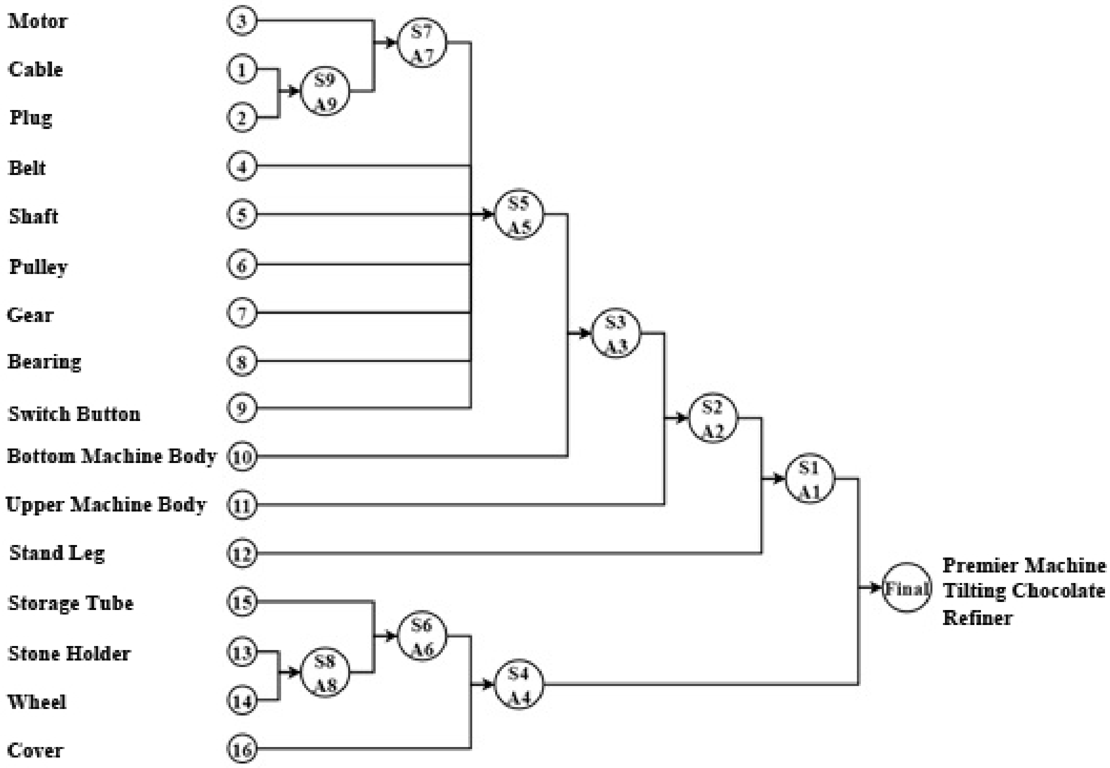


Figure 3. Assembly Process Chart (APC)

3.3 VDI method 2221

The VDI 2221 method is a design method proposed by Gerhard Pahl, Wolfgang Beitz, Joerg Feldhusen, and Karl-Heinrich Grote which contains "Systematic Approach to the Development and Design of Technical Systems and Products" (Agung Prasetyo, 2017). The design was carried out using the Engineering Design method or VDI 2221 (Verein Deutcher Ingenieure). This design is a method for solving problems and optimizing the use of materials, technology, and economic conditions. Ideas and knowledge are the basic sources of product design in order to meet consumer demand and the benefits of all parties (Daywin, et. Al., 2019).

The work steps in VDI 2221 consist of several stages: Clarification of Tasks, Product Conceptual Design, Embodiment of Product Concepts, and Detailed (Daywin, et. Al., 2020). In designing products, the VDI 2221 method is used to meet the aspects of comfort, practicality, ease of use, maintenance, repair, security and safety. Determination of the initial specifications can be seen in Table 2.

Table 2. List of Specifications

No.	Aspect	D / W	Specification
1	Function	D	Process the chocolate dough to achieve the desired particle size
2	Assembly	D	Machines can be assembled and assembled easily
3	Energy	W	Efficient in electricity usage
4	Geometry	D	Chocolate processing capacity of 5 liters
5	Style	W	Equipment weight does not exceed 15 Kg
6	Material	D	Using food grade stainless steel
		D	Using ABS plastic
		D	Motor dynamo 200 W
7	Care	D	Maintenance is easy and cheap
		D	The process of cleaning the tool is easy
		W	Spare parts are easy to get
8	Operation	D	The machine can be operated by 1 operator
		W	Does not require special skills in operating machines
		D	Safe tool when used
9	Cost	W	Affordable Production Costs
		W	Affordable for the lower middle class

Where:
D : Demand is a requirement that must be met.
W : Wishes are desirable requirements and may be ignored if not possible.

After determining the initial specifications, then make the principle of the sub-function solution to determine the components that will be used in the chocolate dough mixer. The principle table for the sub-function solution which contains several alternative components can be seen in Table 3.

Table 3. Principle of Sub-Function Solution

No	Principle of Solution / Sub Functions	Information	1	2	3
1	Storage Tube	Make	Food-grade stainless steel	Food-grade plastic	
2	Motor Dynamo	Buy	200 W	300 W	400 W
3	Machine body	Make	Stainless steel	ABS plastic	
4	Tube Capacity	Make	3 Liter	4 Liter	5 Liter
5	Tube Movement	Make	Static	Dynamic	
6	Roller Wheel Movement	Make	Static	Dynamic	
7	Switch Button	Buy	Manual	Semi-Automatic	

The principle of the sub-function solution is made with the number of resulting combinations of 288 (2 × 3 × 2 × 3 × 2 × 2 × 2) combinations. After the sub-function solution principle is made, the next step is to determine the combination of the sub-function solution principle, the combination is generated by determining the combination that forms the most efficient product. So that the principle combination of sub-function solutions can be seen in Table 4.

Table 4. Combination of Sub-Function Solution Principles

Number	Solution Principle / Sub Function	Information	1	2	3
1	Storage Tube	Made	Food grade stainless steel	Food grade plastic	
2	Motor Dynamo	Buy	200 W	300 W	400 W
3	Machine Body	Made	Stainless steel	Abs Plastic	
4	Tube Capacity	Made	3 Liter	4 Liter	5 Liter
5	Tube Movement	Made	Static	Dynamic	
6	Roller Wheel Movement	Made	Static	Dynamic	
7	Switch Button	Buy	Manual	Semi-Automatic	

Information:
Combination 1
Combination 2
Combination 3

With the principles of the table above, several combinations will be obtained, namely:
a. K1: 1-1, 2-2, 3-1, 4-1, 5-1, 6-2, 7-1
b. K2: 1-1, 2-1, 3-1, 4-3, 5-2, 6-1, 7-2
c. K3: 1-2, 2-3, 3-2, 4-2, 5-2, 6-2, 7-2

Next is the process of selecting the best combination of the three existing combinations. The method of selecting the concept is done by using the selection diagram which can be seen in Table 5.

Table 5. Selection diagram

Industrial Engineering	**Solution Selection Table For Automatic Portable Sink**							
Solution Principle Variations	selection criteria (+) Yes (-) No (?) Less information (!) Check Specifications			Decision Sign Solution Variant (SV) (+) The solution looking for (-) Remove Solution (?) Gather Information (!) View Specifications				
	According to the overall function							
		According to wish list						
			Within production cost limits					
				Adequate knowledge of concepts				
					As per the designer's wish			
						Meet safety requirements		
	A	B	C	D	E	F	Information	SV
K1	+	-	-	+	-	+	Unsuitable	-
K2	+	+	+	+	+	+	Suitable	+
K3	+	-	-	+	-	+	Unsuitable	-

Based on the selection diagram in table 5, it can be concluded that the best combination for designing a new design on a chocolate dough mixer is Combination 2.The following is a modified version of the chocolate dough mixer based on the results of choosing combination 2 which can be seen in Figure 4.

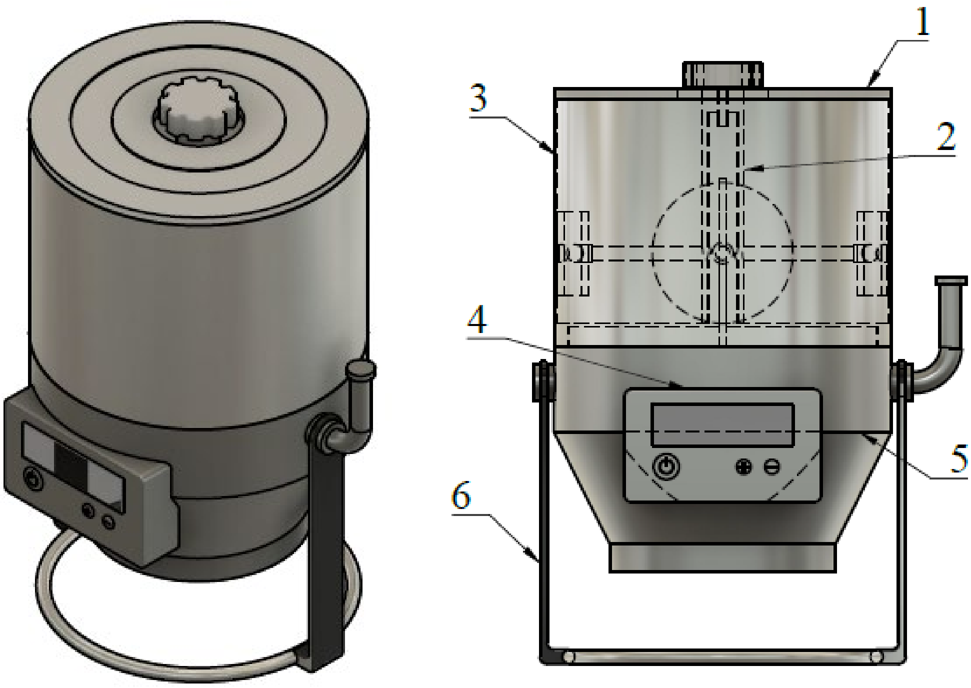
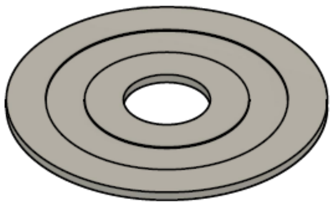
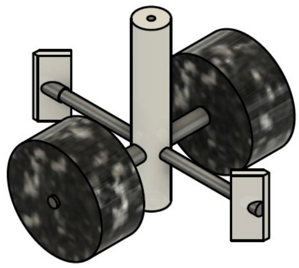
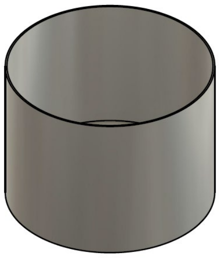
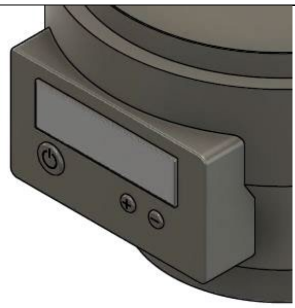


Figure 4. Chocolate Dough Mixer Machine after Modification

The following is a list of components on the chocolate dough mixer after modification which can be seen in Table 6.

Table 6. List of components of the chocolate dough mixer after modification

No	Component Name	Component Drawing	Dimensions
1	Tube Cover		Cover Diameter: 24 cm Cover thickness: 0.7 cm Material: Plastic
2	Stone Holder and Grinding Wheel		Stone Holder Height: 16.7 cm Middle Diameter: 3 cm Stone Holder Material: ABS Plastic and Stainless Steel Wheel Diameter: 10.5 cm Wheel Thickness: 4.5 cm Wheel Material: Granite Stone
3	Storage Tube		Tube Height: 17.7 cm Tube Diameter: 24 cm Material: Stainless Steel

4	Automatic Timer		Timer length: 14 cm Timer width: 8 cm Material: Plastic and Glass
5	Machine Body		Machine Height: 17 cm Machine Body Diameter: 24 cm Material: Stainless Steel
6	Stand Leg		Leg Stand Height: 21.5 cm Bottom Diameter: 24.1 cm Material: Stainless Steel

The components that are improved and added to the chocolate dough mixer are the dimensions of the container tube, the dimensions of the stone holder, the addition of a timer function, and the addition of a lever function.

4. Results and Discussion

4.1 Trials on a Chocolate Dough Mixer Machine

Test the particle texture mixture against changes in temperature, humidity, and stirring time on a chocolate dough mixer using several tools and materials, such as:

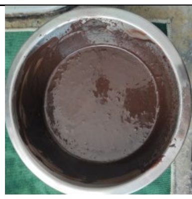
1. Chocolate Nibs 28%
2. Sugar 28%
3. Milk Powder 21%
4. Chocolate Butter 23%
5. Thermogun serves to measure the temperature during stirring
6. Digital Thickness Gauge serves to measure the mixture of particles texture after stirring.

The trials on the chocolate dough mixer were carried out 3 (three) times. Each test was stirred for 60, 120, and 180 minutes at a temperature of 50 and 60 ° C. Image of test results can be seen in Figure 5.

Figure 5. Chocolate Test Results

The following is the test result data which can be seen in Table 7.

Table 7. Data on Test Results on the Chocolate Dough Mixer Machine

Moisture 56 % (RH)							
Temperature (°C)	Time (Minute)	Testing (μm)					
		1		2		3	
50	60	83		87		82	
	120	57		57		56	
	180	49		52		50	
60	60	74		73		74	
	120	56		57		58	
	180	41		43		44	

Based on the test results on the chocolate dough mixer machine, the resulting particle texture mixture is quite consistent. The effectiveness of the amount of chocolate produced before and after increasing the capacity of the tube to 5L can be seen in Table 8.

Table 8. Effectiveness of Amount of Chocolate after Enlarged Capacity

Tube Capacity	Number of Chocolate Bars @0,05 Liter
3 Liter	60
5 Liter	100

The number of chocolate bars (per 0.05 Liter stick) produced by a 3 liter tube capacity is 60 chocolate bars while a 5 liter capacity produces 100 chocolate bars.

4.2 Experimental Design Analysis

The design of experiment is a multipurpose method used in various situations to identify input variables and how they relate to the response variable (Output). The use of DOE has been widely used in many industries as part of decision making both in new product development, manufacturing processes, and enhancements (Benjamin Durakovic, 2017). The experimental design analysis in this test uses the Factorial Design method because it has 2 (two) factors. The Factorial Design formula can be seen in Table 9.

Table 9. Factorial Design Formulas (Salomon, et. Al., 2015)

Source of Variation	SS	D.F	MS	F0
A	$SSA = \sum_{i=1}^{a} \frac{yi^2}{bn} - \frac{y^2}{abn}$	a-1	$\frac{SSA}{DFA}$	$\frac{MSA}{MSE}$
B	$SSB = \sum_{i=1}^{b} \frac{y^2 j}{an} - \frac{y^2}{abn}$	b-1	$\frac{SSB}{DFB}$	$\frac{MSB}{MSE}$
AB	$SSsubtotal = \sum_{i=1}^{a} \sum_{j=1}^{b} \frac{yij^2}{n} - \frac{y^2}{abn}$ SSAB = SSsubtotal – SSA – SSB	(a-1)(b-1)	$\frac{SSAB}{DFAB}$	$\frac{MSAB}{MSE}$
Error	SSE = SStotal - SSAB - SSA - SSB	ab(n-1)	$\frac{SSE}{DFE}$	
Total	$SStotal = \sum_{i=1}^{a} \sum_{j=1}^{b} \sum_{k=1}^{n} yijk^2 - \frac{y^2}{abn}$	abn-1		

The experimental design analysis on this test is based on the following hypothesis:

1. H01: There is no effect of temperature on the particle texture mixture.
   H11: There is an effect of temperature on the mixture of particle texture.
2. H02: There is no time effect on the particle texture mixture.
   H12: There is an effect of time on the mixture of particle texture.
3. H03: There is no interaction effect between temperature and time on the particle texture mixture.
   H13: There is an interaction effect between temperature and time on the mixture of particle texture.

The variable response to the test result data is temperature (° C) and time (minutes). With the humidity conditions on the test of 56% (RH) and the α value used is 0.05. The results of the total calculation can be seen in Table 10.

Table 10. Total calculation

		Replication	Time (Minute)			Total
			60	120	180	
Temperature (°C)	50	I	83	57	49	189
		II	87	57	52	196
		III	82	56	50	188
	Sub Total		252	170	151	573
	60	I	74	56	41	171
		II	73	57	43	173
		III	74	58	44	176
	Sub Total		221	171	128	520
Total			473	341	279	1093

The following are the results of the calculations in the Anova Table which can be seen in Table 11.

Table 11. Anova table

Source of Variation	SS	D.F	MS	F0	Ftabel
A (Temperature)	156,05	1	156,05	70,29	4,75
B (Time)	3272,44	2	1636,22	737,03	3,89
AB	92,45	2	46,225	20,82	3,89
Error	26,67	12	2,22		
Total	3547,61	17			

Based on the results of calculations in the form of ANOVA table, it can be concluded that:
F0A > Ftabel

H01 is rejected, that is, there is an effect of temperature on the particle texture mixture.

F0B > Ftabel

H02 is rejected, that is, there is a time effect on the particle texture mixture.

F0AB > Ftabel

H03 is rejected, that is, there is an interaction effect between temperature and time on the particle texture mixture.

5. Conclusion

The conclusion of the research on the Modification Design of the Chocolate Dough Mixer with Reverse Engineering and VDI 2221 Methods:

1. Based on the data from the test results on the chocolate dough mixer, the resulting particle texture mixture is quite consistent.
2. The number of chocolate bars (per 0.05 liter stick) produced by a 3 liter tube capacity is 60 chocolate bars while a 5 liter capacity produces 100 chocolate bars.
3. Based on the results of calculations in the form of anova table, it can be concluded that:
   a. F0A > Ftabel
      H01 is rejected, that is, there is an effect of temperature on the particle texture mixture.
   b. F0B > Ftabel
      H02 is rejected, that is, there is a time effect on the particle texture mixture.
   c. F0AB > Ftabel
      H03 is rejected, that is, there is an interaction effect between temperature and time on the particle texture mixture.
4. Components that are improved and added to the chocolate dough mixer are the capacity of the container tube to 5 liters, the dimension of the stone holder with the height of the stone holder to 16.7 cm, the addition of a timer function, and the addition of a lever function.

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Biographies

Calvin was born in Binjai, Indonesia on 29th of April 1999. He graduated from SMA Dharma Suci. He is currently on his last year pursuing Industrial Engineering Bachelor Degree at Tarumanagara University, Jakarta. In 2020, had an internship at PT Hasura Mitra Gemilang with the topic of ppic.

Frans Jusuf Daywin was born in Makasar, Indonesia on 24th November 1942. is a lecturer in the Department of Agricultural Engineering at Faculty of Agricultural Technology Bogor Agricultural University since 1964 conducted teaching, research, and extension work in the field of farm power and machinery and become a professor in Internal Combustion Engine and Farm Power directing and supervising undergraduate and graduate students thesis and dissertation and retired as a professor in 2007. In 1994 up to present as a professor in Internal Combustion Engine and Farm Power at Mechanical Engineering Program Study and Industrial Engineering Program Study Universitas Tarumanagara, directing and supervising undergraduate student's theses in Agricultural Engineering and Food Engineering Desain. In 2016 up to present teaching undergraduate courses of the introduction of concept technology, research methodology, and seminar, writing a scientific paper and scientific communication, and directing and supervising undergraduate student's theses in Industrial Engineering Program Study at the Faculty of Engineering Universitas Tarumanagara. He got his Ir degree in Agricultural Engineering, Bogor Agricultural University Indonesia in 1966, and finished the Master of Science in Agricultural Engineering at the University of Philippines, Los Banos, the Philippines 1981, and got the Doctor in Agricultural Engineering, Bogor Agricultural University Indonesia in 1991. He joined 4-month farm machinery training at ISEKI CO, AOTS, Japan in 1969 and 14 days agricultural engineering training at IRRI, Los Banos the Philippines, in March 1980. He received the honors "SATYA LANCANA KARYA SATYA XXX TAHUN" from the President of the Republic of Indonesia, April 22nd, 2006, and received appreciation as Team Jury from the Government of Indonesia Minister of Industry in Industry Start-Up 2008. He did several research and surveys in farm machinery, farm mechanization, agricultural engineering feasibility study in-field performance and cost analysis, land clearing and soil preparation in secondary forest and alang-alang field farm 1966 up to 1998. Up till now he is still doing research in designing food processing engineering in agriculture products. Up to the present he already elaborated as a conceptor of about 20 Indonesia National Standard (SNI) in the field of machinery and equipment. He joins the Professional Societies as a member: Indonesia Society of Agricultural Engineers (PERTETA); Indonesia Society of Engineers (PII); member of BKM-PII, and member of Majelis Penilai Insinyur Profesional BKM-PII.

Adianto was born in Semarang, Indonesia on 29th April, 1955. Adianto completed his “Sarjana Fisika Degree” in 1982 from the Physics Department of the Faculty of Sciences and Mathematics, Gadjah Mada University, Yogyakarta. In 1978 when he got his Bachelor of Science in Physics (B.Sc.) he started working as a Staff of “Field of Nuclear Physics Laboratory”, ”Pure Materials Research Center and Instrumentation Yogyakarta”, Atomic Energy Agency (BATAN). In 1986 to 1993 he received a scholarship from the Ministry of Research and Technology of the Republic of Indonesia to continue his studies in England at the Department of Electronic and Electrical Engineering, University of Salford, England. He received his M.Sc. degree in the field of Computer Instrumentation in 1988 and a Ph.D. degree in the field of Material Science in 1993. He returned back to Indonesia, then in 1994 he moved to Jakarta and appointed as a “Head of Engineering and Advanced Technology”, (Echelon IIIA) at “Nuclear Science and Technology Empowerment Center”, Atomic Energy Agency, BATAN, Jakarta. In 2000 He was assigned to the Ministry of Research and Technology to serve as Assistant Deputy for Science Accreditation and Development Center (Echelon IIA) and in 2005 he was assigned as Assistant Director for Academic Affairs, to Organize Graduate Research in PUSPIPTEK Serpong. In 2008, he took early retirement as a Government Official to take a full time lecturer at Universitas Tarumanagara, Jakarta. Adianto started his profession as a lecturer in the Department of Mechanical Engineering, Faculty of Engineering, Universitas Tarumanagara and the Department of Mechanical Engineering, Faculty of Industrial Technology, Trisakti University of Indonesia from 1994 until now. He has taught mathematics, mechatronics, English and physics, but Physics is the main subject he teaches. As a full time lecturer at Universitas Tarumanagara, in 2012 he was appointed as a Vice Dean for Academic and Student Affairs, Faculty of Engineering, and in 2016 up to now, he was appointed as a Director for Student Affairs, Universitas Tarumanagara. During his profession as a researcher at the Atomic Energy Agency, the Ministry of Research and Technology and as a lecturer at Universitas Tarumanagara, Adianto as an Associate Professor has published scientific and research papers of more than 35 titles at home and abroad.

Lina Gozali is a lecturer at the Industrial Engineering Department of Universitas Tarumangara since 2006 and a freelance lecturer at Universitas Trisakti since 1995. She graduated with her Bachelor's degree at Trisakti University, Jakarta - Indonesia. She got her Master's Degree at STIE IBII, Jakarta – Indonesia, and she recently got her PhD at Universiti Teknologi Malaysia, Kuala Lumpur – Malaysia, in 2018. Her apprentice college experience was in the paper industry at Kertas Bekasi Teguh, shoe industry at PT Jaya Harapan Barutama and automotive chain drive industry at Federal Superior Chain Manufacturing. She teaches Production System and Supply Chain Management Subjects. She researched the Indonesian Business Incubator for her PhD. She has written almost 70 publications since 2008 in the Industrial Engineering research sector, such as Production Scheduling, Plant Layout, Maintenance, Line Balancing, Supply Chain Management, Production Planning, and Inventory Control. She had worked at PT. Astra Otoparts Tbk before she became a lecturer.

Agustinus Purna Irawan was born in Mataram - Musirawas, South Sumatera, August 28, 1971. Is a Lecturer at Universitas Tarumanagara and has served as Chancellor since 2016 until now. Obtained a Bachelor of Mechanical Engineering from the Faculty of Engineering, Gadjah Mada University (1995), a Masters in Mechanical Engineering from the Faculty of Engineering, University of Indonesia (2003), a Doctor of Mechanical Engineering from the Faculty of Engineering, University of Indonesia (2011), Professional Engineer (Ir) Mechanical Engineering from the Faculty of Engineering, Gadjah Mada University (2019) and Professor of Mechanical Engineering from the Ministry of Education and Culture (2014). The fields of scientific research and publication include: Product Design and Development, Strength of Materials, Natural Fiber Composites with implementation in the field of prosthesis and automotive components. Obtaining Research and Community Service Grants for Higher Education / Research and Technology BRIN / Untar / Others ≥ 100 titles; Patents: 7 and still in process: 4; Copyright: 9 books; Textbooks: 6 books; Book Chapter: 2 chapters; Scientific articles ≥ 100 titles. Obtained a Professional Certificate, namely the Educator Certificate, the Intermediate Professional Engineer Certificate (IPM) of the Indonesian Engineers Association (BKM PII) Vocational Engineer Association (BKM PII), and the ASEAN Engineer Certificate (ASEAN Eng.) From the ASEAN Federation Engineering Organizations (AFEO). He is active in education, various scientific activities, the world of business, professional associations, and various social activities. Received several awards: Best Graduate S2 UI GPA 4.00 cum laude (2003); First best Lecturer Kopertis Region III DKI Jakarta (2011); Best Presentation at the Seminar on Research Results of the Centralized Program, PUPT Dikti (2014); Honorary Member of The ASEAN Federation of Engineering Organizations, AFEO (2018); Best PTS Chancellor for the Academic Leader Award Program (2019).

Wilson Kosasih was born in Medan, North Sumatra, Indonesia on 2nd Dec 1980, is a lecturer in the Department of Industrial Engineering at Faculty of Engineering, Universitas Tarumanagara. Since 2005 conducted teaching, research and has served as Industrial Engineering Undergraduate Chairman since 2018 until now. He completed his Undergraduate Mechanical Engineering Education at Universitas Tarumanagara, obtained a Master Degree in Industrial Engineering at the Universitas Indonesia and is currently taking a Doctoral Program at the Institut Teknologi Sepuluh Nopember with a concentration in Industrial Management. Holders of professional certification in the field of supply chain and logistics, Certified Supply Chain Manager (CSCM) and Certified Professional in Logistics Management (CPLM) from ISCEA, USA, certification for Professional Engineer (IPM) from PII, and ASEAN Engineer certification from AFEO. He worked in a multinational company in the FMCG field before becoming a full-time lecturer since 2009. He has professional experience and consultant in the field of Productivity and Quality Engineering. Since becoming a lecturer, he has been active in research, scientific publications and community service by obtaining grants from within and outside Untar, such as from the Ministry of Research, Technology and Higher Education. His research field are Lean Manufacturing, Quality Engineering, and Supply Chain Management. In addition, he is also active in professional organizations, currently as a member of the Industrial Engineering Professional Engineer Competency Appraisal Council at BKTI PII.