Hand-Operated Mixer for Batter, Dough, and Eggwhite Foam

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ABSTRACT

Batter, dough, and egg white foam are the basic baking mixtures that greatly differ in their mixing requirements. Regular baking class encounters inconveniences during hands-on activities whenever there are incidents of electric power interruptions and electric mixer malfunctions that impair mixing process and eventually deviate the standard output of baked products. The major objective of this study was to design, construct, and evaluate an economical and environment-friendly hand-operated mixer for batter, dough, and egg white foam as back up mixing equipment in times of urgent situation and potential community extension services' baking livelihood program. The researchers employed applied research method. The mixing machine was evaluated in terms of functionality, aesthetics, workability, durability, economy, safety and affordability. Based on the findings of the study, the mixing equipment was designed with bike gear system that is easy to operate and maintain and economical for it saves great deal of energy. It is durable and cheaper compared to commercially produced-equipment. It only requires simple construction processes such as measuring, cutting, welding, bending, drilling, polishing, greasing, assembling, testing, and adjusting, which call for mechanical knowledge and fabrication expertise. The evaluation on the level of acceptability of the mixing machine reveals that it is generally excellent.

Keywords: *hand-operated mixer, dough, batter, baking ingredients, mixing machine*

INTRODUCTION

Batter, dough, and egg white foam vary greatly in their mixing requirements and techniques (Osborne, 2014; Phillips, 2000). Batter mixture requires a mixing process that is somewhat slower or else it will turn a lumpy batter or develop gluten, which is not desirable if one is preparing for quick breads. Dough mixture requires extensive kneading for gluten to develop if one is preparing for yeast breads. Egg white foam mixture requires continuous beating in order to incorporate air and stabilize the foamy mixture. Once interrupted, one will have from start all over again.

Food mixing devices are very vital in baking classes. In achieving these appropriate mixing processes, particularly, in the College of Industrial Technology

(CIT) Food Service Management (FSM) Department of Bulacan State University (BulSU). Food mixing devices are normally used in hands-on baking activities of the Bachelor in Industrial Technology (BIT) students specializing in FSM because of time constraints. Approximately, only two to three hours are allotted to baking subject in each class session. A slight delay greatly affects the quality of baked products and interrupts the succeeding classes of the students.

Students also encountered inconveniences in their baking activities whenever there are incidents of electric power interruptions that stopped electric-operated mixer (Hilario, 2004). The outputs of baked products are far from the expected standard outcome. Food, money and efforts are wasted.

In addition, as early as 2012, Energy Secretary Jose Rene D. Almendras notified the government and the public of possible power supply shortages in Luzon in 2015 if the proposed coal-fired power plant would not be installed immediately (Remo, 2012). It is, but timely, that the state universities and colleges (SUCs) make advance preparation to projected power supply interruptions by coming up with various support equipment that will be made available to upcoming power supply disruptions in the region.

As cited by Nieburg (2013), Gomez, Talegon, and de la Hera (2013) stated that the speed of mixing, mixing time and the type of mixer device have a great influence in mixing process and mixing requirement of dough and of other baking mixtures.

Moreover, the National Higher Education Research Agenda – 2 (NHERA 2) 2009 – 2018 stated that one of the priority themes for multidisciplinary/ multisectoral research is the protection of the environment and ensuring energy security in a multidisciplinary approach (Angeles, 2013). Energy security is secured if ways to save it is transformed into immediate actions. Bringing back the manual way of doing things may seem to be primitive but beneficial in saving and preserving finite energy sources. Manually-operated devices or machines for everyday use are very handy and practical to use to mitigate the apprehended energy crisis in the future and increasing exploitation of the natural energy sources. The researchers highly considered the energy-saving capability of the hand-operated type of food mixer and the use of indigenous, locally available materials in pursuing research studies in order to support the national thrust in research and development (NHERA - 2 2009 – 2018).

The researchers, therefore, were encouraged to produce this support equipment. The major objective of this study is to design, construct, and evaluate an economical and environment-friendly hand-operated mixer for batter, dough, and egg white foam specifically intended for BIT - FSM students in the BulSU - CIT as

handy back up mixing equipment and potential community extension services' baking livelihood program of the university in the province of Bulacan.

Specifically, the study determined the following: (1) appropriate design for a hand-operated mixer for batter, dough, and egg white foam; (2) how the hand-operated mixer for batter, dough and egg white foam is constructed and (3) the level of acceptability of the hand-operated mixer for batter, dough, and egg white foam in terms of: (1) functionality; (2) aesthetics; (3) workability; (4) durability; (5) economy; (6) safety; and (7) affordability.

The hand-operated mixer for batter, dough and egg white foam was given directions by adhering to the input-process-output model in Figure 1.

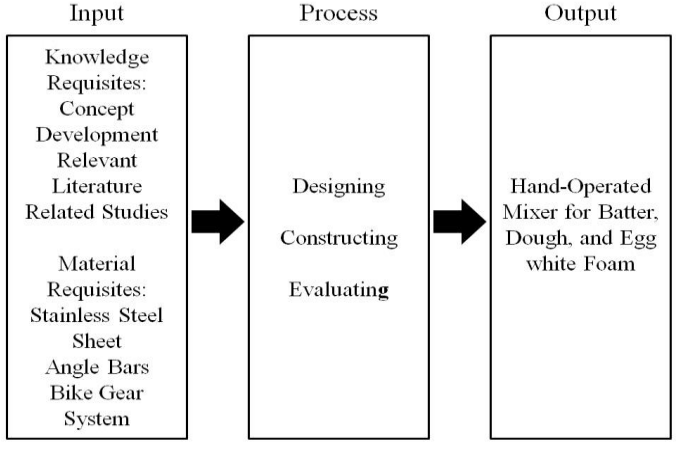

Figure 1. Conceptual Model of the Study

The input components are: (1) knowledge requisites that include concept development, relevant literature, and related studies; and (2) material requisites that involve stainless steel sheet, angle bars, and bike gear system.

The process section takes account of the designing, constructing, and evaluating of the hand-operated mixer for batter, dough and egg white foam.

The projected output is the hand-operated mixer for batter, dough and egg white foam equipment.

METHODOLOGY

To attain the objectives of this study, the researchers employed the Project Development Method (PDM) and applied research method to attain the objectives of this study. According to Jones (2012) project development includes five main

stages: (1) envision; (2) plan/analyze; (3) design; (4) build; and (5) operate. The concept was further supported by Stewart (2014) that project development involves five different stages: (1) initial stage; (2) project specification stage; (3) project design; (4) build stage; and (5) project implementation. The first stage involves establishing the purpose of the project in consultation with the end user. The second stage involves estimating the budget, time, and project requirements. The third stage involves the drafting of project specifications. The fourth stage involves the actual building of the project. The fifth stage involves putting the project into operational mode.

In keeping with Bickman and Rog (2008), applied research has two major phases – planning and execution. The planning phase involves defining the scope of the research and developing a comprehensive research plan. The execution phase involves implementing and monitoring the plan. Moreover, Kowalczyk (2014) emphasized that applied research is used to answer a specific question that has direct applications to the world. Still, he accentuated that applied research intends to solve a problem. According to Cherry (2014), applied research refers to scientific study and research that seeks to solve practical problems and to find solutions to everyday problems, cure illness, and develop innovative technologies. The researchers particularly employed the stages of planning, designing, constructing/building, testing/implementing/operating, and evaluating to come up with the hand-operated mixer. Eventually, permission from the college dean to distribute the questionnaire and demonstrate the operation of the machine by following the correct procedures to the respondents was secured.

Table 1
List of construction materials

Quantity	Unit	Item Description	Specifications
1	piece	chain wheel	165mm and 28T
1	piece	bicycle hub	20H
1	piece	sprocket	16T
1	piece	bicycle chain	single-speed type, ½ inch pitch (ANSI standard#40), 1/8 width
1	piece	roller (boha)	
2	pieces	gear	external gear with straight chain path gear ratios
2	pieces	bicycle fly wheel	7 speed friction
4	pieces	flange bearing	XHM UC201
1	piece	angle bar	3 1/16 x 1 x 1 x 20ft
2	pieces	bushing	isolator or mechanical, bearing
1	piece	shafting	6 inches height ½ inch width
1	piece	handle	6 inches stainless steel rod, 1inch diameter
1	piece	stainless sheet	1mm thick
2	pieces	spring	6 inches
2	piece	stainless steel bowl	24cm

Materials of the Hand-Operated Mixer for Batter, Dough, and Egg White Foam

Table 1 presents the list of construction materials that are needed for the manufacture of the equipment. The quantity, unit, item description, and specifications were distinctively presented.

Construction Hand Tools and Specialized Equipment

The fabrication of the hand-operated mixer for batter, dough, and egg white foam equipment necessitates the utilization of certain hand tools and specialized equipment to produce the required parts for its construction. Table 2 lists the particular hand tools and specialized equipment used in the construction of the hand-operated mixer for batter, dough, and egg white foam equipment. The list of hand tools, specialized equipment and its respective functions are specified.

The production of the hand-operated mixer for batter, dough, and egg white foam equipment involves a sequential process in order to put all the construction materials together. Table 3 lists the different processes engaged in the construction of the hand-operated mixer for batter, dough, and egg white foam equipment.

Construction Procedure

The procedure in construction of the mixer is as follows:

1. Measure the angle bar and stainless-steel sheet with a tri-square and marking it up.

Table 2
List of construction hand tools and specialized equipment

Hand Tools and Specialized Equipment	Functions
Welding Machine	It is used for joining or bonding metal parts or alloys permanently.
Grinding Machine	It is used for grinding and cutting small metal chips from the work piece via shear deformation.
Plasma Cutter	It is used for cutting metals sheets.
Drill	It is used for drilling holes in various materials or fastening various materials together with the use of fasteners.
Sand Paper	It is used for smoothening metal surfaces.
Grinding Stones	It is used for removing metal, dimensioning, and finishing.
Cutting Disc	It is used for cutting through metal materials like cutting exhaust pipes, trimming bolts, and slicing through sheet metal.
Tape Meter	It is used for measuring length and diameter.
Tri Square	It is used for getting the right angle and measurement of stainless-steel sheet.
Angle Grinder	It is used for cutting, polishing and grinding.
Buffing Soap	It is used for mirror-type finishing.
Bending Machine	It is used for bending stainless steel sheet.

2. Cut the angle bars with grinder and cutting the steel sheet with cutting machine or plasma cutter.
3. Weld the angle bars to connect one piece to another and form the frame for the mixing machine.
4. Bend the stainless-steel sheet with the use of bending machine.
5. Drill holes through the stainless sheet and angle bar to fix the two together and screwing it with bolts and nuts in place.
6. Polish the rough surfaces of welded areas and buffing the stainless-steel sheet to a glossy surface.
7. Grease or lubricate the sprocket and bike gear system.
8. Assemble the bike gear system into the body frame of mixing machine, rotating handle, and other attachments like mixing bowl and mixing implements.
9. Testing the mixing machine includes rotating capability of the handle, the rotating performance of the attachments, and stability of the mixing machine while in operation.
10. Adjust or modify the size of mixing bowl, designs of beater attachment and dough hook, and placement of rubberized stand support.

Construction Time Frame

Construction requires time to complete the hand-operated mixer for batter, dough and egg white foam. The progress of work takes about 12 weeks to get done. The mixing machine was conceptualized for three weeks, planned for four weeks, prepared for its materials for one more week, constructed in two weeks and an extra two weeks for testing.

Table 3
Material cost

Quantity	Unit	Item Description	Price (PhP)
1	piece	bicycle chain wheel	250.00
1	piece	bicycle hub	140.00
1	piece	sprocket	120.00
1	piece	chain	250.00
1	piece	roller (boha)	210.00
2	pieces	gear	1,500.00
2	pieces	bicycle fly wheel	300.00
4	pieces	flange bearing	1,200.00
1	piece	angle bar	450.00
2	pieces	bushing	420.00
1	piece	shafting	350.00
1	piece	handlebar	650.00
1	piece	stainless sheet	2,000.00
2	pieces	spring	50.00
2	pieces	stainless steel bowl	176.00
		Total	8,066.00

Table 4
Construction cost

Particulars	Amount
Supplies and Materials	PhP 8,066.00
Labor	PhP 5,000.00
Total	PhP 13,066.00

Construction Cost

Construction always entails doling out certain amount. Table 3 presents the comprehensive cost of each component used in the construction of the hand-operated mixer for batter, dough and egg white foam equipment. The material cost reflects the quantity, unit, item description, and corresponding market price.

Table 4 discloses the construction cost of the hand-operated mixer for batter, dough, and egg white foam. The materials for constructions are charged about PhP 8,066.00 while labor cost accumulated amount is PhP 5,000.00. It shows a total amount of about PhP 13,066.00. The estimated return on investment (ROI) for the mixing machine is 53%.

Operation Manual of Hand-Operated Mixer (HOM) for Batter, Dough, and Egg White Foam

Usage Procedure:

The procedure in using the mixer is as follows:

1. Place the HOM on a clean, sanitized, and sturdy working table.
2. Before operating the HOM for the first time, make sure the *mixing bowl* and *dough/beater attachments* are thoroughly clean. Wash in hot soapy water and rinse with hot clean water.
3. Place the baking ingredients in the *mixing bowl* as specified on the recipe card.
4. Do not fill the *mixing bowl* more than half full.
5. Insert the *mixing bowl* into the *mixing bowl insertion slot* and make sure it is fixed properly with the *side safety locks*, one on the left side and one on the right side.
6. Select the required mixing attachment (*beater attachment* or *dough hook attachment*) as per recipe and place it securely in the *attachment port*.
7. Hold the *rotating handle* and start rotating counter clockwise. Watch out closely on the mixing time requirement and mixing speed cautiously. (Note: If during mixing, some mixture start building up on the sides of the mixing bowl, halt shortly. Use a long-handled spoon or rubber spatula and scrape down the sides of the mixing bowl. Then, continue mixing.)

8. Once mixing is finished. Remove the attachment (*beater attachment or dough hook attachment*) from the *attachment port* together with the *mixing bowl* from the *side safety locks* and *mixing bowl insertion slot* to keep the mixed ingredients from splattering. With the use of rubber scrapper, scrape off thoroughly the mixture from the *mixing bowl*.

Figure 2. Hand Operated Mixer

Cleaning Procedure:

Clearing the mixer follows the procedure:

1. *Beater attachment*, *dough hook attachment*, and *mixing bowl* require thorough washing using hot soapy water before and after use to ensure food safety. Rinse with hot clean water as well. Air dry and store it in a dry, clean place or container to keep it away from rodents or other kitchen pests.
2. *External case* should be wiped clean with a clean damp cloth from side to side, from the upper surface down to bottom including corners, holes, and remotest parts that might have been spilled with the mixed ingredients. Wash the damp cloth and wipe the *external case*. Do this three times. Soak a dry clean cloth in a sanitizing solution or apply a sanitizing solution onto the dry clean cloth. Wipe it on the *external case*. Do this before and after using the HOM to ensure food safety.
3. The bike gear system should be greased once a month. The HOM internal system and external case should undergo regular weekly inspection for possible repairs and spare parts replacement.

RESULTS AND DISCUSSION

A. Design of Hand-Operated Mixer for Batter, Dough, and Egg White Foam

The AutoCAD representation of the hand-operated mixing machine as reflected in Figure 2 shows the specific design identified by the researchers to be appropriate reflecting a dimension of 16” X 18 1/2”.

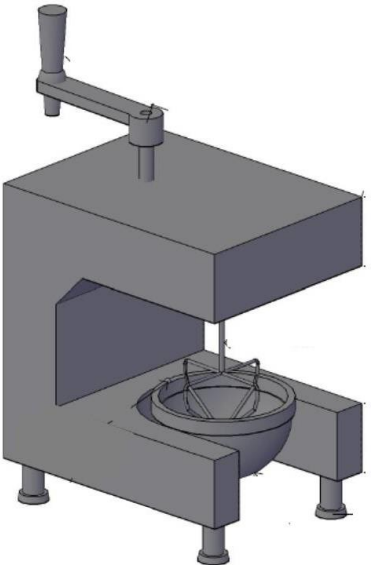

Figure 3. Hand-Operated Mixer for Batter, Dough, and Egg White Foam AutoCAD Representation

The hand-operated mixer for batter, dough and egg white foam equipment is mainly built of stainless steel. As stated by Schmidt and Erickson (2011), equipment used for processing and handling food products must be designed, fabricated, constructed, and installed according to sound sanitary design principles. Stainless steel is the preferred general use metal for food contact surfaces because of its corrosion resistance and durability in most food application (Wilmcow, 2014). The handle is specifically placed on top of it for easy grip and control. The installed bike gear mechanism in the inner part of the equipment facilitates trouble-free maneuver which goes in a single direction that is, counter clockwise. It is furnished with an attachment port, where beater attachment and dough hook attachment can be appended. A mixing bowl insertion slot is provided purposely to hold the stainless mixing bowl of about 10 Liters capacity. It also has safety lock to keep mixing bowl firmly in place. The equipment has rubberized stand support to keep it stable on flat surfaces. Rubber is also corrosion resistant so equipment will stay longer (Ahmed, van del Klundert, and Lardinois, 1996). The hand-operated mixer for batter, dough, and egg white foam equipment was fabricated in a private machine shop, F.G.

Avendaño Machineries located at 2291-2292 La Trinidad Subdivision, Lolomboy, Bocaue, Bulacan, Philippines. The draft of the AutoCAD design was presented to the fabricator.

Construction of the Operated Mixer

The construction materials for the building of hand-operated mixer for batter, dough and egg white foam underwent measuring, cutting, welding, bending, drilling, polishing, greasing, assembling, testing and adjusting. Angle bars are measured and marked with the following specific lengths: four pieces 16”; four pieces 12”; two pieces 14”; four pieces 3”; and fourteen pieces 10”. Cutting of the angle bars is facilitated by using the angle grinder. The angle bars are joined together with the use of welding machine to form the main frame. Then, the bike gear system is assembled and installed into the main frame. Lastly, the stainless-steel sheet is measured, cut with the use of plasma cutter, bent with the use of bending machine, and welded the specific parts against the main frame as shown in Figure 3.

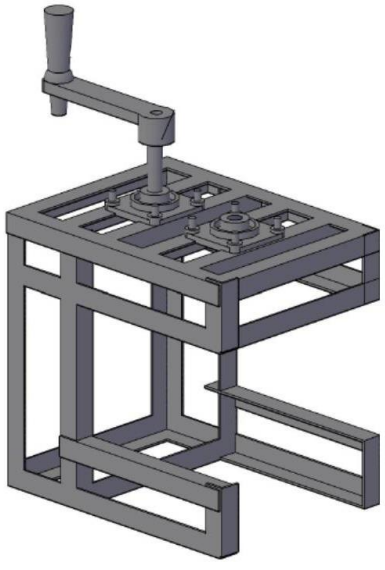

Figure 4. Hand-Operated Mixer for Batter, Dough, and Egg White Foam Main Frame AutoCAD Representation

Table 5 shows the testing and revising procedure made after the construction of the mixing machine. After testing, defects were discovered along the way and immediately revised.

Table 5
Result on testing and enhancing of hand-operated mixer for batter, dough, and egg white foam

Testing	Enhancing
1. Initial size of mixing bowl with 5 Liters capacity was fitted into the mixing machine port. When baking ingredients were placed into it and started mixing up, the ingredients were splattering from the brim. No insertion slot for mixing bowl (See Figure 4).	1. Mixing bowl was adjusted into a 10 Liters size to contain well the baking ingredients. When it was retested, the mixing machine became sturdier. Insertion slot for mixing bowl was provided (See Figure 4).
2. Initial design of the bowl has no lock provision to keep it in a steady place. When mixing started, mixing bowl was doing a rocking motion with every stirring motion of the attachments.	2. A locking and unlocking device was provided to keep the mixing bowl in place firmly while mixing. When it was retested, the mixing bowl became more secure.
3. Initial design has no stand supports. The mixing machine was placed on a wooden table. The mixing machine showed shakiness while on the wooden table and same with stainless top table, during mixing motions made (See Figure 4).	3. Rubberized stand support was fixed underneath the four stands to keep the mixing machine more stable on table tops during mixing (See Figure 4).
4. Initial design of dough hook was attached into the mixing machine. When bread ingredients were placed and started kneading it with a dough attachment. The dough was not kneaded well (See Figure 5).	4. Dough hook was revised into another new design. When it was tested, it worked just fine (See Figure 5).

Figure 5. Hand-Operated Mixer for Batter, Dough, and Egg White Foam Pictorial Representation Before and After Enhancing

Figure 6. Dough Hook Pictorial Representation Before and After Enhancing

Figure 7. Hand-Operated Mixer for Batter, Dough, and Egg White Foam Top View, Side View, and Front View Pictorial Representation

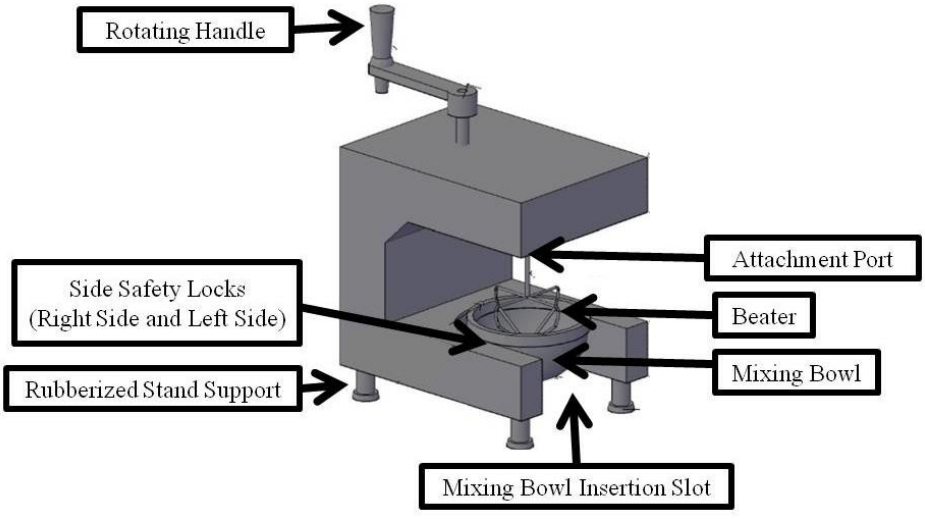

Figure 8. Parts of Hand-Operated Mixer for Batter, Dough, and Egg White Foam

Evaluation of Hand-Operated Mixer for Batter, Dough, and Egg White Foam

As shown in Table 6, the level of acceptability of the equipment in terms of functionality, durability and affordability recorded excellent mean rates of 4.53, 4.59, and 4.72, respectively. The mixing machine is capable of mixing dry and liquid ingredients. It can increase the productivity in the work place. The respondents agreed that assembling the device is simple. The equipment is guaranteed food graded as it is made up of stainless steel, which is of high-quality material. It can be used over and over again for the longest time as it is rust-proof. It will not chip, nick, crack, stain and fade. It has a greater advantage over other materials in terms of corrosion resistance.

The maintenance, installation and operation of the equipment are in a broad sense very simple. It absolutely saves any form of energy and money.

Table 6
Level of acceptability of hand-operate mixer for batter, dough, and egg white foam

	Items	Weighted Mean	Descriptive Rating
1.	Functionality	4.53	Excellent
2.	Aesthetics	4.36	Very Good
3.	Workability	4.47	Very Good
4.	Durability	4.59	Excellent
5.	Economy	4.40	Very Good
6.	Safety	4.45	Very Good
7.	Affordability	4.72	Excellent
	Total	4.50	Excellent

On the other hand, aesthetics, workability, economy and safety registered mean scores of 4.36, 4.47, 4.40, and 4.45, correspondingly, which are all very good ratings. It is portable.

Summary of respondents' description on the newly constructed mixer and its performance

It is easily set up in surfaces for stability. The small body dimension of the hand-operated mixer for batter, dough and egg white foam saves space. It functions and performs excellently. The materials used for constructing the equipment are affordable and very much available. There is no trouble in replacing and changing the spare parts of the equipment. The equipment operates smoothly without difficulty. There is a very low probability of experiencing accidents in using the equipment. All in all, the equipment will be acceptable to the food industry. The equipment is entirely different from all other food mixers that are manually operated since it was customized. The equipment for the most part is run by a bike gear in it. To clean the equipment is convenient to clean. It can last for a number of years as there is no installed electric motor, which usually causes troubles to most electrically operated equipment. The equipment has smooth edges that prevents it from harming the users.

CONCLUSIONS

Based on the findings of the study, the hand-operated mixer for batter, dough and egg white foam equipment is easy to operate; materials used are in conformity with industry standard; and saves a great deal of energy. The equipment is quite heavy and bulky but much cheaper and equally durable compared to commercially- produced equipment. The tedious construction of the hand-operated mixer for batter, dough, and egg white foam involved processes such as measuring, cutting, welding, bending, drilling, polishing, greasing, assembling, testing and adjusting, which require mechanical knowledge and fabrication expertise. The evaluation on the level of acceptability of the hand-operated mixer for batter, dough, and egg white foam reveals that it is generally excellent.

RECOMMENDATIONS

Further improvement and changes in the design and structure of the device should be done to make it more portable like installing wheels and handles for transporting. Fiber glass on top should be installed to show internal mechanism of the device and to easily monitor the working condition. Multiple gear mechanism should be installed to replace the chain and sprocket to increase the ease of turning the crank. Larger scale model of the equipment should be developed for bigger batches of ingredients. Special gear shift mechanism should be installed to control

the speed of time rotation and the equipment should be used for baking demonstration either in culinary seminar or baking livelihood program on community extension services.

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