Prototype Development of Low-Cost Semi-Automated Foam Shredder Equipment

Melani B. Cabrera, Jaypee B. Pajarillaga, Wilfredo L. Infante, Ariel G. Cabildo, R-Jay P. Quiambao

Abstract*: The Furniture Industry of the Philippines is one of the most labor-intensive and artistic industries in the country which develops the hardworking, creative and enterprising qualities of Filipinos in manufacturing best-quality furniture. With this, the Philippines is dubbed as the "Milan of Asia." In Pampanga alone, there are several furniture SMEs which manufactures for both local and international clients. Aside from the saw dusts as the by product, scrap foams are also a hurdle for the furniture manufacturers in Pampanga and Central Luzon. Due to the continuous demand of the furniture industries in Pampanga, the study incubated to develop a low-cost semi-automated foam shredder prototypes that will cater the need of furniture industries to crash foams within the customer specification to create a new set of raw materials. The system requirements for the prototypes followed the first utility model that was created. The target of the study is to reduce the production and operating cost of the foam shredder without compromising the capacity, quality and aesthetics of the prototype. The prototype must pass the requirements as follows: (a) safe and efficient, (b) easy to use; (c) reliable and maintainable; (d) yielding capacity of 40 kgs/hr. Ten (10) furniture companies are selected in order to conduct the validation testing of the prototypes developed.

Keywords: Shredder, Foam, Furniture, SME's, safe and efficient

I. INTRODUCTION

The Furniture Industry of the Philippines is one of the most labor-intensive and artistic industries in the country which develops the hardworking, creative and enterprising qualities of Filipinos in manufacturing best-quality furniture. With this, the Philippines is dubbed as the "Milan of Asia." The industry provides 2.1 million indirect workers nationwide and provides business to 5.4 million in its supply chain, given that 95% of the industry is categorized under

Small and Medium Scaled Enterprises (SMEs) which is scattered on the three major production areas of Manila, Pampanga and Cebu.

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***** Correspondene Author

Melani B. Cabrera. School of Engineering and Architecture, Holy Angel University, Angeles City, Pampanga, Philippines Email: mbcabrera820@gmail.com

Jaypee B. Pajarillaga., School of Engineering and Architecture, Holy Angel University, Angeles City, Pampanga, Philippines Email: jpajarillaga1975@gmail.com

Wilfredo L. Infante. School of Engineering and Architecture, Holy Angel University, Angeles City, Pampanga, Philippines Email: wlinfante126@gmail.com

Ariel G. Cabildo., School of Engineering and Architecture, Holy Angel University, Angeles City, Pampanga, Philippines Email: arielgonzalescabildo@gmail.com

R-Jay P. Quiambao. School of Engineering and Architecture, Holy Angel University, Angeles City, Pampanga, Philippines Email: rjay.quiambao@gmail.com

In Pampanga alone, there are several furniture SMEs which manufactures for both local and international clients. Aside from the saw dusts as the by product, scrap foams are also a hurdle for the furniture manufacturers in Pampanga and Central Luzon. These scrap foams are generated from their upholstery section during furniture production. However, they can utilize scrap foams by making throw pillows and other furniture accessories by manually cutting them into small pieces. With Bureau of Investments' target of 10% - 15% annual growth rate, many furniture manufacturers opt to outsource the shredding of their scrap foams or to procure shredded foams due to the unproductive and labor-intensive manual cutting of scrap foams. Coming to the previous research of the proponents, the furniture makers opts to have a low-cost yet locally available foam shredder equipment that can aid them on their day to day operations with the shredding of foams unlike the foam shredders available internationally with a price ranging from two thousand dollars to forty thousand dollars (PhP 90,000.00 to PhP 1,800,000.00) without shipment cost. Due to the continuous demand of the furniture industries in Pampanga, the study incubated to develop a low-cost semi-automated foam shredder prototypes that will cater the need of furniture industries to crash foams within the customer specification to create a new set of raw materials. The system requirements for the prototypes followed the first utility model that was created. The target of the study is to reduce the production and operating cost of the foam shredder without compromising the capacity, quality and aesthetics of the prototype. The prototype must pass the requirements as follows: (a) safe and efficient, (b) easy to use; (c) reliable and maintainable; (d) yielding capacity of 40 kgs/hr. Ten (10) furniture companies are selected in order to conduct the validation testing of the prototypes developed.

The Solid Works software of the university's mechanical engineering department was used in the simulation and analysis of the design. The prototypes developed are mostly made of AISI 4140 alloy steel to prevent kinds of degradation such as rusting. Three horsepower three-phased motors were installed in the two prototypes while the third prototype uses a 1.5 horsepower single-phased motor. All metal blades are fabricated made of stainless steel. The yielding capacity of the machines is at 36 kgs/hour. The costs of prototypes are Php 104,388.02, Php 103,071.24 and Php 44,398 respectively. The fabrication of blades, body plate and hopper are outsourced to a third-party fabricator, which is also for capacity building while the machine assembly and performance testing of the prototypes were done at the Holy Angel University Engineering Laboratory. Validation testing were done to the 10 companies initially selected, as to collect more data for the prototypes' improvement.

Society constantly generates a huge amount of waste, much of which could be recycled or recovered [1] so, it is becoming gradually significant for different industries to find low-cost methods in recycling their waste materials. Particularly, in furniture industries, one material being recycled now that provides both environmental and financial benefits is the polyurethane foam. Polyurethanes are used in diverse applications and industrial uses. In which then creates foam scraps that adds to the huge pile of solid waste. They enter the municipal solid wastes stream usually by ways of discarded consumers and industrial products including upholstered furniture and mattresses. The concept of 3 R's known as reduce, reuse, recycle has been applied to address the solid waste problem of the industries. Polyurethane foam is easy to recycle. Because of its recyclability, FPF provides both environmental and financial benefits. Recycling polyurethane foam is sustainable and the chance to make additional income while eliminating costly waste removal has caught the attention of many home furnishings manufacturers, foam fabricators, carpet installers and other converts of flexible polyurethane foam because it is an easy product to recycle [2]

The previous research, Design and Development of Foam Shredder for the Furniture Industry, has shown that there is really a demand of foam shredders in Pampanga and Central Luzon. However, since the furniture makers are mostly SMEs, the cost of the internationally available foam shredders limits them to procure such equipment for them to improve their shredded foam production. In return, either they would procure shredded foams available in the market at a higher price or have the burden to manually cut the foam which incurs a manual intensive work and would expose their worker to Musculoskeletal Disorders due to poorly designed workstation and work process. This is on top of the scrap foams piling up when manual cutting is reinforced. Through the development of the research, the proponents were able to fabricate a foam shredder that is equally able with the readily available shredders in the market but is available locally. The challenge is just to make the production and operational costs of the foam shredder lower, and user friendly with the SMEs of the furniture industry.

This study aims to improve the previous study, Design and Development of Foam Shredder for the Furniture Industry, by developing foam shredder prototypes that are low-cost and semi-automated that is:

a) safe and efficient

b) easy to use

c) reliable and maintainable

d) yielding capacity of 40 kgs/hour

II. METHODOLOGY

A. *Conceptual framework of the study*

The development of this research is from the initial research conducted by the proponents. After the creation of the utility model, validation testing was executed to different furniture companies and end users in Pampanga as well as the technology review with the Department of Science and Technology (DOST) Region III. Feedback was collected and it was known that there is still a niche with regards to the cost of the utility model which limits its commercialization stage. The initial research was then continued to pursue different prototypes that will abide to the requirements of the end users from the feedback provided that the system requirements will not be deviated. As shown in figure 1

The effectivity and success of the prototypes will be measured if the objectives are met and that the end users are satisfied and have accepted its over-all performance.

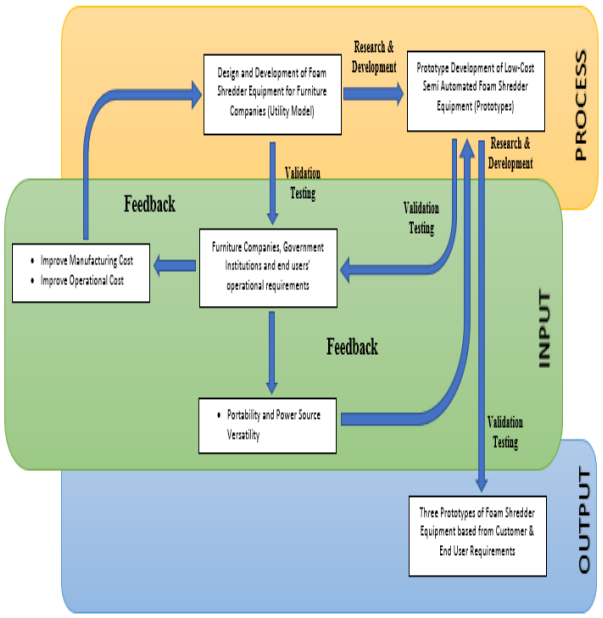

Figure 1: Conceptual Framework of the Study

B. *Research Design*

A shredder is a machine designed to reduce large solid material objects into a smaller volume, or smaller pieces. Shredders may be used to reduce the size or change the form of waste materials so they can be more easily disposed of or recycled, or to reduce the size of a solid mix of raw materials (as in rock ore), so that pieces of different composition can be differentiated [3].

With the previous research by the proponents, the development of the prototypes followed the initial system requirements of the end users with the provision of the additional findings during the validation testing of the utility model. From the previous research, it was found out that the furniture companies in Pampanga and Central Luzon are still doing manual foam cutting due to unavailability of foam shredder equipment. This yields to (a) lower productivity and slower turnover of shredder foams as raw materials and (b) laborers exposed to Musculoskeletal disorder due to un-ergonomically designed practice. In designing a machine, one concept that needs to be considered is ergonomics. Shaum stated that ergo¬nomic correctness attempts to determine how the workplace can be designed and adapted to the worker to prevent a variety of health problems and still increase efficiency. In order to comply with today's ergonomic sensibilities, machine manufacturers must find a way to make the machine operation fit the worker, instead of forcing the worker to conform to the machine. Ergonomic design issues that machine builders should consider are:

Operator interface height, operator control access, safety considerations (safety mats, light curtains, emergency stop operator access, etc.), visibility and maintainability. All of which has to be incorporated without jeopardizing the machine's performance or output quality challenging requirements in a highly competitive global market. The lack of properly designed machines and equipment may lead to lower work performance and higher incidence to work related injuries. The researchers applied both the system requirements and the anthropometric measures from the previous study. They have further improved the machine by means of lowering down the manufacturing and operational cost of the machines (eg: lessening the number of blades, lowering down the motor horsepower, improving portability) without compromising the output and capacity. After the prototypes were developed, performance testing and validation testing were done in order to compare the output and document the improvement from the initial utility model.

C. Action Research Design

The researchers used an action research design in which it follows a characteristic cycle where an understanding of a problem is developed, and plans are made for some form of interventionary strategy. Then the intervention is carried out during which time, pertinent observations are collected in various forms. The new interventional strategies are carried out, and the cyclic process repeats, continuing until a sufficient understanding of the problem is achieved. The approach is iterative or cyclical in nature and is intended to foster deeper understanding of a given situation, starting with conceptualizing and particularizing the problem and moving through several interventions and evaluations.

D. Research Participants

The furniture manufacturing companies in Pampanga are asked to participate to get relevant information for the study. The researchers selected 10 companies through stratified sampling approach across Pampanga and Bataan. These samples are furniture manufacturers who produce upholstered furniture as follows: Novelita Furniture; Betis Crafts and Furniture; Mallari's Nursery Furniture; Furnitureville Inc.; Peter's Custom-built Furniture; Vera's Mabuhay Furniture Trading, Inc.; DFS Furniture (DAN's Furniture); Philiana Design Draperies and Furniture Marketing; More Than a Chair; Raloha Furniture Designs and Manufacturing Corporation. The Pampanga Furniture Industries Foundation was also tapped to consolidate the validation testing to one site to ease transportation and transfer issues. The Department of Science and Technology was also considered as pertinent organization for the data gathering and generation.

E. Instrumentation

Aside from the previous research as initial basis on the system requirements, the researchers conducted one-on-one pre-assessment evaluation / interview with the owners of 10 companies around Pampanga and Bataan to further understand what improvements can be done to the utility model. The researchers also conducted interview with Department of Science and Technology – Region III to understand what concerns are being raised to them by the furniture industries. Post-assessment evaluations were also conducted to assess the effectivity of the prototypes developed and if the solutions to their problems are met

F. Reliability

The prototypes are expected to last up to 5 years from its initial use; wear and tear becomes a vital point for the failure of the machine. There are certain parts of the machine that must be monitored and maintain to verify its function according to its desired or intended purpose. The gear lifespan last only from 5 years to 6 years based from daily usage. The motor temperature should also be monitored especially during continuous operations in room to above room temperature. Ventilation were reinforced to the first two prototypes to lessen the accumulated heat from the motor. In case of overload, the machines were electrically installed with trip sensors to avoid motor breakdown.

G. Validation

Since the prototypes requires a cheaper manufacturing and operational cost, testing from the conceptual design up to its development will be done. The focus of the testing will be the speed, safety and production output which is at par to the utility model despite the reduction of raw material and manufacturing cost in consideration with reduction of the motor power. There were series of initial and performance testing during the development of the prototypes and two validation testing during the entire project duration. In the series of validation testing, adaptive solutions were taken into consideration such as the speed of the machine, motor power, power source / input, motor ventilation, portability and weight. Since the research design is an action research, it is aligned and focused on pragmatic and solution-driven research rather than testing theories which paved way to the results from initial and validation testing. The validation testing to 10 different furniture companies answered the objectives: safe and efficient; easy to use; reliable and maintainable; yielding capacity of 40 kgs/hour and the secondary problems encountered by the end users: machine manufacturing and operating cost; portability; motor specification and power source versatility.

H. Project Design

Three prototypes were created by the researchers throughout the course of the research. The first two prototypes were identical in terms of system specifications and only different in size and aesthetics (second prototype is smaller). The third prototype was generated from the concept given by the end-users that needs to be portable and power source versatility (single phased instead of three phased). The prototypes one and two, As shown in figure 2 is composed of (1) Eurodrive Three-phased 3 Horsepower Motor as the main device that produces motion in order for the foam cutters/blades to move; (2) Foam Cutter Assembly as the main assembly part that comprises the blades which rotates in opposite direction which then produces motion that will enable shredding or cutting of foams through low speed-high torque; (3) Body Plate Assembly as the assembly that holds the Foam Cutter Assembly and protects the operator from accidental feeding; (4) Orifice which regulates the flow of shredded foams from the foam cutter assembly and mesh down to the bin/ foam collector; (5) Stand

Assembly which supports the whole assembly of the machine (eg. Foam cutter assembly, body plate assembly, motor, hopper); (6) Lock Assembly ensures that tapering and unauthorized access to the foam cutter and body plate assembly are not possible; (7) Hopper Assembly that protects the operator from accidental feeding and improper feeding procedures; (8) Three-button switch which toggles the on and off of the machine; (9) Control Panel where the electronic and overload feature are reinforced to the machine; (10) Wheels for support for easy transport; (11) Mesh Assembly which serves as a replaceable filter and quality control of the size of shredded foams aligned to the requirements of the end user.

Figure 2: Unit 1 & 2 Prototype Design

Prototype three, As shown in figure 3 is a blender type foam shredding machine that is composed of (1) 2 Horsepower converted into single phased motor as the main device that produces motion in order for the blade to rotate; (2) Hopper Assembly that protects the operator from accidental feeding and improper feeding procedures; (3) Body Plate Assembly as the assembly that holds the Blade Assembly and protects the operator from accidental feeding; (4) Blade Assembly the main assembly part that comprises the blades which rotates in same direction which then produces motion that will enable shredding or cutting of foams through high speed-low torque; (5) Orifice which regulates the flow of shredded foams from the blade assembly and mesh down to the bin/ foam collector; (6) Stand Assembly which supports the whole assembly of the machine; (7) Control Panel where the electronic and overload feature are reinforced to the machine; (8) Switch Assembly which toggles the on and off of the machine; (9) Wheels for support for easy transport; (10) Mesh Assembly which serves as a replaceable filter and quality control of the size of shredded foams aligned to the requirements of the end user.

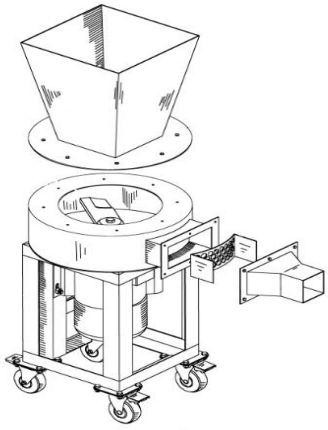

Figure 3: Unit 3 Prototype Design

The Solid Works software of the university's mechanical engineering department is used in the simulation and analysis of the design. The foam cutter assembly, body plate assembly, and hopper assembly will be fabricated to an accredited supplier under the supervision of the researchers. The Euro-drive motor will be outsourced, and other parts of the prototype will be fabricated inside the Mechanical Engineering Laboratory. Final assembly, initial testing and performance testing will be done within the premises of the Mechanical Engineering Laboratory. Validation testing will be done to 10 furniture companies in Pampanga and Bataan: Novelita Furniture; Betis Crafts and Furniture; Mallari's Nursery Furniture; Furnitureville Inc.; Peter's Custom-built Furniture; Vera's Mabuhay Furniture Trading, Inc.; DFS Furniture (DAN's Furniture); Philiana Design Draperies and Furniture Marketing; More Than a Chair; Raloha Furniture Designs and Manufacturing Corporation. The Pampanga Furniture Industries Foundation will also be tapped to consolidate the validation testing to one site to ease transportation and transfer issues. Equipment operation and maintenance manual will be developed by the project staff. Personnel from the technology adaptor will be provided with training on the operation and maintenance of the developed equipment. The machine is expected to yield at least 40 kilograms per hour of operations.

III. RESULTS & DISCUSION

A. Project Description

The previous research, Design and Development of Foam Shredder for the Furniture Industry, has shown that there is really a demand of foam shredders in Pampanga and Central Luzon. However, since the furniture makers are mostly SMEs, the cost of the internationally available foam shredders limits them to procure such equipment for them to improve their shredded foam production. In return, either they would procure shredded foams available in the market at a higher price or have the burden to manually cut the foam which incurs a manual intensive work and would expose their worker to Musculoskeletal Disorders due to poorly designed workstation and work process. This is on top of the scrap foams piling up when manual cutting is reinforced.

Through the development of the research, the proponents were able to fabricate a foam shredder that is equally able with the readily available shredders in the market but is available locally. The challenge is to make the production and operational costs of the foam shredder lower, and user friendly with the SMEs of the furniture industry. By developing a foam shredder prototype that is low-cost, semi-automated but would ease the labor-intensive manual cutting of scrap foams, the furniture industries in Pampanga would increase their production rate by 11.5 times more than the current setup. The prototypes developed are mostly made of AISI 4140 alloy steel to prevent kinds of degradation such as rusting. Three horsepower three-phased motors were installed in the two prototypes while the third prototype uses a 1.5 horsepower single-phased motor. All metal blades are fabricated made of stainless steel. The yielding capacity of the machines is at 36 kgs/hour. The costs of prototypes are Php 104,388.02, Php 103,071.24 and Php 44,398 respectively. The fabrication of blades, body plate and hopper are outsourced to a third-party fabricator, which is also for capacity building while the machine assembly and performance testing of the prototypes were done at the Holy Angel University Engineering Laboratory. Validation testing were done to the 10 companies initially selected, as to collect more data for the prototypes' improvement.

B. Product Cost

The product cost of each foam shredder is shown in table 1 to 3.

Table 1: Product cost for Prototype 1

Item	Amount	
Foam Cutter Assembly	PHP	24,711.45
Body Plate Assembly	PHP	9,875.24
Hopper Assembly	PHP	800.00
Third Part Labor Cost	*PHP*	*20,000.00*
Orifice	PHP	350.00
Stand Assembly	PHP	1,968.33
Lock Assembly	PHP	450.00
3 Button Switch	PHP	560.00
Control Panel	PHP	1,113.00
4 Wheels	PHP	410.00
Mesh Assembly	PHP	150.00
3 HP Three Phased Motor	PHP	44,000.00
Total	**PHP**	**104,388.02**

Table 2: Product cost for Prototype 2

Item	Amount	
Foam Cutter Assembly	PHP	23,244.67
Body Plate Assembly	PHP	9,875.24
Hopper Assembly	PHP	800.00
Third Part Labor Cost	*PHP*	*20,000.00*
Orifice	PHP	350.00
Stand Assembly	PHP	1,968.33
Lock Assembly	PHP	450.00
3 Button Switch	PHP	560.00
Control Panel	PHP	1,113.00
4 Wheels	PHP	410.00
2 Mesh Assembly	PHP	300.00
3 HP Three Phased Motor	PHP	44,000.00
Total	**PHP**	**103,071.24**

Table 3: Product cost for Prototype 3

Item	Amount	
Hopper Assembly	PHP	1,200.00
Body Plate Assembly	PHP	700.00
Blade Assembly	PHP	4,500.00
Third Part Labor Cost	*PHP*	*15,000.00*
Orifice	PHP	350.00
Stand Assembly	PHP	968.00
Control Panel	PHP	560.00
Switch Assembly	PHP	560.00
4 Wheels	PHP	410.00
Mesh Assembly	PHP	150.00
1.5H Single Phased Motor	PHP	-
2 HP Three Phased Motor	PHP	20,000.00
Total	**PHP**	**44,398.00**

C. Machine Validation

The researchers have chosen the Action Research as the design of the project. Since the research design is an action research, the foam shredder prototype developments are progressive depending on the results from the initial and performance testing. From the fabrication culmination the first prototype last Quarter 3 of 2018, the initial results are shown in Table 4.

Table 4: Prototype 1 Initial Testing: July 21, 2019

Accomplishments	Remarks
Tested last July 21, 2018 and initially failed KPI on letters a, c and d. Started the repair last July 26 to July 31. Conducted the second testing last August 16 but failed on the KPI letter d. Output of only 11kgs per hr instead of committed capacity of 40kgs / hr.	As discuss with DOST TAPI last September 11, unit 1 Prototype is considered to be a Trial Model where in all the design issues in unit 1 will be considered in the design specification of unit 2. Findings / Issues from Unit 1 as follows: 1. Machine Stoppage due to Choking 2. 20% to 25% Machine Efficiency 3. Waiting Time / Ten Seconds Interval in Foam Feeding. Corrective Actions on the issues as follows: 1. Replacement of Mesh thickness to adjust clearance from mesh to blades. 2. Gear Box Replacement (from 1:40 to 1:30) 3. Reduction of Hopper Size

With the initial testing, the first prototype still failed on KPIs a, c and d. Corrective actions on the issues are iterated in Table 1 for the refurbishment of the machine. After series of testing, the gear box and chains were removed. The motor was also replaced from the initial 1HP to 3 HP directly attached to the foam cutter assembly. The fabrication of the second prototype was also started during the refurbishing of prototype 1.

Table 5: Prototype 1 Initial Testing: November 7, 2019

Accomplishments	Remarks
2 units underwent validation testing and trial run. Findings that were identified in the design of unit 1 were noted and considered in the design of unit 2.	
During the on field testing of Unit 2: 1. It was noted that the machine is safer, and easier to use. (with the overload feature, forward and reverse rotations) 2. The reliability and maintainability of the machine is comparable with unit 1. 3. The yielding capacity of 40kgs / hr is still not attainable. Speed is still at 11kgs per hour. (needs further testing and machine enhancement)	End users commented that there should be a portable foam shredder with a single phased motor. Prototpyes 1 and 2 uses a Euro-Drived 3HP Three-phased motor.

From the validation testing last November 7 shown in Table 5, another demand of a prototype which requires lesser power consumption, but same output is needed by smaller furniture makers. The researchers studied on how to reinforce and re-design the shredder in a way that can sustain the end-user's requirements. The third prototype, compared to the first two prototypes, are very opposite in nature since the first two prototypes are more on low-speed torque based while prototype three is high-speed low torque. The initial testing of unit 3 is conducted after the initial fabrication on December 2019. As shown in table 6.

Table 6: Prototype 3 Initial Testing: December 2019

Accomplishment	*Remarks*
1. a higher satisfaction from clients (comparing unit 2 and Unit 3) 2. A Safer, more efficient to use. (one rotation only) 3. Compared to the first two units, unit 3 only has a single blade bore at the middle (blender type) making the maintainability of the unit 3 easier than two units 4. a yielding capacity of 3kgs per 5 minutes(600grams per minute) or 36 kgs per hour	Results are more favorable compared to 1 and 2

After the initial testing of prototype 3, the results were more favorable versus the prototypes 1 and 2 especially for small batch production. Smaller SMEs also wanted the prototype 3 because of its power versatility since they can plug it to usual 220V socket. After the fabrication of prototype 2, the validation testing were done to 10 companies around Pampanga and Bataan for prototypes 2 and 3.as shown in table 7.

Table 7: Prototype 1 & 2 Testing: February to May 2019

Accomplishments	Remarks
The machine was further improved through the notes of the operators and user of the machine during the testing.	From the improvement done, both Large and Small Foam Shredder Equipment were able to yield at 36 kgs per hour from the initial speed of 11 kgs per hour. The motor that were use were Eurodrive Motor type. These motors are compressed but powerful at 3HP.
Large and Small units have been tested to the different companies in Pampaga. It was noted that some companies prefer single phased while others prefer three phased motor. Additional note is that the unit 3 needs to have a single phased motor which is faster than the current (1750 RPM). The techical team is looking for a single phased machine with at least 3000 RPM.	From the needed KPIs, 4 out of 4 was achieved. a) safe and efficient b) easy to use c) reliable and maintainable d) yielding a capacity of 36kgs (±5kgs) / hr
The team was able to conduct training to employees, operators and administrators of different furnituire companies around pampanga. The location was sponsored by Pampanga Furniture Industries Foundation	The team was able to train workers and operators from companies across Pampanga and Bataan

After the series of validation testing, some improvements were still reinforced to the three prototypes prior the final painting and tagging of the prototypes.

The Machine Validation and Equipment Tagging of Department of Science and Technology – Technology Application and Promotions Institute and Department of Science and

Technology – Philippine Council for Industry and Emerging Technology Research and Development was concluded last July 2, 2019 at the Technology Business Incubator, Holy Angel University. The proponents of the Prototype Development of Low-Cost Semi-Automated Foam Shredder Equipment created a spin-off and is currently being incubated at the TBI of Holy Angel University.

IV. CONCLUSION & RECOMMEDATIONS

After the series of development from the initial research of the proponents, Design and Development of Foam Shredder for the Furniture Industries, the development of a low-cost semi-automated foam shredder prototypes were made possible in this research. The initial need of the end-users: low manufacturing and operating cost and portability and power versatility were also addressed. At the end of the research, the proponents were able to optimize the operating characteristics of the machine acceptable to the end-user in terms of its capacity, weight and size of shredded foam and has fabricated and assemble three units of foam shredder equipment. The equipment were (a) safe and efficient; (b) easy to use; (c) reliable and maintainable and; (d) yielding a capacity of 36 to 40 kilograms per hour.

Three out of 10 companies showed their interest in the procurement of the machine as well as the Pampanga Furniture Industries Foundation, Inc.

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AUTHORS PROFILE

Melani B. Cabrera, a graduate of Master of Management in Business Management at University of the Philippines, currently the TBI manager of Encephalon and the Chair of the Industrial Engineering Program of Holy Angel University. a Professional Industrial Engineer, Also the vice president of the Philippine 4.0 Inventors Society affiliated by the Department of Science and Technology - Technology Application and Promotion Institute, before joining the academe she has been with the garments industry for 14 years where she acquired her extensive strategic management and organization skills. Now, with her over 20 years in the academe, she has been continually ensuring to maintain the standard of the Industrial Engineering Program.

Jaypee B. Pajarillaga, a registered Mechanical Engineer with a masters and doctorate degree in Engineering Management. A graduate school professor in Engineering and full time Mechanical Engineering Faculty at Holy Angel University. He served as the Program Chairperson of the Department of Mechanical Engineering and Associate Dean of School of Engineering and Architecture. Dr. Pajarillaga is a researcher, he is the lead and co-researcher of different government funded research projects from DOST-Department of Science and Technology and CHED-Commission on Higher Education.

Wilfredo L. Infante, a Licensed Mechanical Engineer. He is currently the Program Chairperson of the Mechanical Engineering Department of Holy Angel University. He had worked in several manufacturing industries specialized in production of raw materials for semiconductor and processing of raw materials for automobiles. He finished his degree in Master of Science in Engineering Management in the same school. He is currently pursuing his degree in Doctor of Philosophy in Engineering Management at Nueva Ecija University of Science and Technology. His research interest ranges from design and development of machines for the improvement of small scale industries, tracer studies of graduates, energy management system and design of mechanical system and its performance. He is co-researcher for government funded researches awarded to Holy Angel University. He is one of the makers of the first patent of Holy Angel University under the Utility Model Registration with the title Foam Shredding Machine.

Ariel G. Cabildo. A Licensed Mechanical Engineer. Currently full time faculty member under the Mechanical Engineering Department of Holy Angel University. He is currently pursuing his degree in Master of Engineering Management at Nueva Ecija University of Science and Technology (NEUST). He is a regular member of the Philippine Society of Mechanical Engineers (PSME). He focuses in design and Fabrication Engineering, also His research interest ranges from design and development of machines and rocket propulsion projects, and He is co-researcher for government funded researches

R-Jay P. Quiambao., a Certified Industrial Engineer, currently in thesis writing stage for the degree, Master of Science in Engineering Management. A full time Industrial Engineering instructor at Holy Angel University. He served as the Industry-Academe Linkage Coordinator of the School of Engineering and Architecture (Holy Angel University) from 2016-2019.