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Coconut Husk Mini-Chipper Machine

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Abstract- The study focuses on the design and fabrication of a coconut husk mini-chipper machine which can contribute and improve the lives of farmers and the competitiveness of micro-scale coconut industries particularly in rural areas.

The machine is connected into a cold roll shaft and utilizes a 6hp diesel engine generator. This is used to produce chips out of coconut husk and utilized as a potting medium for gardeners and orchids enthusiasts.

This has been developed to further improve the utilization of the coconut husks into a productive used which are commonly ignored by most of the farmers in the rural areas. By adapting this machine, farmers can earn more from coconut husks and become competitive in coconut husk industries.

The average coconut husks processed by the mini-chipper machine is 282 pcs in an hour while the volume of coconut husk chips produced has an average of 155 kilogram in an hour. The diesel used for an hour is 0.72 liters

Normally, the 282 pcs of coconut husks should have an approximate weight of 169 kg but from the data above it produced 155 kg which is almost 92% chips and 8% waste or dust. This proves that the machine is efficient. (Note: average weight of *coconut husk in Lucban, Quezon is about 0.6 kg).*

The machine obtained an overall acceptability mean rating of 4.9 and interpreted as Very Highly Acceptable. It means that Mini-Chipper is technically and operationally acceptable. This machine is considered very useful and significant to the end users specifically to the farmers who can earn more profit from processed coconut husks.

Keywords: coconut husks, mini chipper, machine, potting

Introduction

Most of the farmers in the rural areas were not aware the importance of the coconut husks. They usually leave the coconut husks as a waste after harvesting the coconut and send it into the market wherein they do not realized that their wastes are something that can contribute and improve their lives and the competitiveness of micro-scale coconut industries particularly in rural areas.

In consideration of the above observation, the researcher proposed a machine that can be very useful to turn the wastes into money. He initiated the designed and development of the coconut husk mini-chipper machine which can process the coconut husk into a very useful chips that can be sold to the market and used it as a potting medium for orchids and other ornamental plants.

This study was focused on the fabrication, testing and evaluation of an coconut husk mini-chipper machine. The efficiency of a coconut husk mini-chipper machine was limited to processing the coconut husks into chips. The study also includes determination of the capacity of the machines in processing coconut husk within a period of time and its energy requirements for the operation.

The drying, baling, softening, bleaching, dyeing, analysis of fibers and chemical compositions of the coconut husks were not included in this study

Research Objectives

This project was focused on the development of a coconut husk mini-chipper machine.

Specifically, it aimed to achieve the following objectives:

1. To design a machine for chipping the coconut husks.
2. To fabricate the coconut husk mini-chipper machine
3. To test the output performance and efficiency of the coconut husk mini-chipper machine in terms of coconut husk chips produced

4. To evaluate the acceptability of the coconut husk mini-chipper machine based on the following criteria:
   a. Functionality
   b. Adaptability
   c. Cost Effectiveness
   d. Originality

Related Literature and Studies

According to Bob and Wellenstein (2012), in order to grow a good root system on a Paph you need to balance a number of things. Roots need adequate aeration, firm anchoring (wobbly plants' roots will have their sensitive growing tips damaged/destroyed), adequate supply of moisture without remaining too wet too long (which eliminates adequate aeration), adequate and properly balanced mineral nutrition without excess, reasonable temperatures, and a suitable pH in their surroundings. Because paphs do depend on root hairs for water and mineral uptake, it is important to grow new roots frequently as the effectiveness of root hair uptake does diminish with age.

They mentioned two medium components that defy logic and have the capacity to hold large amounts of air and water simultaneously.

The first is New Zealand sphagnum moss used alone. NZ sphagnum will simultaneously hold more water and more air than almost any other potting medium commonly available if kept loosely packed. They experienced that it was a very good medium for temporary root recovery culture of the acid substrate Paphiopedilums, but they have not found it to be particularly good for long term culture.

The second was coconut husk chips. While holding approximately the same level of air immediately after watering and as it dried out over a 5-day period in 2.5-inch rose pots; it also held substantially more water. After six months under greenhouse conditions, fine fir bark had broken down and dramatically lost its air holding capacity and stayed quite soggy, while the small coconut husk performed essentially as it did when new.

According to them, one of the most encouraging signs that the plants like the coconut husk chips is that when they unpot them, all of the new roots are attaching themselves firmly to the cut fiber end of the husk chunks, as if they are seeking out their personal water and nutrient reservoirs(*ladyslipper.com/coco3.htm).*

Terry (2012) of eHow Contributor mentioned that Orchids are bright, elegant plants and are available in a wide range of species and cultivars. All orchids do best with soft, indirect lighting and good air movement, and need loose, organic potting media. Plant or re-pot orchids in airy foundations, like coconut husks, to guarantee quick drainage and good air circulation around the roots (http://www.ehow.com/how_8623523_use-coconut-husk-chips-orchids.html).

The Metals Industry Research and Development Center (MIRDC) mentioned that the decorticator is a machine that separates coco fibers (coir) from coconut husk through crushing action of multiple replaceable blades with holder. The holder is strategically welded on the main shaft (rotating drum) . The design configuration of blades cause the rapid separation of fibers and dust as the husks are crushed against a set of fixed counter blades arranged horizontally and parallel to the axes of the decorticating blades. Fibers and dust are discharged in separate outlets (http://www.mirdc.dost.gov.ph/index.php/available-technologies-mainmenu-68/144-decorticating.html).

On the article of Madel R.S. posted in Manila Bulletin (2008), stated that DOST developed versatile machines for coconut products. These new machines can process coconut-husk based products, including one which can produce geotextiles for erosion and landslide control, have been developed by the Metals Industry Research and Development Center (MIRDC).

Among the machines developed by MIRDC is the "Coco Fiber Twinning Machine," which makes coconut fiber twines for use in producing geotextile nets for erosion control as well as for road and river embankment. It can process 20 kilos of coconut fiber twines per day or five kilos "more than its conventional counterpart."

Rangania, Ramakumar, and Said (2010) studied the development and performance evaluation of a nutmeg decorticator which addressed to solve issue on the traditional process of decortication which is done manually using a hammer or mechanically a cracking hand tool. The study introduced faster processing of nutmeg, a mechanical decorticator has been developed which consisted of a cylinder and a concave. The cylinder was made up of M.S. angle flats of size 4.8 × 1.9 cm and a rubber of 0.5 cm thickness was fixed on to these flats to establish impact to the nuts. While, the concave was fabricated using 6 mm size M.S. rods.The length of concave was 25 cm with slotted opening size of 7.7 × 1.0 cm. The developed decorticator had the decortication efficiency, total recovery, breakage and capacity of 98.11, 63.92, 3.08 and 56.59 per cent kg/h, respectively, at the cylinder speed of 450 rpm.

Shansen, Yan, and Zhaoyu (2015) conducted study entitled the design of coconuts automatic decorticator based on the PLC. They said coco industry plays an important role in Hainan economy. However, with coconuts production increased year by year, the issue like how to pretreat the coconuts and improve the added value of coconuts will come out. The current situation that most areas of

Hainan are still hand- shelled coconuts, so they designed a new type of coco decorticator equipment based on PLC, they elaborated overall structural features and working principle of machine, key components and its parameters were analyzed. The machine is adaptable to process a variety of coconuts, peel with high efficiency and the breakage rate is low, the machine plays a great role in promoting mechanization level of coconut processing industry.

*Palomar et al. (2008) conducted study on the d*esign, fabrication and evaluation of a prototype coconut husk decorticating machine. They made decorticating machine driven by a 10-hp, 3-phase electric motor and evaluated based on its performance to defiberize coconut husks. Its main features include, among others, 1/4- cu m capacity cylindrical case which encloses the 16 blades rotary assembly to decorticate the husks, and two hoppers which serve as separate passages for coir fibers and dusts exiting from the cylinder. The estimated cost of fabrication was P64,168.00. Results of test showed that the machine has an optimum output of three tons of husks per day. Recovery of coir fibers was 40 percent while the dusts constituted the remaining 60 percent. Based on the grading standard, the coir fibers produced fall under CH-3 or mixed fibers. The estimated production cost of coir fibers was P0.90 per kilogram.

Venkataramanan, Abhinav, and Rahul (2014) presented paper on developing an automated coconut de-husking and coconut crown removal machine. The main purpose of this machine is to eliminate the skilled operator involved in de-husking the coconut and to completely automate the dehusking and crown removing process. In some small scale industries, the process is either manual or semiautomatic. A completely automated machine with manual loading and unloading of coconuts will yield productivity higher than the existing process. In view of this they focused on an automated machine for dehusking and crown removing. The machine aims at de-husking and removing the crown of the de-husked coconut of various sizes across the world. In order to get to know about the different sizes of the coconut, various places across India has been visited where exuberant yielding of coconuts are made. Also, dimensional data of coconuts have been collected in some of the other most eminent countries where prominent coconut cultivations are done.

Hellstrom (2010) observed that the chipping process was found to be a versatile tool. He noticed from his study, there exist different types of fracture processes, each giving different chip thicknesses. He concluded that the friction between the wood and the chipping tool is probably one crucial factor for the chip formation process. Another outcome from his experiment is that just prior to the formation of a chip, there is a concentration of strains in an arrow zone in a thin region starting from the edge of the tool and directed parallel to the grain.

Bolaji, Adejuyigbe, and Ayodeji (2008) studied the performance evaluation of a locally developed cassava chipping machine. A cassava chipping machine was designed and constructed, and its performance evaluated. The results showed that motor speed has significant effects on chipping capacity, chipping efficiency, and chips geometry. The higher the motor speed, the higher the chipping capacity and the lower the chipping efficiency of the machine. The machine has a maximum capacity of 245 kgh1 at 500 rpm, and maximum chipping efficiency of 92.6% at a speed of 300 rpm. The overall best performance of the machine is obtained at a speed of 400 rpm with chipping efficiency of 86.5% and chipping capacity of 240 kgh1.

Ugoamadi and Ekwere (2014) studied the development and performance evaluation of a manually operated cassava chipping machine. The chipping machine was designed and fabricated, and its performance was evaluated. The machine has the following parts: the hopper, groove chipping disc, chipping unit, pulleys, shafts, frame, bearings, and handle. The chipper Performance evaluation was done using the following machine speed: 63 rpm, 66 rpm, 69 rpm, 72 rpm, 75 rpm, 78 rpm, 81 rpm, 84 rpm, 87 rpm, and 90 rpm. The chipper's highest efficiency was 91.20% at 78rpm and capacity of 29.50 Kg/h at 90rpm. An overall mean efficiency of 89.404% (0.825) and mean capacity of 26.59 (1.66) Kg/h were achieved. The optimum machine speed was in the range of 72 rpm to 78 rpm. From the results, it was observed that as the machine speed and capacity increase, both the chipping time and chipping efficiencies decrease. Hence high quality chips are produced using groove chipping disc at relatively low speed. The machine is simple to operate and maintain without special training and is suitable for small and medium scale farming.

Conceptual Model

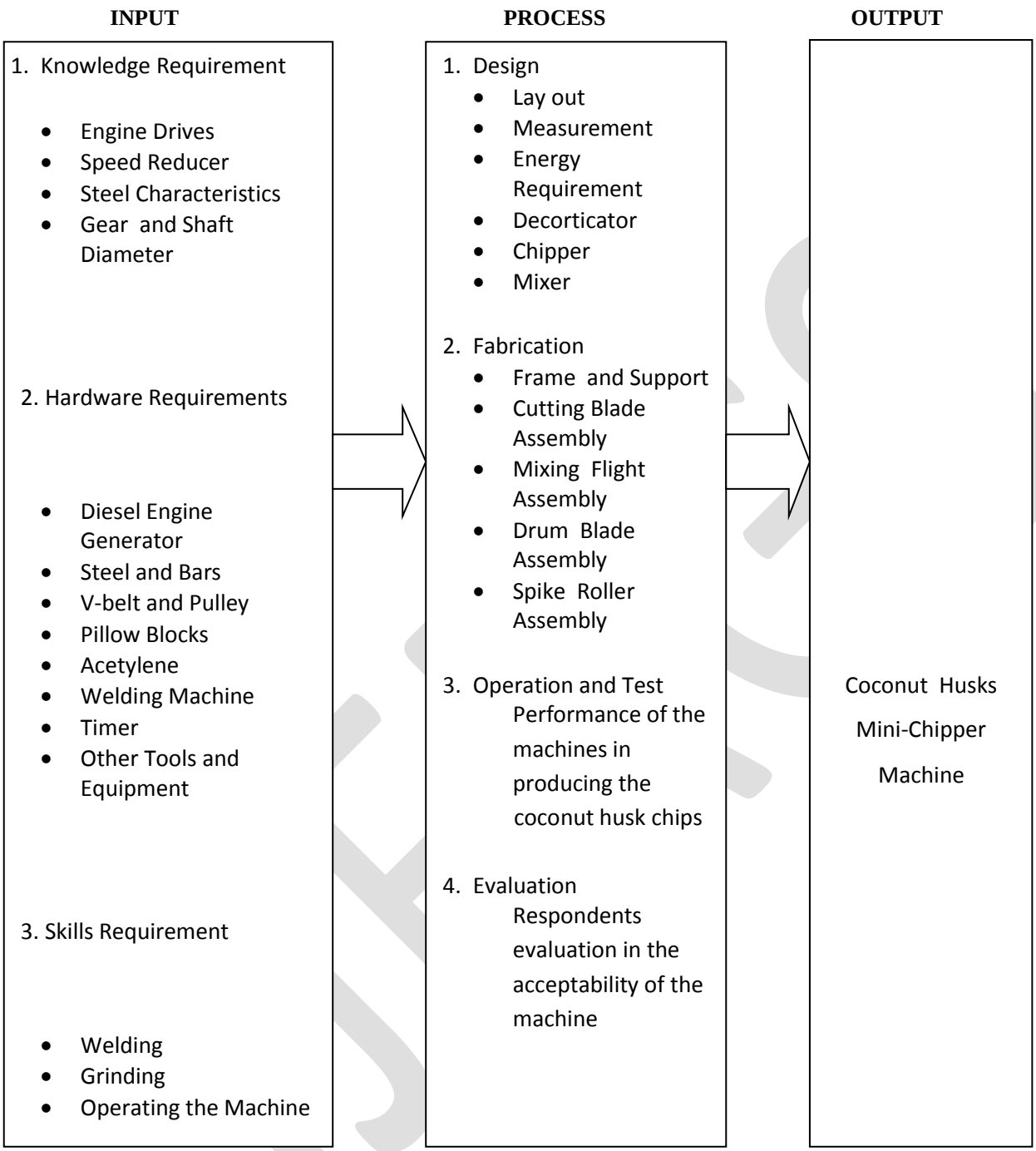

Figure 1. Conceptual Model of the Study

The figure above serves as a guide in carrying the machine design and fabrication. Input indicated the required knowledge relative to the desired project. Individuals who are skilled in planning, welding, grinding and operating the machine are also needed in conceptualizing the design Appropriate tools, equipment and financial requirements in purchasing supplies and materials must be used to fabricate the machine. Based from the design concepts of the machine, several testing must be considered to validate its performance. Moreover, the validation based from the evaluation criteria must also be considered to determine the level of acceptability of the machine.

After all of these considerations, the output project would be the new developed coconut husk mini- chipper machine which can improve the lives of farmers and competitiveness of micro-scale coconut industry in rural areas.

Methodology

This chapter presents the project design, project development, operation and testing procedure, instruments and techniques used, and evaluation criteria.

Project / Research Design

The developmental research and experimental type of research were employed in this study.

The predictive capabilities of the machines were determined through experimental method where series of test were undertaken. While the acceptability of the machines in terms of functionality, adaptability, cost effectiveness and originality was evaluated through descriptive researc

Project Development

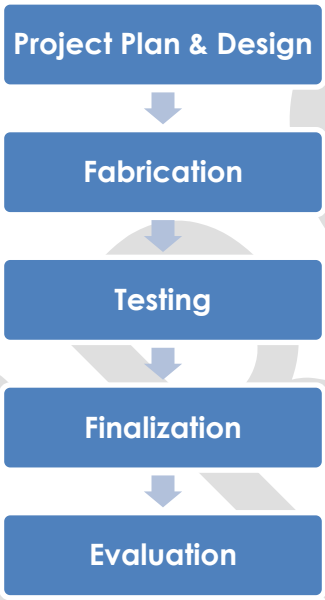

Figure 2. **Stages of Development of the Machine**

The figure above shows the development of the project. It started with the project plan with corresponding design of an integrated coconut husk processing machine. After planning and conceptualizing the design, machines were fabricated. A test was conducted to find out whether the machines are performing well based on the design. The series of testing of the fabricated machines have been done to determine its performance. Adjustment and some corrections were taken before finalizing and fixing the machines. After all the corrections, the machines were finalized. The newly developed and fabricated machines were subjected to evaluation in order to determine the acceptability of the machines.

Design Concept

The technical design of the machine was conceptualized through analyzing the functions of the chipper machine. The principle of operation of the machine has been considered. Determining the sizes and parts of the machine gave high consideration in finalizing the design in order to fix the machine for effective and efficient operation. The researcher used the concept of the chipper machine purposely to help improve the lives of the farmer and competitiveness of micro-scale coconut industries in the area.

Design of the Integrated Coconut Husk Mini-Chipper Machine
Mini-Chipper Machine

Indicated below is the actual design including the features and measurement of the coconut husk mini-chipper machine.

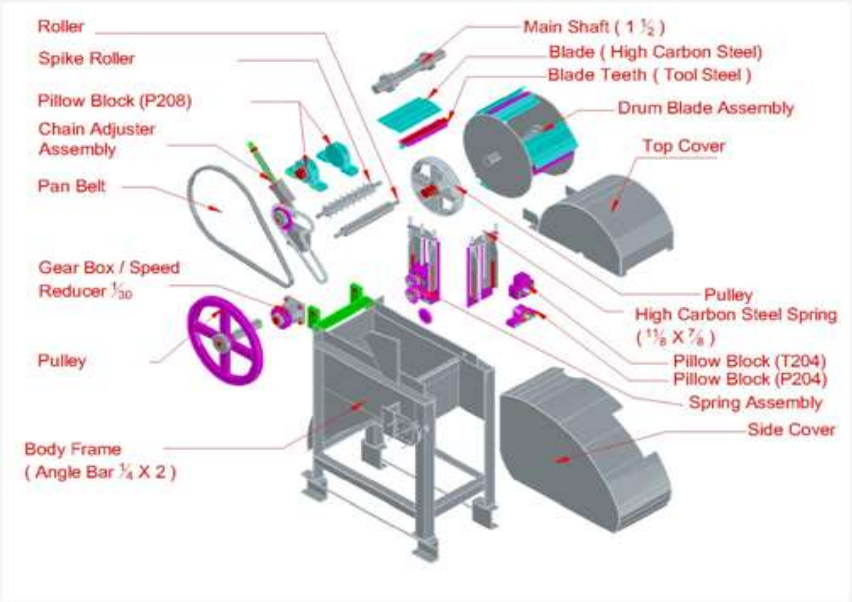

Figure 3. **Exploded Parts of Mini-Chipper Machine**

The figure above shows the exploded parts of the mini-chipper machine. It shows the drum blade and spike roller which play the vital role in the operation of the mini-chipper.

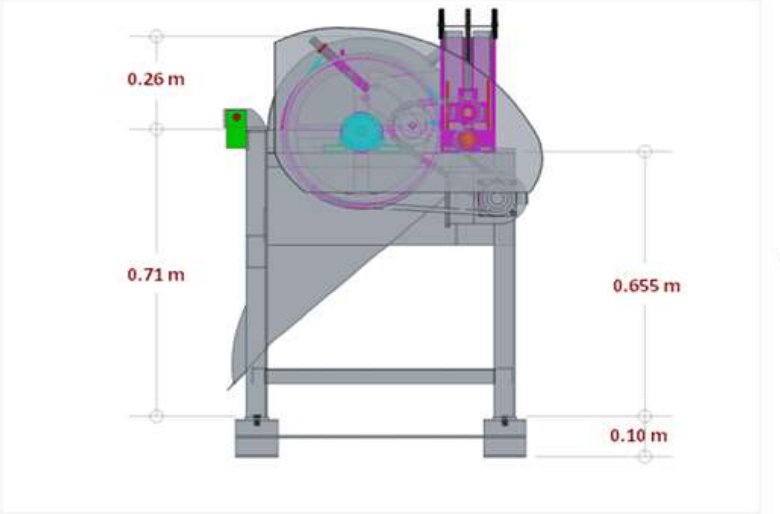

Figure 4. Right Side View of the Mini-Chipper Machine

The figure above shows the spring assembly attached to the upper body of the machine. Spring assembly is automatically adjusting while holding the coconut husk to be cut by the beating blade.

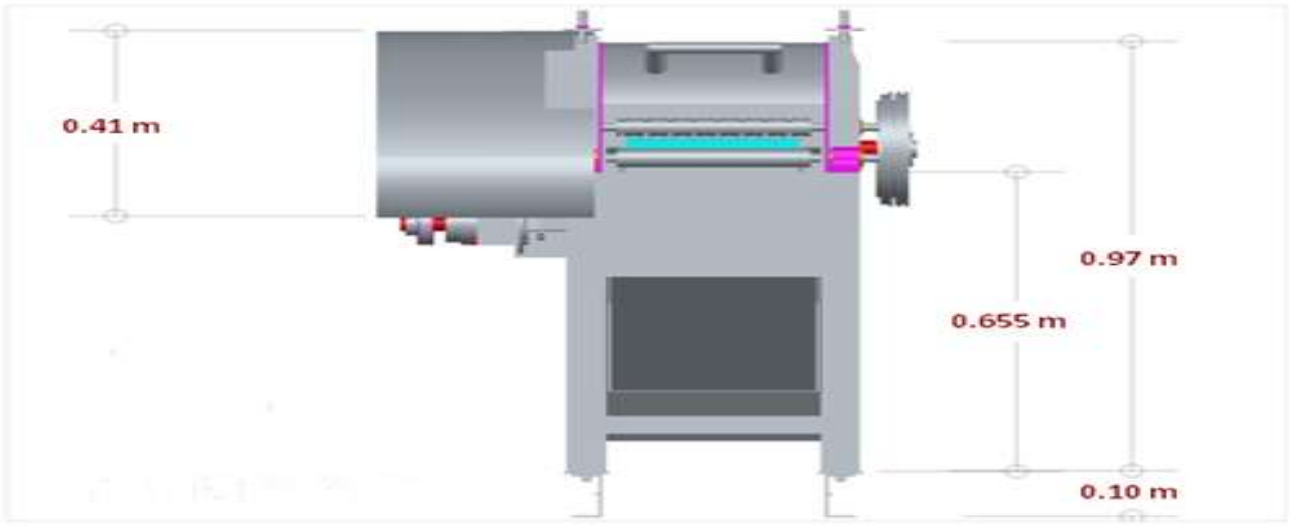

Figure 5. **Left Side View of the Mini-Chipper Machine**

The figure above shows the left side view of the mini-chipper. It shows the cover and the output panel where the coconut husk chipped
came out. The spike roller is used to hold and feed the husk to be cut by the beating blade.

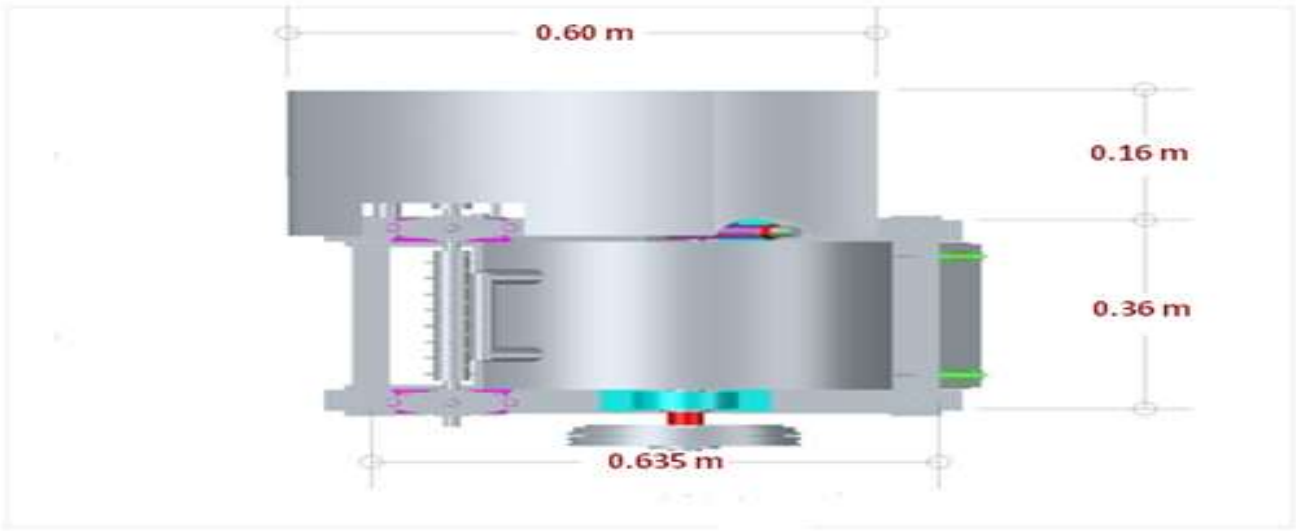

Figure 6. Top View of the Mini-Chipper Machine

The figure above shows the cover, spike roller and the pulley. The pulley is attached to the drum blade assembly where the v-belt is connected. It is used to rotate the blade and the spike roller.

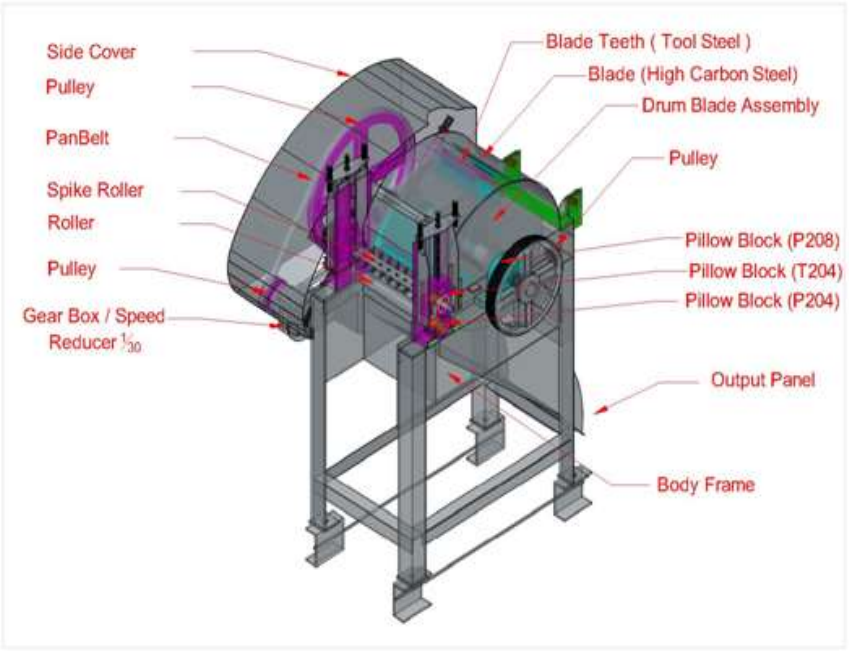

Figure 7. Isometric View of Mini-Chipper Machine

The figure above shows the isometric view of mini-chipper machine. It shows the front, side and top view of the machine. Complete parts of the mini-chipper are being illustrated.

Operation and Testing Procedure

The Coconut Husk Mini- Chipper machine was operated using the 6Hp diesel engine generator. Presented hereunder is the operation procedure of the machine.

a. Inspect all the connection and parts of the machine if these are in proper position.
b. Prepare the coconut husk.
c. Turn on the diesel engine generator.
d. Put with care the coconut husk into the feeder passing though the roller spike of the machine.
e. See to it that the spike roller and drum assembly run smoothly, no unnecessary sounds must be heard.
f. If the unnecessary sounds are heard, there is trouble so check it and make necessary correction. If sounds are heard clearly, proceed to the next step.
g. Continue cutting by putting the coconut husk into the feeder of the machine.
h. After cutting, turn off the machine and clean it.

Instruments and Techniques Used

The instrument and technique used in this study were the actual interview, survey questionnaires, and evaluation questionnaire regarding the use of machine in processing coconut husk.

Data were gathered by means of actual interview from the ten (10) selected farmers of Bgy. Palola, Lucban, Quezon, ten (10) faculty of Industrial Technology and ten (10) experts from the Industry.

Evaluations were conducted which dealt on the two (2) criteria:

1. First, on the performance of the processing machines in terms of coconut husk chips produced
2. Second, acceptability of the mini-chipper machine based on the following criteria:
   - 2.1 Functionality
   - 2.2 Adaptability
   - 2.3 Cost Effectiveness
   - 2.4 Originality

Results and Discussion

A. **Discussion on Performance Test of Mini-Chipper Machine**

The machine was tested several times. It was observed that during the 1st test of the operation of the machine using the 2Hp AC Induction Motor, it was effective on the 1st five minutes but came after, the operation did not work properly because of the insufficient energy supply that caused intermittent power resulted to poor processing of the coconut husks. As a result, the motor from AC source 5 Hp Induction Motor was changed to 6Hp Diesel Engine Generator. Through this change and adjustment, the operation went back to normal which resulted to the following observations:

Table 1. **Performance Test of Mini-Chipper Machine**

Description	**Trial 1**	**Trial 2**	**Trial 3**	**Average**
Number of Coconut Husk Processed for One (1) Hour (pieces)	280.00	285.00	283.00	282.70
Volume of Coconut Chips Produced for One (1) hour (Kilogram)	154.00	157.00	156.00	155.67
Diesel Used for One (1) Hour (Liter)	0.74	0.73	0.70	0.72

Table above shows that the average coconut husk processed into chips is 282.70 while the volume of coconut chips produced has an average of 155.67 kilogram. The diesel used for an hour is 0.72 liters. It proves that the machine is efficient because the chipped husk produced is 92.00 % while the waste is about 8.00 %.Note: average weight of *coconut husk in Lucban,Quezon is about 0.6 kg.*

B. **Acceptability of the mini-chipper machine based on the following criteria**

Project Evaluation

The project was evaluated in order to determine the acceptability level of the mini-chipper machine. This was evaluated by thirty (30) selected individuals who were farmers, technical teachers and technology experts who have technical and appropriate knowledge about the project.

Table 2. **Functionality of the Machine**

Functionality	**Numerical Equivlent**
1. Parts of the machine are purposeful	4.87
2. The machine functions effectively	4.93
3. The machine has a control knob to control the revolution of the crank shaft.	5.00

4. The machine can decorticate, mix, and chip according to desired volume.	4.80
5. The machine can be selected into each desired uses as for decorticator, mixer and chipper	5.00

The table above shows descriptive average value 4.92 which is interpreted as the machine is functional based from the responses of the respondents to the given evaluation questionnaires. The parts of the machine are said to be purposeful, effective, and able to pass the required output for the machine. The selector knob for the speed of the generator functions properly as selected by the user.

Table 3. **Adaptability of the Machine**

Adaptability	**Numerical Equivalent**
1. The machine can be operated in any weather condition	4.83
2. The machine can process coconut husk whether wet or dry	4.87
3. The machine can process the husk into a desired volume	4.93
4. The machine can be placed in the farm or backyard	5.00
5. The machine can be operated by single, two or three persons	4.80

Table above shows the adaptability rating of the machine which is 4.88. This is interpreted as the machine is adaptable in any situation and condition. Most of the respondents agreed that the machine can be operated by one person or more. They also believed that the machine can be placed in a backyard or farm.

Table 4. **Cost Effectiveness**

Cost Effectiveness	**Numerical Equivalent**
1. The fabricated machine is less expensive compare to buying in the market.	5.00
2. The parts and components of the	4.87

machine are available and easy to be bought in different stores.	
3. The price of the parts and components of the machine are cheaper	4.87
4. Parts and components of the machine can be changed or replaced easily.	4.93
5. The materials used in the machine are long lasting.	4.90

Table above shows the machine has a mean rating of 4.91. It means that the machine is cost effective. They considered integration of machines which can be operated by single diesel engine generator rather than buying three separate motors for three machines. Most of the respondents believed that the supplies and materials used were available in the market.

Table 5. **Originality of the Machine**

Originality	**Numerical Equivalent**
1. The machine can be integrated into one but multi–purpose used	4.93
2. The machine can be operated through a single 6hp diesel engine generator	4.90
3. The machine can be used simultaneously	4.93
4. The machine can process coconut husk into a different output products within one location	4.87
5. The design of the integrated machine is new and different from others	4.90

The table above shows an average descriptive value of 4.90. It means that the design of integrated machine issomething new and different from the others. Its characteristic of being operational in a simultaneous used using single 6hp diesel engine generator makes different. This is said to be interesting among the farmers and individuals who are working in a micro-scale coconut processing industries because of its originality and uniqueness.

Table 6. **Overall Acceptability of the Machine**

Overall Acceptability	Numerical Equivalent
1. Functionality	4.92
2. Adaptability	4.88
3. Cost Effectiveness	4.91
4. Originality	4.91

The table above shows the overall acceptability mean rating of the machine which is 4.90. It means that the, Mini-Chipper machine is technically and operationally acceptable. This machine is considered very useful and significant to the respondents specifically to the experts such as technical professors and the farmers. This can be used to earn more profit from coconut husk, and manage properly the coconut husk wastes.

Summary of Findings, Conclusions and Recommendations

1. This research study developed a design of a mini-chipper, and pre-compost mixer machine which is an innovative technology used to chip the husk. The machine is connected through a cold-roll shaft attached with pulley and connected to the 6-Hp diesel engine generator.
2. The machine is fabricated using common and locally available parts and materials based on the design requirements. The mini-chipper is composed of drum blade assembly, spike roller, frame and support assemblies.
3. Test results on the performance of the machine revealed that the Mini-mixer machine is efficient. The mini-chipper can cut and chip 92 % of the coconut husk while the 8% is the residue or waste.
4. The acceptability of the processing machines in terms of its (a) functionality, has a mean of 98.40 % which i s very highly acceptable, (b) adaptability, has a mean of 97.72 % which is very highly acceptable, (c) cost effectiveness, has a result of 98.28 % which is very highly acceptable and (d)originality has a mean of 98.12% which is very highly acceptable. The data above show that the machine was rated very highly acceptable with the mean average of 98.13%.

Conclusions

Based on the results of the study, the following conclusion were drawn:

1. The design of the mini-mixer machine is best suited in the farm or backyard near with abundant source of coconut husks.
2. The fabricated machine is easily be made because of its materials are available in the local market. The machine can help improve the lives of the farmers and suitable for the micro-scale coconut processing industries particularly in rural areas.
3. The result of the test for the machine demonstrated the efficiency of the mini-chipper. It functioned very well as to cut or chip the coconut husk.
4. The acceptability of the coconut husk mini-chipper processing machine attests to the functionality, adaptability, cost effectiveness and originality. This proves that the machine is not just a prototype but rather a very useful machine that helps farmers to earn more in coconut industry.

Recommendations

To further improve the mini-chipper machine, the following were recommended:

1. To conduct further study on a bigger capacity of the mini-chipper machine to be installed in urban and rural areas.
2. To provide much bigger feeder for the mini-chipper for a much larger inputs of the husks.
3. To mount protective screen on the feeder of the machine
4. To include protective guard on the rotating spike roller of mini-chipper.
5. To install safety cover for the rotating shaft and belts of the machine in order to maintain safety of the workers.

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