International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-2, July 2019

Automated Cow Manure Tiles Maker

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Abstract*: Bricks are widely considered as one of the longest-lasting and strongest building material. Recently it is also used as aesthetic items that are commonly used on gardens and garages. On the other hand, cow manure has given a decent amount of attention in the recent times due to the various applications that may be utilized for the society. This research is a microcontroller-based machine which focuses on cow manure to garage tile conversion to provide an alternative process in the creation of said tiles. It is an applied research designed to utilize electronic and mechanical processes to manipulate the given input to a specific end product. The device's design starts with two receptacles which are connected to separate grinder, which then inputted materials will be weighted onto a load cell. This in turn will pass through a mixer, which also accepts fluid input from three separate fluid reservoirs filled with differently colored fluids. The mixture then finally comes to a chosen designated molder. The entire process will be controlled by the user through LCD screen to display user options. After the process the device will output a designed and colored garage tile. This device was developed in the hopes of finding an alternative material other than clay and soil from making garden tiles and also in automating and further improving the time for manufacture. The speed of mixing and molding cow manure as well as the compressive strength of the produced tiles were considered and passed under the set standard. The evaluation results based on functionality, reliability, usability, efficiency and maintainability of the Automated Cow Manure Tiles Maker was 3.48 which signify a neutral acceptance of the respondents.

***Index Terms*: Cow manure, microcontroller-based machine, tile maker.**

I. INTRODUCTION

Bricks are widely considered as one of the longest-lasting and strongest building materials. Sometimes referred to as artificial stone, this material has a wide range of ways to create, but it is mainly subdivided into two categories; air-dried and fired. Cow manure on the other hand, has seen a decent amount of attention in the recent times due to the various applications that may be utilized for the society, ranging from fuel and biogas, repellents and disinfectants, fertilizer, and in relation to the proposed project, as a building material [3].

During these recent times, several materials that were deemed as unconventional have shown great promise, when configured properly, to be utilized as building materials. One of these materials is cow manure, due to its structural similarity to mud or clay when dried properly. Since cows chiefly only eat farm grass and plant-based feeds, bovine cow-based excretions lose its unpleasant smell once dried.

Most buildings in the Philippines over years ago constituted the use of hand moulded clay bricks that are covered with plaster. It was only during the mid-18th century that visible brickwork regained some degree of popularity. The characteristic of clay brick for being much more resistant to cold and moist weather conditions has enabled the construction of the buildings with the added warmth benefit of slowly storing heat energy from the sun during the day and continuing to release heat for several hours after sunset [1].

Diversely, not only are bricks well-known for being structural materials, but have been recently used as aesthetic items that are commonly used on gardens and garages. These type of bricks also typically undergo fragility tests, but is not required to be as structurally stable under a certain given amount of pressure compared to building bricks. Because of these aforementioned statements, the researcher proposed a project that could utilize cow manure as the raw material and transform it to commercially-comparable garden bricks. The modern regular building bricks are usually made of clay or mud that is moulded or dry-pressed, and is either heated in a kiln or chemically set by composition of either calcium-silicate or concrete. This results in a decently usable building material, but three potential problems occur: it imposes a significant effect on price, since mud and clay basins will cost the builders due to tariffs required by the basin land-owners; it deals an effect on nature since several harmful by-products will be dealt from mud or clay excavation alone; and bricks made from mud or clay has seen a decline in usage compared to concrete and hollow blocks since it is innately heavy.

Using cow manure instead of the traditional materials will yield a solution for these potential problems: cow livestock producers will not impose a great amount of cost to get rid of the animals' wastes; cow manure as a building material only requires it to be sun-dried prior to harvesting; and cow manure is far less dense than mud or clay, and so will yield a lighter but as structurally adept end product.

A. Statement of the Problem

The Automated Cow Manure Tiles Maker is presented to make brick tiles for garage only.

Specifically, it aims to answer the following questions:

1. How to design and develop a machine that can convert cow manure into bricks?
2. How to test the performance of the device in terms of:
   2.1 Speed in mixing and moulding cow manure
   2.2 Strength and compressive strength of the product

Revised Manuscript Received on 30 July 2019.
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3. How to evaluate the acceptability of the device in terms of:
   3.1 Functionality
   3.2 Reliability
   3.3 Usability
   3.4 Performance
   3.5 Supportability

II. RESEARCH METHODOLOGY

A. Project Design

In this study, the researcher have sought to use applied research because according to [5], an applied research is fundamentally the practical access and application of accumulated theories, knowledge, methodologies, and techniques for a specific product-driven purpose. It deals with solving practical problems, and generally employs empirical methodologies in accordance to more provisional, conceptual frameworks of working hypotheses and pillar questions [6]. The Automated Cow Manure Tiles Maker is an apparatus designed to utilize electronic and mechanical processes to manipulate the given input into a specific end product, and thus the study will involve the application of these aforementioned concepts.

In addition, the researcher has also utilized certain aspects of qualitative research since the study has no concern with statistical quantities but instead opts to give more focus on the collection, analysis, and interpretation of observed information with regards to the used materials' qualities and characteristics. According to Berg and Lune [2], qualitative research does not emphasize on numeral counts or empirical measures, but gives an almost unmitigated answer to how and when does a particular phenomenon occur. More distinctly, the conceptualization of the Automated Cow Manure Tiles Maker has sought to use grounded theory since data observations from reviews of empirical experimentation have been utilized while the apparatus undergoes its development. Qualitative data and concept collection have also been done accordingly prior to building the device to aid with efficiency and overall functionality.

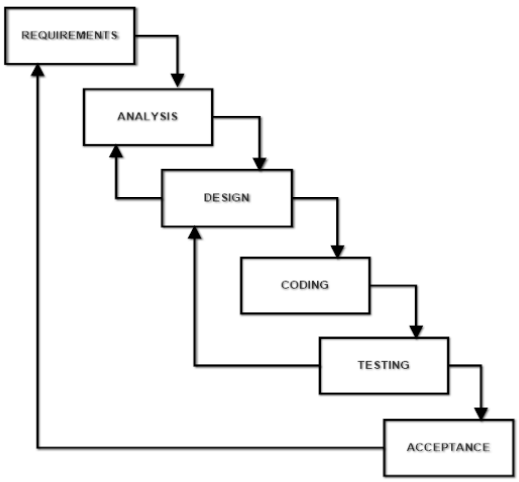

Fig.1 Waterfall Model

A software development model known as waterfall was used in this study. This model was used to create the system and achieve the entire objective of the research.

B. Project Development

In developing the Automated Cow Manure Tiles Maker, the researcher followed several steps for building the proposed system and these are the following: (1) Requirements, (2) Analysis, (3) Design, (4) Coding, (5) Testing and (6) Acceptance.

The first phase is the requirements, in which the problem is identified. In this stage the requirement for the software and hardware of the system will be specified. The main purpose of this phase was to gain a real understanding of the proposed system. Another purpose of this phase is to define the real specification of the system. It will ensure that the remaining phases in the waterfall model will work in a smooth process and the researcher will not find it hard if there's a change at later phase of the model.

Next is the analysis phase wherein the design was created in order to analyzed the flow and the overall view of the whole system.

The design phase includes the hardware and the software requirements of the study. C++ programming language was used together with Arduino Software 1.6.6 (IDE). The Arduino compiler/IDE accepts C and C++ as is, making it easier to put a program on the hardware [4]. The following are the hardware components of the machine.

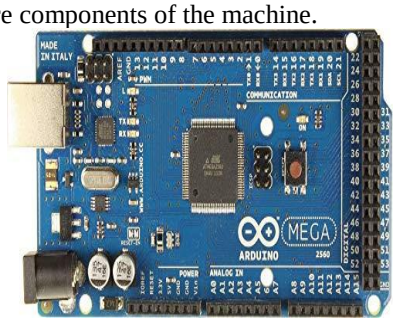

Fig.2 Arduino Mega 2560

Arduino Mega 2560 is a micro-controller that will act as the heart and brain of the machine which gives functions to the hardware components of the machine. It contains the intended program for the machine.

Fig.3 Grinder

Grinder will serve as the pulverizer to grind the input into tinier bits and supply it to the load cell.

Fig.4 Load Cell

Retrieval Number: B2855078219/19©BEIESP
DOI: 10.35940/ijrte.B2855.078219
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Load Cell is the weigher of the machine that determines the amount of the input needed for the mixture. After the weighing process, it will dispense to the mixer.

Fig.5 Mixer

Mixer is the one that will mix the combined input materials. A certain amount of time will be inputted by the user to do the mixing process. Once the mixing is done, it will go straight to the molder.

Fig.6 Tile Molder

Tile molder will serve as the framework of the product. The mixture will be poured in the molder. As the mixture takes shape, it will also have a design based on what the user inputted in the keypad.

Fig.7 20 x 4 LCD Line Address

20 x 4 LCD Line Address will be the screen of the machine to show the variety of options for the user and also to show the process while the machine is working.

Fig.8 4 x 4 Key Membrane Switch

4 x 4 Key Membrane Switch will serve as the medium for the user and the machine. The user can use the keypad to input the necessary options for the machine to work.

Fig.9 Water Dispenser

Water Dispenser is a container for the colors of the mixture. It contains the colors red, blue and green. It is responsible for dispensing the color fluid to color the mixture.

Fig.10 Plastic Tubes

Plastic tubes will help the way through of the water dispenser to dispense the color fluid into the mixer.

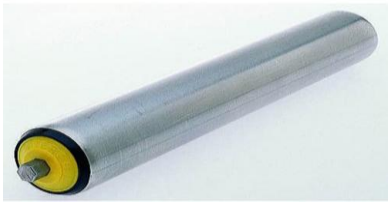

Fig.11 Rollers

Rollers are responsible for flattening the mixture and taking away the excess mixture in the moulder.

After the software and hardware of the machine has been developed, the researcher moved on to the integration of the device to determine the reliability, efficiency and functionality of the device.

Coding phase follows. It is where the system process design was translated to the chosen programming language, C++.

In the testing phase, it will undergo a thorough test involving checking for errors, identifying erroneous steps, searching for design flaws, and ensuring that the system has been designed as per the correct specifications. If this stage has been executed properly, it will ensure that the end user will utilize the system with optimal experience in accordance to the intended process flow. Otherwise, it must be reveries back to the designing phase to implement changes then proceed to the succeeding stages.

The final phase was acceptance wherein the design project will be evaluated by the respondents.

C. Evaluation

The designed project was evaluated by 50 respondents where they answered five categories with 3 statements each. They rated the device based on the stated sentences and picked the ratings which is 5 as the highest and 1as the lowest.

Table I. Basis of Results of Weighted Mean

Weighted Mean	Interpretation
4.50 – 5.00	Strongly Satisfied
3.50 – 4.49	Satisfied
2.50 – 3.49	Neutral
1.50 – 2.49	Dissatisfied
1.00 – 1.49	Strongly Dissatisfied

III. RESULTS AND DISCUSSION

This part of the study mainly presents the output of the research study. This will answer the questions and show if the requirements of the statement of the problem has been achieved and if the Automated Cow Manure Tiles Maker has been effective.

A. Project Capabilities and L imitation

The project used Arduino Mega 2560 microcontroller, relays, and wirings to develop the machine.

1. The machine can grind the raw materials to use as the main input for the desired output.
2. The load cell of the device can adjust its weight settings based on the user's needs and interests.
3. The machine has two molder designs to choose from.
4. The molder designs can be removed from the plate to change the desired designs.
5. The device can clean the mixer manually.

The device has its own limitations also that could affect its performance. The limitations are as follows:

6. The grinder can only pulverize small amount of the raw materials. Inputting big amount will clog the exit of the grinder.
7. The device can make 1 tile at a time only.
8. The drying process will be done manually.

B. Testing

Table II. Test Table for Mixing and Molding Cow Manure

Trial No.	250g cow manure + 250g clay (minutes)	260g cow manure + 240g clay (minutes)	700g cow (minutes)
1	6.20	6.28	8.12
2	6.26	6.33	8.23
3	6.34	6.42	8.25
4	6.27	6.56	8.31
5	6.59	6.34	8.28

Table II shows the time it takes for mixing and molding using the three samples for five trials. The result indicates that as the amount of cow manure increases, the time for mixing and molding process increases too.

Table III. Test Table for Compressive Strength

Samples	Machine Reading (in psi)	Standard (in psi)
250 grams of cow manure 250 grams of clay	1986	1600
260 grams of cow manure 240 grams of clay	2010	
700 grams of cow manure	2412	

According to [7], bricks can have an ultimate compressive strength for as low as 1600 psi. Analyzing the information produced by the test, all the three trials exceeded the standard psi for the bricks. Comparing the three samples, pure manure has the highest compressive strength which has a difference of 812 psi compared to that of the standard in bricks. Since all samples have passed the standard compressive strength for tile bricks, the researcher used the relative accuracy percentage formula to measure the percentage acceptability from the standard. The first sample has 24.125%, the second sample has 25.625% and the last sample has 50.75%.

C. Evaluation Result

The design project was high in terms of Functionality and lowest in Maintainability.

Table IV. Assessment of the Respondents on the Functionality of the Automated Cow Manure Tiles Maker

Functionality	Mean	Interpretation
1. The time process is just appropriate to make the product.	3.70	Satisfied
. The flow of the process is smooth and convenient.	3.42	Neutral
3. The system functions according to its intended purpose.	3.54	Satisfied
Overall Mean	**3.5**	**Satisfied**

Table V. Assessment of the Respondents on the Reliability of the Automated Cow Manure Tiles Maker

Reliability	Mean	Interpretation
1. The system didn't encounter any problems during the process.	3.26	Neutral
2.The system has a consistency on the output.	3.52	Satisfied
3.The system can endure the intended process.	3.52	Satisfied
Overall Mean	**3.43**	**Neutral**

Table VI. Assessment of the Respondents on the Usability of the Automated Cow Manure Tiles Maker

Usability	Mean	Interpretation
1.The usage of the system is easy to understand.	3.48	Neutral
2.The system can give convenience to the user every time.	3.40	Neutral
3.The system can be used to its maximum design and capacity.	3.18	Neutral
Overall Mean	**3.35**	**Satisfied**

Table VII. Assessment of the Respondents on the Efficiency of the Automated Cow Manure Tiles Maker

Efficiency	Mean	Interpretation
1. The system can adapt to the system environment.	3.78	Satisfied
2. The system can respond to the desires of the end user.	3.44	Neutral
3. The system can achieve the desire output.	3.52	Satisfied
Overall Mean	**3.58**	**Satisfied**

Table VIII. Assessment of the Respondents on the Maintainability of the Automated Cow Manure Tiles Maker

Usability	Mean	Interpretation
1. Repair can be done easily by the user.	3.60	Satisfied
2. The system only requires simple tools to be maintained.	3.48	Neutral
3. The system can adapt in any changes.	3.52	Satisfied
Overall Mean	**3.53**	**Satisfied**

Table IX. Overall Assessment of the Respondents on the Automated Cow Manure Tiles Maker

Overall Mean	Mean	Descriptive Evaluation
1. Functionality	3.55	Satisfied
2. Reliability	3.43	Neutral
3. Usability	3.35	Neutral
4. Efficiency	3.58	Satisfied
5. Maintainability	3.53	Satisfied
Overall Mean	**3.48**	**Neutral**

IV. CONCLUSION AND RECOMMENDATION

A. Conclusion

Cow manure has various applications that may be utilized for the society ranging from fuel to biogas, repellents to disinfectants, fertilizers, and as building materials. Automated Cow Manure Tiles Maker was designed to produce brick tiles using cow manure as a building material which only requires sun-dried prior to harvesting. The speed in mixing and molding the cow manure is automated. The amount of the cow manure and the clay was considered as the main composition of the tiles. A sample test was made to test the compressive strength of the produced tiles. All the samples passed the standard compressive strength of 1600 psi. Moreover the result shows that the more the amount of cow manures in the tile's composition, the higher the compressive strength it produced. The evaluation of end-users in the system reached a neutral acceptability level in terms of overall performance.

B. Recommendation

Using the comments and suggestions from the survey of the respondents, it is recommended to consider the probability of using other animals' manure as an alternative for the cement.

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Monaliza S. Jimenez is a graduate of Doctor of Technology at the Technological University of the Philippines. She also received her Master of Science in Electrical Engineering major in Computer Engineering in the said university. She finished her Bachelor of Science in Computer Engineering at Adamson University and graduated as scholar of Adamson University Financial Aid Program (AUFAP) in 1998.

She was the Head of the Computer Engineering Department from 2007-2012 and was the Head of the Engineering Graduate Program from 2012-2014 in Bulacan State University.

Presently she is a member of Institute of Computer Engineers of the Philippines (ICpEP) and a member of the Regional Quality Assessment Team (RQAT) of the Commission on Higher Education (CHED) Region III.

Dr. Jimenez is a faculty member of the College of Engineering, Computer Engineering Department of Bulacan State University and now with a rank of Associate Professor V. She passed the Civil Service Eligibility Examination and devoted her time in teaching since 1999.