Design and Analysis of Auto-Plastering Machine

M Zulhazreen1, C H Goh1, W J Tan1, J C Law1, H Radhwan1,2, M S I M Dawi1, M Farizuan4,5 and W A R Asyahid1,2

1Faculty of Mechanical Engineering Technology, Universiti Malaysia Perlis, Perlis, Malaysia.
2Centre of Excellence Geopolymer and Green Technology, Universiti Malaysia Perlis 01000, Perlis, Malaysia

Email: radhwan@unimap.edu.my

Abstract. Nowadays contractors in Malaysia is still using the traditional way in the process of plastering wall. This traditional way not only wastes time, less efficiency and low production but also high in human intensity. Based on the innovation and creativeness, this research is to design an Auto-Plastering Machine. The Auto-Plastering Machine can improve the operation rate is much quicker compared to the traditional method due to less labor with experienced or non-experiences workers able to be used. This machine helps contractors in the construction industry of a building or dwelling in improving the efficiency of time and smoothen plaster finishing. It will perform well compare to the traditional plasterwork process.

1. Introduction

In the process of Malaysia towards a developed country, there are various types of building construction projects are getting underway throughout the whole country, for example, commercial building, residential or school buildings [1]. There are many advantages are gained by the state, the construction industry is one of the major contributors to the development and improvement of the national economy [2].

In the process of building a house, there are various processes that need to be done including basic, designs, construction of walls, installation of roof and wall plaster process [3-7]. A process to plaster walls, we need to include the process is binding the bricks, plaster gross, plaster subtle and plaster chalk. The process of building a house is very complicated and high experience is required. Although, in this study, research team have been seen that contractor still used the traditional way (Manually) in the process of “Plastering Wall” caused the employee felt tired when undergoing this process. Besides that, it also wastes time and high human intensity. Based on the innovation and creativeness, the solution by designing “Auto-Plastering Machine” come out based on data collection [8-11]. With our Auto-Plastering machine operation rate is much quicker compare to the traditional method by plastering wall. The reason that makes the machine is much efficient in plastering wall because less labor intensity and experiences or non-experiences workers able used.

These projects were helps contractors in the construction industry of a building or dwelling. Furthermore, the machine can be improved in the efficiency of time and smoothly plaster finishing. It will performance well compare to the traditional plasterwork process.
2. Method to identify customer needs

To gathering or creating a high-quality information channel directly from the customer, gathering data involves contact with customer and experience with the use environment of the wall plastering method [8-11]. There are some methods used;

2.1. Interview

Team members discuss with a single customer by asking the questions designed to elicit information needs. Give the customer a presenting existing method used and drawbacks of each opinions customer without making a decision. The goal is to gathering data from customer voice.

2.2. Focus Group

The discussion with a group member is typically conducted in a single room allowing several members of the development team to observe the group. The customer will tell their opinion in looking to fulfill a want or need by the way of customer approach the purchase. It is also helpful to ask what customer has seen at competing establishments.

2.3. Observation

Watching customers use an existing method or perform a task for which an Auto-Plastering Machine is intended can reveal important details about customer needs. Observation may be experience team member observe the existing method used in the actual environment and effective information the weakness of existing method.

2.4. Questionnaire

Designing questions to elicit information needs from customer. Written down the information of customer says. Ask for feedback and eliminate the method that the customer feels do not meet their needs and gathering data they given.

3. Customer Needs

The wall plastering process can be used in automatic way is ranked as the most important need because until nowadays manual method is still using in construction. To make convenient for the workers in construction, automatically way of wall plastering process is the most important need. The second ranked important need is the wall plastering process able to plaster on topside of wall plastering is ranked as third important need. A normal human height is about 5.7ft and the wall is about 10ft. Therefore, to plaster the upper part of the wall the workers need to build a platform and climb up to reach the upper part of the wall. The third ranked is short period time of wall plastering process. It is important need because construction a building needs to spend a plenty of time due to manual method. The fourth ranked customer need is to minimize waste of cement in processing. During wall plastering process, the waste of material used like cement is always occurred. The fifth ranked important need is easy to maintenance if produce automatic system. Easy to maintenance is benefit for customer to separation part by part for cleaning. The last ranked is user hand needs safety protection during wall plastering process is ranked as the last customer need. This is due to the effect happen on the workers after plaster the wall which is white dried cracked plaster on their hand. Table 1 shown rank of customer need based on analysis of customer needs.

The outcome of information customer identifying their needs can be structured in each statement for important the checking data. The responses can then be used to assign an importance weighting to the need statements. The table “Check Box” below show, the needs in rated according to the survey data will summarize a critical need and customers would expect it to be met. Based on the Table 2, the needs in rated according to the survey data will summarize the customer more prefer the Auto-plastering machine functionally in automatic system and operated in short period time.
Table 1. Rank of Customer Needs.

| No. | Customer Needs          | Average Ranking |
|-----|-------------------------|-----------------|
| 1.  | Automatic Function      | 1               |
| 2.  | Ergonomics              | 2               |
| 3.  | Reduce Time             | 3               |
| 4.  | Minimize waste          | 4               |
| 5.  | Safety Protection       | 6               |
| 6.  | Easy to maintenance     | 5               |

Table 2. Critical Needs and Target Specifications.

| Scale | Feature                                           | Check box if feature is unique, exciting, and/or unexpected. |
|-------|---------------------------------------------------|---------------------------------------------------------------|
| 1     | The ‘Auto-Plastering Machine’ operated in automatic function. | unexpected                                                   |
| 2     | The ‘Auto-Plastering Machine’ able operated in good ergonomics. | Unexpected                                                   |
| 4     | The ‘Auto-Plastering Machine’ minimize quantity waste of cement used. | Unexpected                                                   |
| 3     | The ‘Auto-Plastering Machine’ operated in short period time. | Unique                                                       |
| 6     | The worker needs safety protection.               | unique                                                       |
| 5     | The ‘Auto-Plastering Machine’ easy to maintenance. | exciting                                                     |

3.1. Bench Mark on Customer Needs

Bench mark on customer needs is the relationship of the new product to competitive products is critical in determining its potential for success in the marketplace. Gathering information on competing products is the best way to understand that the Auto-plastering machine that are relative position of the proposed product with respect to its competitors and helps to validate the specs as shown in Table 3. Comparing the new product and existing products meaningfully better than its competitors on high priority needs creates differentiation and increases the likelihood of commercial success.
Table 3. Bench Mark on Customer Needs

| No. | Needs                        | Imp |
|-----|------------------------------|-----|
| 1   | Able automatic function      | 1   |
| 2   | Allow short period time      | 3   |
| 3   | Allow minimize quantity waste | 4   |
|     | of current                   |     |
| 4   | Good ergonomic               | 2   |
| 5   | Easy to maintenance         | 5   |
| 6   | Safety protection            | 6   |

| Competitors (Wall Plastering Machine) | TUPO2 | PLMC2 | XIFQ-0 | 300 | EZ- VISTA 2011 | ZB800-2A |
|--------------------------------------|-------|-------|--------|-----|----------------|----------|
| 1 - Most perceived satisfaction of the need |       |       |        |     |                |          |
| 2 - Perceived satisfaction of the need    |       |       |        |     |                |          |
| 3 - Moderate                               |       |       |        |     |                |          |
| 4 - Least perceived satisfaction of the need|       |       |        |     |                |          |
| 5 - Not perceived satisfaction of the need   |       |       |        |     |                |          |

4. Concepts Generation

These four concept generations are created by different concepts which have kinematic, jaw hydraulic, electrical hydraulic pulley and gear concepts as shown in Figure 1. From these four concepts, the advantages and disadvantages can be determined and make decision for the final concept selection whether it is selected with one concept only or combination of two concepts which will discuss. This step is important to produce a better performance of a product based on customer need [8].

Concept selection is often performed in two stages as screening way and scoring way to manage the complexity of evaluating dozens of product concepts. Throughout the screening and scoring process, several iterations may be performed, with new alternatives arising from the combination of the features of several concepts.

Concept selection is performed in two stages as screening way and scoring way to manage the complexity of evaluating dozens of product concepts. First, the concepts are compared with the screening way by selection criteria of strength operation system, good ergonomic, safety used, portable, reliability, aesthetic value, low cost, easy to get spare part, easy maintenance and easy to storage. After that, the concept is sum up with the net score and ranking whether is continued or combined the concepts. Next, the scoring way is used for finalize to get the final concept as shown in Figure 2.
Figure 1. Concepts Generation

Concept Description:

i. Kinematical Designed.

ii. The top bar has a press button to change the motor condition.

iii. The conveyer belt used to transport the cement upward to the trowel for plastering.

iv. The trowel is able to plaster the cement (in an angle) and make finishing (in 90 °C).

v. The machine is used the gear system to move upward and downward.

Advantages:

i. The machine can plaster until the maximum height of the wall.

ii. The trowel is able to plaster the cement and make furnishing.

iii. The machine able be move in all direction with the four wheels at the bottom.

iv. The system and switch controller box are at the handle.

v. The machine has handle to enable move front, back, left and right.

Disadvantages:

i. The machine cannot plaster the minimum height of the wall.
5. Conclusion

The “Auto-Plastering Machine” is divided into three parts, top, body and base, while it is combined from the 28 small parts. Otherwise, the types of testing that are available in the market in order to finalize the product specifications of a certain product. All the testing available in the market is used based on the requirements and the features of the product.

Overall, the results of this project concluded that the project has been designed successfully according to plan even there are occurred some problems. However, all the problems faced are overcome smoothy. In addition, we had learnt and improved the skills in using equipment and machine correctly during the process of fabricating the Auto-Plastering Machine. Indirectly, the existing skills on the use of equipment and machinery can be further enhanced and applied on real working environment.

In addition, we had learnt and practiced the safety rules that are always emphasized during implementation of the project. The implementation of this project can provide many benefits in various aspects, especially in terms of knowledge, experience and the level of one's thoughts.

References

[1] M W M Shafiei, H Abadi and W N Osman 2017 Int. J. Appl. Eng. Res. 12 2182-2189
[2] T D Oesterreich and F Teuteberg 2016 Comput. Ind. 83121-139
[3] Information on http://www.google.com/patents/US1757627
[4] Information on http://www.google.com/patents/US1659440
[5] Information on http://www.google.com/patents/US1757627
[6] Information on http://www.google.com/patents/US3140801
[7] Information on http://www.google.com/patents/US5578327
[8] Radhwan H, Effendi M S M, Rosli M F, Shayfull Z and Nadia K N 2019 IOP Conf. Ser. Mater. Sci. Eng. 551 012028
[9] Radhwan H, Shayfull Z, Nasir S M and Irfan A R 2020 IOP Conf. Ser. Mater. Sci. Eng. 864 012144
[10] Radhwan H, Shayfull Z, Farizuan M R, Effendi M S M and Irfan A R 2019 AIP Conf. Proc. 2129 020153
[11] K.T. Ulrich “Product Design and Development” (McGraw-Hill Education, 2012)

Acknowledgements

The authors would like to acknowledge the Faculty of Mechanical Engineering Technology, University Malaysia Perlis for giving the opportunity to conduct this study.