Smart Trowel Tool for Smooth Plastering Work

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Abstract. Plastering is the most important activity in construction works. It is done widely as a finishing technology for interior and exterior walls made of bricks, concrete or timber, as it provides heat insulation, sound absorption and protection against air pollution and weather, thus providing a clean, level surface for further finishing tasks. Plastering work usually consumes time and involves a lot of cement wastage. A trowel is used as a tool in plastering work but yet time consumption is high in completing the work. It is because the design of the trowels and the quality of the trowel itself is not suitable for plasterers. This study focuses on designing a smart trowel tool for smooth plastering work for low-cost residential building, and to compare the time consumption for the smart trowel tool with the conventional method. The smart trowel tool was tested with 4 experts from the construction industry at the end. The main aspect that was taken into consideration in determining the most suitable materials to build this tool was the time factor in conducting and completing the plastering works. The feedbacks given through expert validation was positive and suggested that such a tool should be marketed in the related field. This is mainly because the smart trowel tool that was build tends to give comfortability and convenience to its' users. The tool further plays the role of as environmentally friendly that contributes towards sustainability. Lastly, the smart trowel tool consumes lesser time compared to the conventional method.

1. Introduction
The most important part of the construction of the building is the plastering process [1]. Plastering is widely used as a finishing technology for interior and exterior walls made of bricks, concrete or timber. Plastering of exterior walls provides heat insulation, sound absorption and protection against air pollution and weather [2]. The application of plaster to the interior walls improves the indoor climate by regulating the humidity and serves to compensate for the inevitable tolerances of the brickwork, thus providing a clean, level surface for further finishing tasks [2]. Wall plastering is one of the most important tasks in the construction site [3]. However, skilled workers are needed for plastering processes as it takes up a lot of time [1]. Furthermore, construction workers are at high risk of developing work related musculoskeletal disorders (MSDs) that are associated with exposure factors in this working environment. Working related to MSDs is one of the most common occupational health issues affecting millions of worker every year [4]. According to [3], most workers are exposed to MSDs in wall plastering work, which are very common in the construction industry. During the walls plastering work, the workers suffer from back pain, and issues relating to their shoulders, wrists and elbows as well [5].

Figure 1 shows a study conducted by [6] in Malaysia, where it can be seen that the highest percentage of complaints was from plastering worker trade (80%), where most respondents experienced wrist and hand pain or discomfort. This could be due to their working nature, which involves extensive use of hand movement for vertical plastering and at the same time holding the
harling trowel containing the cement mixture. Constant hand and wrist movement during the work could eventually cause pain on these body parts. The plasterers also reported that they experience low back pain or discomfort (70%).

![Body discomfort survey in wall plastering job (n=50)](image)

**Figure 1.** Report the percentage of Workers with Body Discomfort in Wall Plastering Task [7]

In Malaysia, plastering work often attracts the attention of some parties. This is because plastering has included many aspects, such as time, cost and quality of the trowel itself. Plastering work in a building usually takes a long time and involves a lot of cement waste. There is even a lot of smart trowel, but plasterer still lacks plastering time. It is because the design of the trowels and the quality of the trowel itself is not suitable for plasterers [4].

### 2. Study Objective and Scope

The main aim of this study is to build a smart trowel tool for smooth plastering work that is able to save time and energy in completing the plastering task. Apart from that, this tool should also be able to prevent cement wastage from happening and lastly able to reduce any bodily discomfort while or after conducting the plastering task/job. To achieve this aim as suggested, few objectives come along with this and they are as follows:

i. To build a smart trowel tool for smooth plastering work for low cost residential building.

ii. To compare the time consumed using smart trowel tool with the conventional method.

iii. To test the smart trowel tool with experts from the construction sectors.

The single storey low cost residential buildings were the focus in developing the smart trowel tool. This smart trowel tool is able to be used in exterior wall plaster works. This smart trowel tool is powered by energy generated using a battery and handled by workers. Construction players familiar with plastering works or finishing works in a construction site were selected to test and validate this tool.

### 3. Research/Project Design

In order to successfully establish the development of the smart trowel tool for smooth plastering work, a proper project design in logical sequences and which was also seen to be achievable was put forward. Ideation of the project was very important to obtain a good design that will be functional.
Software that was used to draft the design for the smart trowel tool is Paint 3D. This Paint 3D incorporates features of the Microsoft Paint and 3D Builder applications to combine a lightweight hybrid 2D-3D editing experience that allows users to pull in a variety of shapes from the app, their personal computer and Microsoft’s Remix 3D service [8]. Figure 2 shows the end result of the design that was established using the Microsoft Paint and 3D Builder applications.

![Figure 2. Smart Trowel Tool Design](image)

During the process of designing the smart trowel tool, main materials for the development of the model was also identified. These materials were 1) a cordless screwdriver which is a power tool used to set or remove screws or other threaded fasteners [9], 2) Lithium-ion batteries(LIB) are a family of rechargeable batteries having high energy density and commonly used in consumer electronics and it also uses intercalated lithium compound instead of metallic lithium as its electrode, 3) a screw which is a type of fastener, in some ways similar to a bolt, typically made of metal, and characterized by a helical ridge, known as an external thread, 4) a Hollow Structural Section or HSS, which is a type of metal with a hollow tubular section, especially Rectangular Hollow Section(RHS) steel is commonly used in welded steel frames and lastly 5) a battery charger of the model SY21-08 with power supply voltage of 110-240V, which is used for lithium technology and provides longer running time and more power. Further step by step procedure on the development of the tool are as follows:

(i) First step is to cut the hollow steel using anger grinder machine to make rectangle shape using 16.3cm x 6.6cm.

(ii) Then, the rectangular hollow steel is attached with screw head using a welding tool.

(iii) Next, the end of the each screws are snipped approximately about 0.5cm. The merged screw head and hollow steel are then attached to the sponge trowel using four screws.

(iv) Lastly, the cordless screwdriver is inserted into the merged sponge trowel.
After the tool was built, it was further tested to determine its’ efficiency by analysing the time consumption to conduct the plastering work using the smart trowel tool and by the conventional method. The testing was conducted together at the same time by both methods (smart trowel tool and conventional plastering method), using a digital clock. The function of the smart trowel tool and as well as the conventional method are to plaster a wall of the same size, from start and to finish simultaneously. The time was therefore set to determine the time consumption for plastering a wall with the measurement of 1.0m x 1.0m between the two methods. Once the test was completed the data was collected and analysed to compare the time differences between both methods. The result obtained through the time comparison showed that the developed smart trowel tool has less time consumption to complete the plastering work compared to the conventional method with an equally good plastering work quality. Based on this result, the smart trowel tool was later given to experts from the construction industry to be validated by them. Figure 3 shows the smart trowel tool that was built and tested.

Figure 3. The Developed and Tested Smart Trowel Tool

4. Results and Analysis
The time consumption for both methods was focused as the main criteria for the purpose of analysis. An unplastered wall with the dimension of 1.0m x 1.0m was chosen for the purpose of product test-run. Table 1 shows the results based on the product test-run that was conducted using the smart trowel tool and the conventional method on a 1.0m x 1.0m unplastered wall.

Table 1. Time Consumed Using Smart Trowel Tool With The Conventional Method for 1.0m x 1.0m Unplastered Wall [10]

| Num. of Expert | Num. of Testing | The Time Consume Using (min) |
|----------------|----------------|-----------------------------|
| Expert 1       | Testing 1      | Smart Trowel Tool 25        |
|                | Testing 2      | Conventional Method 30      |

Table 1 shows the time consumption between the smart trowel tool and the conventional method when tested twice, where both tests shows lesser time consumption using smart trowel tool compared to the conventional. The observation on the quality of plastering work was equally good using both the
methods as well. Therefore, this test shows that the smart trowel tool has positive outcome both in time consumption wise and as well as producing smooth work.

The expert validation on the smart trowel tool was conducted with 5 construction players who are familiar and have experience with plastering works for the past 10 to 20 years. The outcome from the expert validation on this tool was satisfactory where they unanimously stated that this product was provided convenience in handling and saves time.

5. Conclusion and Recommendations

For the conclusion, smart trowel tool has fulfilled the main aim and the objective of this study mainly referring to the outcome based on the testing of the tool. The smart trowel tool consumes lesser time for smooth plastering work and it is also handled conveniently compared to the conventional method, therefore this product innovation is suitable for workers and the use of this tool could also reduce their exposure towards health issues such as musculoskeletal disorders (MSDs) which was mentioned earlier.

The recommendation given by the experts during the validation on the smart trowel tool is that this tool should use a circular shape sponge as it will able to give better effect during the plastering work especially when conducting the smooth plastering at edges and corners of a structure.

6. References

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