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# INNOVATION OF CEILING PLASTER GUN

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## ABSTRACT

***Finishing is the final work in the building work element. A delicate and neat finish can describe the status of the building as well as provide a liven up the space. The quality of the finish depends on the finishing method and the tools used while doing the finishing. One of the finishing works is plastering the ceiling. Plastering the ceiling is a way to cover the surface using cement plaster, lime plaster or gypsum. Plastering the ceiling aims to cover defects on the original surface of a ceiling in order to highlight the tidiness and provide protection to the ceiling. The initial surveys obtained by the Department of Public Work (PWD) and construction workers at Taman Merlimau Emas Seksyen 1 , it's found that the problem faced by theirs non-ergonomic ceiling plastering work. This is because this work requires the process of taking mixed plaster from the mixing bucket as well as the process of levelling the plaster on the ceiling by using existing tools repeatedly which can lead to the risk of Musculoskeletal Disorders (MSDs). The objective is to innovate Ceiling Plaster Gun. Secondly, to measure the suitability of the product from the aspect of time taken during ceiling plastering, layer of plaster layer and product design. The effectiveness of this product is to ensure whether this product can be used in the long term or not. Therefore, the tests carried out to measure the effectiveness by comparing existing tools and our products are by conducting on-site tests. In addition, a questionnaire was also conducted to construction workers who use our products to test the effectiveness of the Ceiling Plaster Gun. Overall, the existing plaster tools have a lack of effectiveness compared to the Ceiling Plaster Gun which is able to reduce the risk of Musculoskeletal Disorders (MSDs).***

**Keywords:** Ceiling; Defects; MSDs; Plastering

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## 1. INTRODUCTION

Plasterwork is finishing work using plaster and called as plastering and it has been used in building construction for centuries. Tools such as trowel and hawk are needed in plastering work (Gumerova *et al.*, 2017; Holmes & Wingate, 2007). For ceiling, plastering work is also required. A ceiling installation in building is crucial because it serves as a sound reflector and able to enhance the building's appearance. There are many types of ceiling in building such as conventional, suspended, coffered, tray, shed, cathedral, coved and beam ceiling. However, not all types of ceilings may be used with a ceiling plaster gun, with the exception of conventional, suspended, coffered, tray and shed ceiling. The type of surface texture on the ceiling that is produced by our products is smooth.

The first step in plastering ceiling is preparing the mixture of plaster (Subramaniam, 2022; Cordon *et al.*, 2019; Freire *et al*., 2009). Next, apply the plaster. To do that step, hawk and trowel are needed. To begin, pick up a small amount of mixed plaster from the hawk then apply to the ceiling using the plastering trowel. Spread firmly with the trowel angled slightly away from the ceiling (Hendries, 2022).

However, the difficulty in ceiling plastering is position and way of workers during plastering also the neatness at the end (Cowley & Leggett, 2003. For example, construction workers need to stand close under the ceiling and look up while plastering the ceiling. Not only that, by using existing tools, it also requires to take plaster mixture from the mixing bucket and level the plaster on the ceiling repeatedly to get a greater precision. This shown that ceiling plastering work is non-ergonomic because requires more time and energy as well as can lead to risk of Musculoskeletal Disorders (MSD) (Bevan, 2015; Bhattacharya, 2014) due to repetitive work. Worker safety must be emphasized during the work.

The International Ergonomics Association (IEA) states that ergonomics is concerned with adapting tasks and work environments to workers through a scientific approach. Ergonomic principles emphasize maintaining a comfortable environment and reducing worker tiredness. In general, ergonomic-related diseases are frequently linked (MSDs) (Cheraghi *et al.*, 2019). Muscles, tendons, discs in the back of the body and other support components are all impacted by Musculoskeletal Disorders (MSDs) (Halim, 2021).

An individual exposed to an MSD risk factor will initially experience fatigue. Musculoskeletal problems will develop over time as fatigue worsens and musculoskeletal abnormalities continue to exist. Musculoskeletal Disorders (MSDs) are caused by someone actions or environment that does not follow safe and healthy work practices. Among the actions and environments in the workplace that can cause Musculoskeletal Disorders (MSDs) risks are repetitive movement, awkward and static postures and also constant energy and force use over a long period of time (Halim, 2021).

Besides, among the disease related to Musculoskeletal Disorders (MSDs) is Carpal Tunnel Syndrome (Ekpenyong & Inyang, 2014; Werner, 2011). Pressure on the nerve is what causes carpal tunnel syndrome. Nerve-damaging conditions, inflammatory conditions and workplace factor are the risk factor of this disease (Clinic,2022a). Next is Tendinitis. Tendinitis can occur in any tendon (Siegel *et al.*, 2009; Faure & Daculsi, 2009). But it's most common around shoulders, elbows, wrists, knees and heels. The most likely reason is repeating the same movement again over time. Repetitive movement can overload the tendon and cause tendinitis (Clinic, 2022b). Other than that, is Tension Neck Syndrome. Tension neck syndrome develops as a result of poor body posture, stress and tension (Valachi & Valachi, 2003; Gerwin, 2001). Due to a muscular overload, repetitive arm and hand work, which is especially required in ceiling plastering, it cause the development of tension neck syndrome (Reyfman, 2020).

Therefore, in this study are proposed construction site at Taman Merlimau Emas Seksyen 1, the problem that needs to be solved is the difficulty faced by workers in ceiling plaster work by creating a tool called Ceiling Plaster Gun, which able to solve the problem that has been stated to fulfill the final year student project. All knowledge will be used to make this project a good project.

## 2. METHODS

Based on objectives, the scope of study is to compare the existing tools with our new product. Things that can be compared are time taken during ceiling plastering, thickness of plaster layer and design product. In this study, questionnaire on the effectiveness of the product was conducted (Patten, 2016). Questionnaire filled by construction workers that used this innovations product during on-site testing. Among the question are related to time taken during ceiling plastering, thickness of plaster layer and design of our product. This questionnaire helped in analyzing the pros and cons of Ceiling Plaster Gun so that it can improve the product.

For this questionnaire, google form application is needed to facilitate all parties especially construction workers in construction site at Taman Merlimau Emas Sekyen 1 to make feedback for the suitable of the use of Ceiling Plaster Gun compared to the conventional method. From the google form, it can be analysis in Microsoft Excel to find out the percentage of each question

## 3. RESULTS AND DISCUSSION

Questionnaire form were given to 14 respondents consisting of construction workers only where it is to find out either this innovation product can help them in term of time and energy saving also the risk of Musculoskeletal Disorders (MSDs).


**Figure 1. Work experience respondents**

Based on figure 1 on working experience, respondents are mostly have 1-5 years and more than 15 years experiences. The advantage of having work experience data listed, it can help prove that even if the workers is new to the construction field, respondents are also proficient in handling existing tools and innovation products. This data also helped to find out if experienced workers can change the usual method they used in ceiling plastering work to new method using this innovation product.

For the first question is from aspect of thickness of plaster produced, 86% of respondents agreed with that statement but there are 14% respondents are not sure with that. Respondents are agreed because they believed with the innovation 5mm thick plate on the front of the gun, the plaster that comes out from the bottle will follow the thickness of plate (see figure 2).


**Figure 2. The thickness of plaster using this product is the same every time applied**

For second question on this product only need one swipe to reach a thickness of 5mm, 64% respondents agreed and 29% respondents are not sure. However, there 7% are disagree that our product only needs one swipe to reach a thickness of 5mm. This statement is also supported by plaster thickness test using this innovation product which has been carried out at the construction site. It proves that the thickness of plaster produced on ceiling is inconsistent. Because of that, there is some of them are confident with the function of plate on the front of gun and some of them are not. However, it also depends on someone's skills (see figure 3).

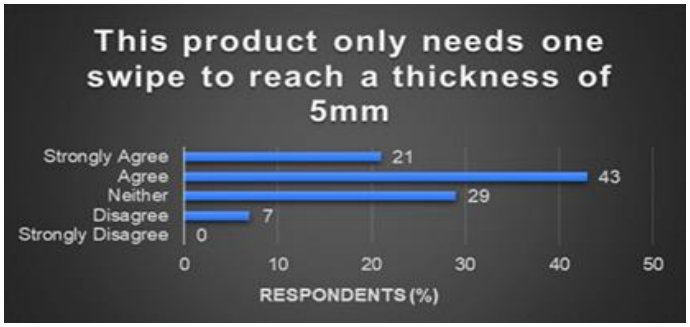


**Figure 3. This product only need one swipe to reach a thickness of 5 mm**

Third question on this product only required one layer compared to existing tools, 79% respondent are agreed. However, there still 14% respondents are not sure and 7% respondents are disagreed with the ability of our product to complete ceiling plastering work with only one layer. This question also supported by plaster thickness test using this innovation product which has been carried out at the construction site. From the analysis data got from the test, it shown that there are construction workers who need more than one layer to achieve a better result. However, there are also construction workers who only need one layer to achieve the 5mm thickness plaster layer with the advantage of the plate on the front of gun (see figure 4).

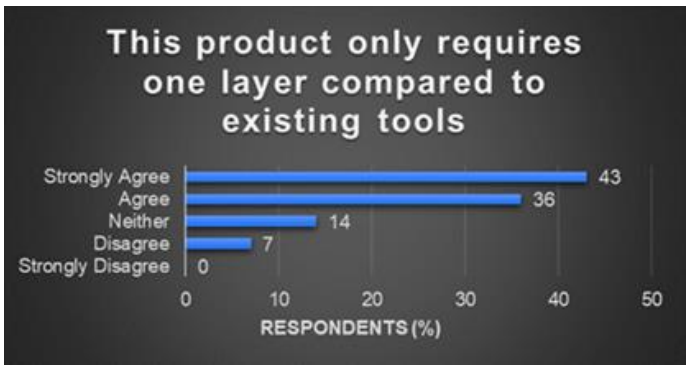


**Figure 4. This product only required one layer compared to existing tools**

For the aspect of thickness of plaster layer produced, all of the respondents gave positive feedback with 100% agreed with that. The plaster mixture from the bottle came out through the hole in the plate and filled the space inside the plate to allow the plaster to be levelled on the ceiling surface. Even though the thickness of plaster layer produced are inconsistent, our product is still able to full fill in the inside of the plate after considering the plate thickness design and it makes all respondents agreed with this statement (see figure 5).

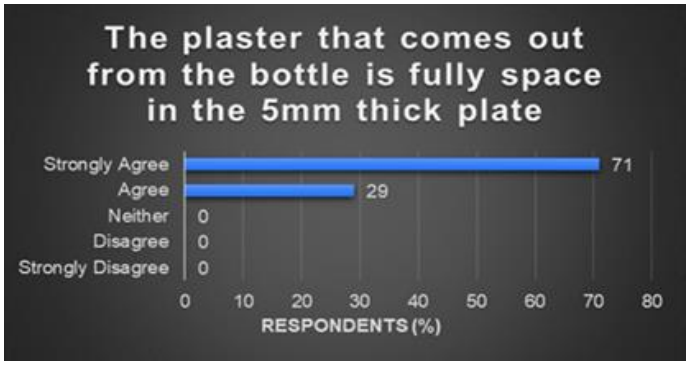


**Figure 5. The plaster that comes out from the bottle is fully space in the 5mm thick plate**

Next, this statement prove that all the respondents agreed that this innovation product can complete the plastering work within the specified time period. Even though, our product is still need trowel to give neater

and better result, all respondents agreed that innovation product able to beat the time taken during ceiling plastering by existing tools (see figure 6).


**Figure 6. This product can complete the plastering work within the specified time period**


**Figure 7. Preparation time to use this product is longer than existing tools**

Furthermore, figure 7 showed that, 71% respondents agreed that preparation time before using this innovation product on the ceiling is longer than existing tools method which is using trowel and hawk. In other words, this innovation product was able to complete the ceiling plastering work faster but not able to beat the preparation time using existing method before the work starts. It is because, this innovation product used bottle as a place to put the plaster mixture. To start the work of plastering the ceiling, the plaster mixture should be put into the bottle first. Meanwhile in existing method, respondents just put the plaster mixture on the hawk but need to do that repeatedly due to constrain of tools. According to respondents, the idea of replacing a hawk with the bottle is great but the work became slow because the process of put the plaster mixture into the bottle takes a bit of time but not too long. So, it's make sense that still 21% respondent disagreed with this statement.

For the last question from the aspect of time taken, it involves time for the plaster layer to dry on the ceiling surface. It shown that majority of respondents are disagree with 93% that plaster layer will take a long time to dry if using this innovation product. This innovation product use plaster as ceiling finishing material and plaster is one of the materials that harden and dries quickly. Although our product has a thicker thickness than ceiling surface, time for the plaster to dry is same as the trowel and hawk method because the usage of ceiling finishing material is same (see figure 8).

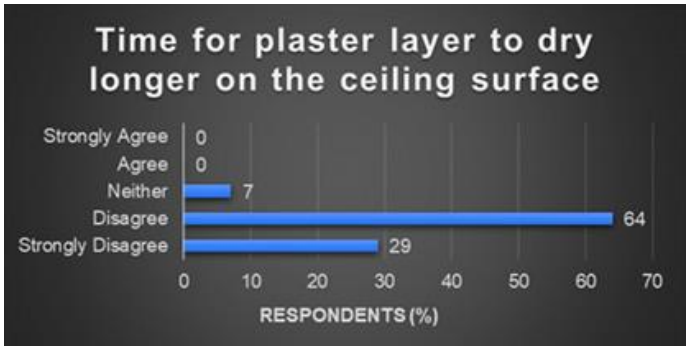


**Figure 8. Time for plaster to dry longer on the ceiling surface**

Besides, this questionnaire also included the design of product. For this statement, it's clear that innovation product is practical to use. From the analysis graph, all the respondents gave positive feedback to this innovation product. With the chosen of aluminium as a new body part that connected to the existing body part, our product became lighter. When the material used is light, it can reduce the burden on respondents as well as the risk of Musculoskeletal Disorders (MSDs) due to constant energy use over a long period of time (see figure 9).


**Figure 9. This product is easy to carry and use**

This statement is to find out if it is easy to push the plaster came out from the bottle. If it is hard to press the trigger, it will increase the force indirectly which can lead to Musculoskeletal Disorders (MSDs) due to constant energy and force use over a long period of time. Luckily, all the respondents agreed that it's easy to push the plaster came out from the bottle with 100% (see figure 10).

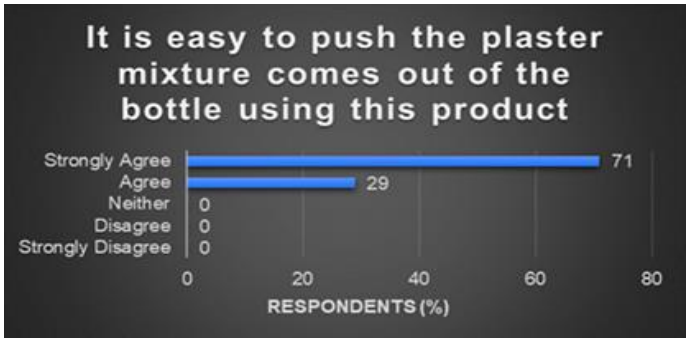


**Figure 10. It is easy to push the plaster mixture comes out of uhe bottle using this product**

For the next statement, 86% respondent are agreed that bottle has the suitable size and capacity but 14% are disagree with that. They agreed because plaster mixture capacity that put in the bottle can cover an area of 3m x 3m based on test that have been carried out at the construction site. So, respondents no need to refill the

bottle with plaster mixture too often. Meanwhile, the reason they not disagree because they think that the bottle is not suitable due to the large size will increase the weight of the product (see figure 11).

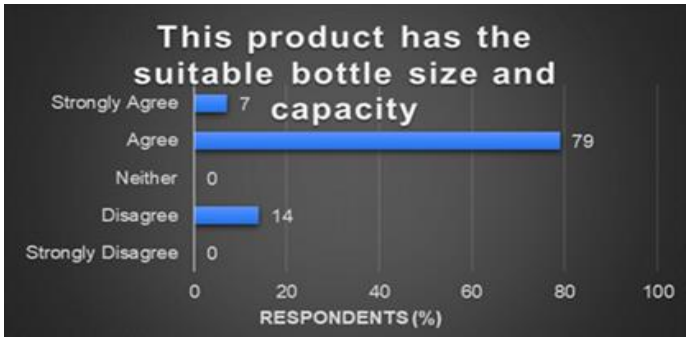


**Figure 11. This product has the suitable bottle size and capacity**

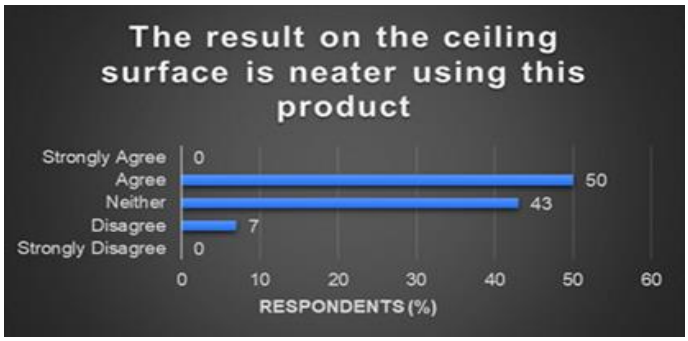


**Figure 12. The result on the ceiling surface is neater using this product**

Besides, there is significant disagreement among the respondents. Figure 12 showed that, 50% respondent are agreed, 43% respondents are not sure and small percentage respondent that disagree which is 7%. This is because it depends on respondent skills itself. But with the 5mm thick plate design, the plaster will come out according to the shape of the plate. This will result in a neater finished look. The plaster will not smudge to the unnecessary part. However, the respondents that disagree and not sure are because they still need trowel after using this innovation product, so it will cause the plaster layer that used to follow the shape of the plate changed and make it messy. Last but not least, there is no denying that innovation product are capable of reducing the risk of sprained wrist. 100% respondents are fully agreed with this statement. It is because with existing tools, respondents need to level the plaster layer on ceiling repeatedly in order to get better result. Doing that, it can cause to repetitive movement at wrist which is one of the risk factors in Musculoskeletal Disorders (MSDs). Meanwhile, this innovation product is only swipe to level the plaster layer on ceiling surface (see figure 13).

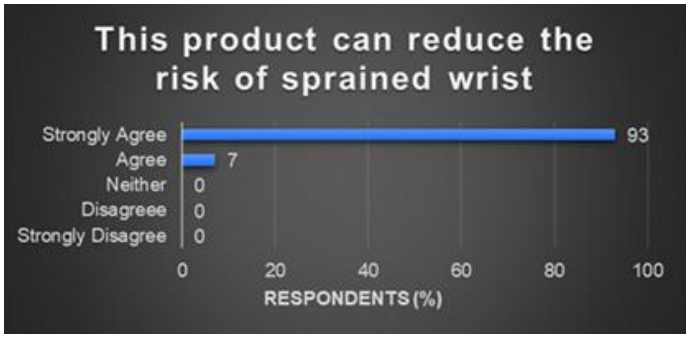


Figure 13: This product can reduce the risk of sprained wrist

## 4. CONCLUSION

It can be concluded that, the main objectives for undertaking this study were to measure the effectiveness of Ceiling Plaster Gun for the purpose to reduce the time, energy and risk of Musculoskeletal Disorders (MSDs). A study was conducted to calculate the percentage of satisfactions toward this innovation product based on data from questionnaire created using google form. In this study, it is shown that, this innovation product is suitable and significantly used in construction site for ceiling plastering works. From the data analysis, it shown that the Ceiling Plaster Gun have helps a lot in finishing work. The percentage calculated in Microsoft Excel prove that majority of the respondents which is construction workers agreed with the positive statement stated in questionnaire. The potential for the future research from the project found that the product produced has its own advantages. Among the advantage of product is the design of the product itself. For example, the plate, it helps a lot in saving time in levelling plaster on ceiling. With the dimension 70mm x 90mm, it can cover the ceiling gap and cordless screwdriver hole. Other than that, is the size of bottle. The capacity plaster that can put in the bottle is enough to plaster ceiling for an area of 3m x 3m which is a medium-sized room. Besides, the choices material of new body part which is aluminium is also good due to lightweight material.

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