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Improving Work Quality in Painting Between Wall and Ceiling Areas Using a Paint Edger

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ABSTRACT

In the painting process, many tools have been proposed to paint the wall and keep the ceiling from being exposed to the paint color. The workers' main problem is that they have to use a ladder to reach the ceiling and place tape between the wall and ceiling. This technique was employed to shield the paint-exposed area, particularly when the ceiling and wall were painted in contrasting colors. Because the tape absorbs the color of the painting, its quality typically does not match the ceiling's surface, and when the worker tries to remove it, the color is still visible on the ceiling. The objective of the study is to implement a new additional tool to attach to the paintbrush in order to paint between the ceiling and wall area smoothly and neatly. To complete this study, the primary data collection was conducted through interviews with the painters at a construction site in Padang Besar, Perlis. The techniques of brainstorming, benchmarking, and morphological charting are used to produce and develop good ideas, which are expressed in detailed sketches and technical drawings. The polylactic acid (PLA) material was used in the 3D printing process to create the tangible prototype. The new additional tool that is called a paint edger, is attached to the paintbrush and this product can save working time to paint the area of the ceiling and wall by 32.9% compared to the conventional method. Moreover, the risk of the fall can be reduced by using the paint edger, whereas it uses the extended pole to complete the work with the same quality.

Keywords: Painting job, Design development, Painting tool, 3D printing.

1. INTRODUCTION

The goal of painting walls, buildings, and other structures is to achieve a good finish and to protect the structure. It protects the surfaces against fungi and erosion caused by weather and the environment. It also enhances the building's visual value, making it more appealing and colorful [1]. Painters often use a brush or a paint roller to paint the surfaces of buildings, and then climbing, bending, and stretching are also part of the painting process. This procedure normally takes a great deal of movement and time [2].

Nowadays, the workers are just using the same roller to paint all surfaces of the wall and paint the corner of the wall. Painting using a brush takes longer than using paint rollers. The size of the paint roller, which can range from 4 to 18 inches, is determined by the breadth of the roller. The two most popular sizes are rollers with a width of 7 inches and 9 inches. Typically, a paint tray and a paint roller are used together [3]. Besides that, this process requires a ladder to climb to paint the walls and ceiling; this process comes with various side effects for the worker, such as body pain and the possibility of falling. There are many types of injuries when workers use the

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ladder, but the other side of the ladder is a very important tool. By using the ladder, the painting process can be reduced because workers do not need to prepare the other objects to climb [4].

Painter's tape is acclaimed by amateurs and professionals alike for its capacity to create precise, clear paint lines without the danger of paint leaking over the borders due to its contra color. Because the adhesive on painter's tape is weaker and less persistent than that on traditional masking tape, it comes off without leaving any residue and without absorbing any additional paint. The best time to remove painter's tape is just after the paint has dried, but users can leave it on the walls, floor, ceiling, or windows for up to 14 days without it being an issue [5]. Table 1 shows product benchmarking with the existing products.

Table 1: Existing Products [6].

Type			
Product name	Deyln paint brush clean cut	Paint edger brush	Paint edger handle casing roller
Material	High quality plastic	Plastic and nylon bristles	Plastic
Usage	Color separation paint brush to paint edges of the wall.	Use in edges to trim color paint with the pad can replace what its full usage.	Use to cut in the paint around the door, window, ceiling, accent wall and Baseboards.

By implementing the current technique to paint between the wall and ceiling area, there are no safety guarantees because they need to climb up and down the ladder to paint between the wall and ceiling area. Additionally, they always cover the floor with a plastic sheet, and this is a high risk of getting injured because the floor is slippery and in an unsafe condition. Besides that, the painting result is messy because the current brush has a huge tendency to touch the ceiling while painting the wall. These days, the major issue faced by the workers is the need to take a long time to tape, cut, and ensure the ceiling surface is taped perfectly. Sometimes, the workers need to remove the tape and reinstall new tape if the tape is exposed to the paint color. After completing the painting, the workers needed to remove and collect all the tapes, but the paint was not dry properly, and this situation will make the paint affected the ceiling color. The study proposes an additional tool to attach to the paintbrush that can improve the painting technique.

2. MATERIAL AND METHODS

The area of the study is among workers who do the painting job in Perlis, Malaysia. It is focused on the investigation of the painting job, especially when the paint is between the ceiling and wall area. The collected data was analyzed to identify user needs and product target specifications and then help in the idea conceptualization process. The quality of the painting is poor when the worker just used a conventional brush, whereas the line of paint between the ceiling and wall is not perfectly straight, as shown in Figure 1.

Figure 1: The painting quality by using a conventional brush only.

2.1 Data Collection

This interview was distributed to the three workers who were involved in wall painting at the clinic construction site at Titi Tinggi, Padang Besar, Perlis. All the interviewees had 2 to 20 years of experience in painting. They used a 2.5-inch Sancora paintbrush because the quality of the brush is very good. However, they also need to use a telescopic pole to paint the area between the wall and ceiling when a ladder is not used in the painting process. To satisfy customers, they also used rice straw, as shown in Figure 2, because it is cheap and easy to get.

Figure 2: Rice Straw.

The problem always arises when the painting process is trampled, melted, and dripped over the eyes. The workers climb up and down the ladder several times to paint the area between the wall and ceiling, and this takes 30 minutes. Moreover, there is a high risk of falling and the worker can be injured too. As a suggestion, an additional tool can be designed to attach to the brush and the function is to guide the brush at a 45-degree angle so it can paint well in the area. Moreover, the tool needs to be cheap so the worker can afford to buy it. From the interview session and other related studies, the needs of the new tool were defined as tabulated in Table 2 below. The ease of the tool is very important, whereas it is practical and comfortable to use the new tool. The ease of the tool is very important, whereas it is practical and comfortable to use the new tool. Benchmarking is a crucial process to know the strengths and weaknesses of competitor products.

Table 2: User needs of the paint edger.

No.	Needs	Important Weightage
1	Easy to use	5
2	Easy for storage	4
3	Easy to operate	5
4	Easy to clean	4
5	Can hold the brush at an angle of 45 degrees	5
6	Safe to use	5
7	Comfortable handle	4
8	Affordable price	4
9	User friendly	3
10	Lightweight	4

2.2 Design Concept Development

Brainstorming and a morphological chart were used to develop concept ideas after the user demands and product criteria were finalized. Concept 1 is easy to use because the angle of the position is fixed at 45 degrees, and by using this angle, the work output is better than that of the conventional method. Based on the worker's response, the 45-degree angle is the best position for the hand and brush to paint. It has a nice curve for gripping and controlling the hand.

Concept 2 applies a 360-degree angle for the joint of the handle with the brush holder, and by using this angle, the user can adjust the angle according to user comfort. This type of concept is inspired by the existing products that are in the market, whereas the respondent is satisfied with the appearance and the angle used of the product.

The mechanism connection applied in Concept 3 is a keyless drill chuck to connect the brush and the clamp. The user needs to loosen the drill chuck first, insert the brush handle inside the drill chuck, and then twist it to tighten the chuck.

Next, in the Concept 4 bracket, a holder and screw clamp are used to clamp the brush. The position of these two mechanisms is inside the body, and to use this part, the user needs to press the brush handle into the bracket and tighten the screw at the bottom of the body.

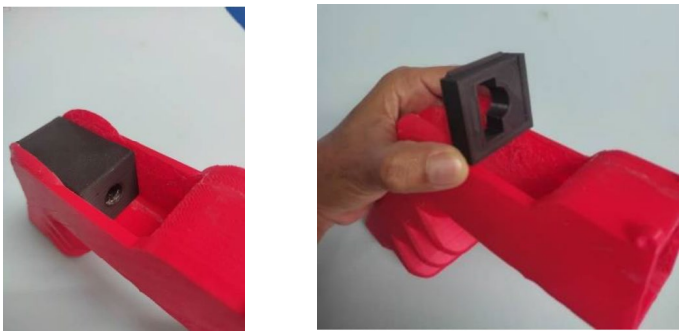
Concept 5 has a paint guide attached to the body. The paint guide also functions as a protective cover, which can rotate 90 degrees and is easy to use. All five concepts were put forth to accomplish the goals, and then the best concept was selected through the concept screening and the concept scoring method. Mock-ups of handles with a 1:1 scale were constructed to evaluate the most comfortable handle and suitable Malaysian palm size.

3. RESULTS AND DISCUSSION

The paint edger is fabricated in real dimensions to be tested by the worker. The complexity of the study appears during prototype fabrication because there are a few parts that need to be printed out several times due to specific issues and defects. The main body needs to be divided into two parts to fit the 3D printer machine requirement and to make sure the body has good strength. The infill setting is 70%, and this is caused by the printing duration taking longer than 24 hours.

3.1 Prototype Fabrication

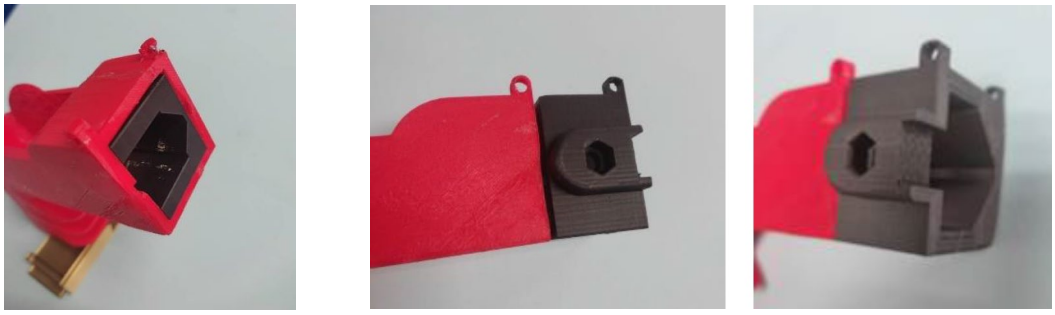
The prototype of the paint edger was built using a 3D printer, and the material is polylactide (PLA). The infill of 3D printing only applies 30% because the design is not complex. However, some issues occur after printing is completed; for instance, the printing process of the back bracket needs to be done twice because in the first printing, the shape of the inner hold was not fit with the brush handle. The new design of the back bracket is pictured in Figure 3.



Original design New design

Figure 3: Original and new design of the back bracket.

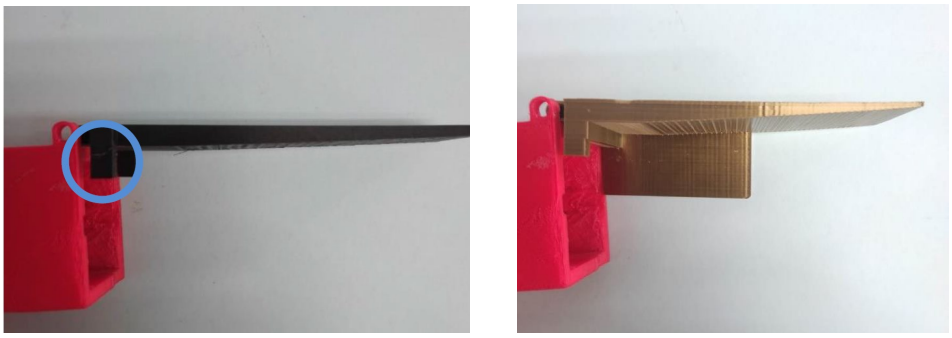
Other than that, the inner slot size does not fit with the SanCora paintbrush. As a solution, design improvement was done by designing a new inner slot and changing the dimension, and then, it was reprinted. A major change needs to be made in the front bracket by adding a tighter slot in the front of the main handle. The change in the design from the final design concept is based on the hand fitting that interrupted the tightening at the back of the handle. Figure 4 shows the new design of the front bracket. The support of the guide clean cut was broken because the support could not sustain the force from the painting process. So, the design improvement was done by enlarging the size of the support, as shown in Figure 5.



Original design New design

Figure 4: Original and new design of the front bracket.

The paint edger (Figure 6) consists of six parts with dimensions of 72 mm length, 275 mm width and 180 mm height. The size of the paint edger is appropriate for human hand size by referring to the anthropometric data of Malaysians, and it is also easy to store as it does not require a large space to store it. The handle can fit the fingers and palm, which makes it comfortable to hold even in long time usage. The pole can still be used to reach high areas like the ceiling and wall, and it has a slot at the bottom of the handle for inserting the pole.



Original design New design

Figure 5: New design of the guide clean cut.

Figure 6: The final paint edger.

The quality of work is increasing while using the paint edger because the guide's clean cut runs smoothly to divide the ceiling and the painting area. The line of the painting is straight and smooth without getting on the ceiling area. Figure 7 below shows the quality of the painting line produced after using the paint edger.

Figure 7: The quality of the painting line.

The time taken to paint five lines using the paint edger and current tool is depicted in Table 2 below. The working time can be saved by 32.9% when using the paint edger. Anyone without painting experience can do the painting because the paint edger already has a clean guide cut to guide people to paint in a straight line in the wall and ceiling area. Based on the worker feedback, by using the extended pole, the result of the paint in the wall and ceiling area is very satisfying, achieving the quality of work that is in accordance with the specified specifications.

Table 2: Time taken to paint by using different tools.

Paint line	Time taken with the current tool (s)	Time taken with the paint edger (s)
1	26	16
2	30	22
3	29	17
4	33	20
5	40	31
Total	158	106
Average	15.8	106
Time can be saved:	$\frac{15.8-10.6}{10.6}$ **x 100**% = **32. 9**%	

4. CONCLUSION

This study attempted to identify the challenge in the painting job, which is the paint between the wall and ceiling area. The primary data was collected through interview sessions, and the data collection helped in concept development and benchmarking with the existing products. The final concept was selected through the screening and scoring method and then became a tangible product. The paint edger faced certain challenges in the printing process, and to prevent this, many aspects need to be considered at the early stage, especially during the design development process. All the functions of the parts must be synchronized well so the paint edger can paint the wall and ceiling area with high-quality paint. The working time can be saved to 32.9% compared to using a paintbrush only. The paint edger is easy to use and can paint the wall and ceiling area, even at the high area, because it can be assembled with a pole.

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