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FACE SHIELD@UKM: An Initiative by UKM to Protect Our Frontliner during Covid-19 Pandemic

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Abstract **- COVID-19 is a threatening pandemic to human being worldwide. Many of frontliner being infected in many ways. Private protective equipment (PPE) is a must to wear by all the medical personal when handling the COVID or treating the contagious patients. In normal circumstances, PPEs are easily available from medical suppliers. However, it there is disease outbreak like this COVID-19 and worldwide are affected, face shields are in high demand. Traditional process may not be able to cope with the sudden surge of the demand as well as the raw material. Manpower and factory accessibility are other factors as most of the country practice social distance through restriction movement order or completely lock down the town. To overcome this problem, rapid prototyping tools such as 3D printing and laser cutting methods are the promising method in producing the medical shields for our medical frontliner in battling the Covid-19 outbreak in Malaysia. To keep this in mind that this effort should be an alternative or interim method while waiting for actual PPE to arrive. With this grant and contribution from various parties (NCWO/Faculty member), we have produced a total of 1834 pieces of 3D printed face shield. The locations of the face shield recipients are from a total of 18 hospital and health clinics.**

Keywords: 3D Printing, Personal Protective Equipment, Face Shield, COVID-19.

I. INTRODUCTION

World Health Organisation declared the 2019 novel coronavirus disease (COVID-19) as a pandemic on 12th March 2020. Many parts of the world have or currently in lockdown to slow the spread of the disease as not to burden their health care system [1]. Worldwide, we see the exposure of healthcare workers to the disease and increased usage of personal protective equipment (PPE) by healthcare workers as they handled COVID-19 positive patients. Private protective equipment (PPE) is needed to be worn by all the medical personal when handling the COVID or treating the contagious patients. [2]. In normal circumstances, PPEs are easily available from medical suppliers. When COVID-19disease outbreak, PPE are in high demand with limited supplies. The situation is worsened when certain countries limit the export of PPE for their own usage [3]. The shortage of PPE supplies in hospital setting has increase the risk of infection to doctors and raised a serious public health concern [4].

Due to sudden spike of PPE usage in hospital and limited PPE supplies worldwide due to pandemic COVID19, various efforts have been done by the nation to support frontliner in fighting COVID19. Many of frontliners workers have forced to use garbage bags for protection against COVID19 virus when treating the patients [5]. Traditional process may not be able to cope with the sudden surge of the demand as well as the raw

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material. Manpower and factory accessibility are other factors as most of the country practice social distance through restriction movement order or completely lock down the town [6].

While PPE manufactures are still struggled to produce the PPF for hospital usage, local community has begun to start various initiative to support frontliners [7]. Community could use any available local resources to help the medical community to ensure adequate safety and protection in hospital. To overcome this problem, rapid prototyping tools such as 3D printing and laser cutting methods are the promising method in producing the medical shields for our medical frontliner in battling the Covid-19 outbreak in Malaysia. Experts from various fields and industries had joined hands in response to the increasing need of the PPE usage. Zhang et al. [8] described the important of community-led initiatives and additive manufacturing approach in facing pandemic COVID19 globally.

The great support from the general community in 3D printing industry, open-source design, simplistic design, and its rapid prototyping nature has made 3D printing a viable option for face shield production in this critical time [5,9-11]. Amin et al used specific 3D printing materials consisting of a 3D printer and polylactic acid filaments [12]. The open-source design and data sharing effort by 3D printing community has expedite the 3D printed face shield design. The 3D face shield model has been optimized for different printer model and adjustment has been made to reduce the printing times [9]. Various efforts and strategy such as stacking concept has increase the printing output in one trial.

To keep this in mind that this effort should be an alternative or interim method while waiting for actual PPE to arrive. The main objective of this work is to produce face shield rapidly using 3D printer and A4 transparency sheet for frontliner usage during pandemic. Furthermore, this report demonstrates the community efforts in combatting COVID19 pandemic in Malaysia, experiences and challenges to provide more pandemic resilience initiative sin future.

II. METHODOLOGY

There are a group of self-initiated 3D Printing Malaysia Community for COVID 19 was established in Facebook to produce 3D printed face shield for medical frontliner. There is various design available online and can be used for this purpose [13-14]. The 3D printed PPE consist of 3D printed frame, A4 plastic sheet and an elastic belt (for people who has smaller head circumference). There are total six support point to support the A4 plastic transparent sheet.

The model as shown in Figure 1 is available from Thingverse [14]. It was developed by a group of people who have experience in various discipline including 3D printing, designers, volunteers, and material supplies. This model has been improved after feedback from medical personnel in Hong Kong. We propose to adapt this design and will do some modification to improve the material usage without compromising the strength of the frame.

A 3D slicer software, Ultimaker Cura (Ultimaker BV), were used to prepare the model for 3D printer. This software is an open-source slicing software that integrate with CAD software for an easier control of the custom setting in 3D printer. The slicer software generates G-code which is a numerical control programming language and transferred to a 3D printer for 3D printing. The model will be loaded to the 3D printer and printing process will take approximately 90 minutes before parameters optimization (Figure 2).

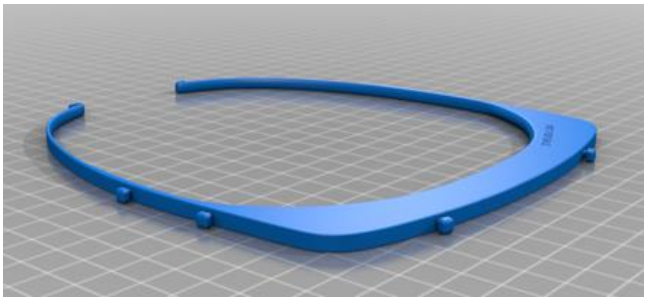

FIGURE 1. The 3D model of medical shield frame.

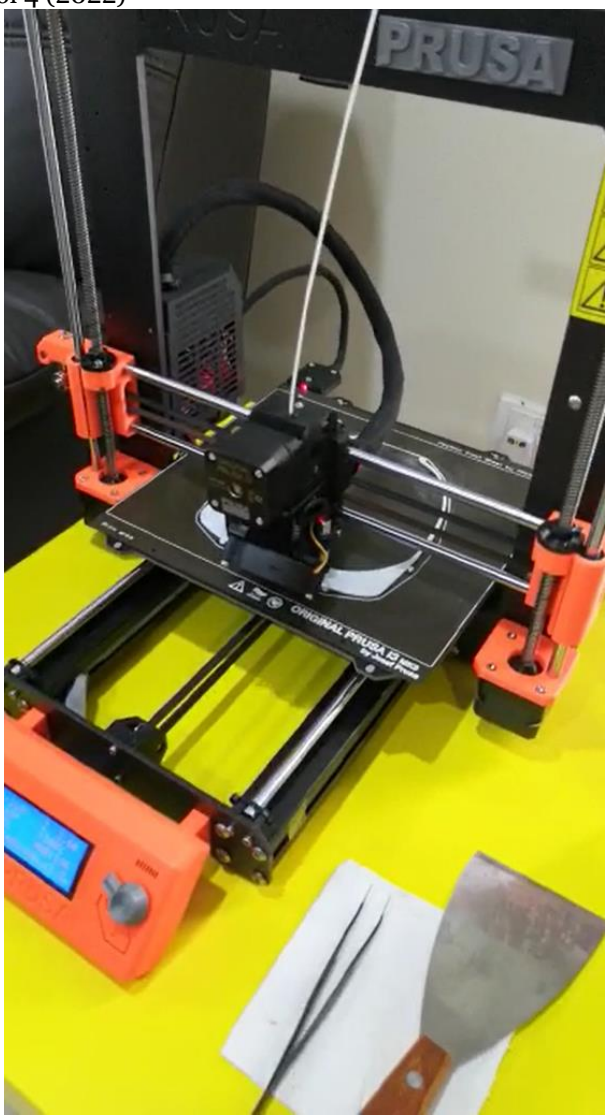

FIGURE 2. 3D printer in action for the frame.

It is not economical to produce one sample with long printing time. Electrical power consumptions and the machine down time are the main factors in long operational hours. Since this project to support frontliners, rapid production is the main task so that the 3D printed face shield can be delivered in time to clinics and hospital. By reducing the printing time doesn't mean that the quality of the 3D printed face shield will be compromised. With proper parameters adjustment and optimized in slicing software, the printing time can be further reduced. Besides stacking and model arrangement on print bed, slicer parameters such as layer height (0.42 mm), line width (0.40), wall thickness (1.2 mm), material print temperature (205 °C) and print speed (50 mm/s) have been adjusted to an optimum level for producing face shield.

The A4 plastic sheet need to be attached to the printed frame at the designated location to form a complete full-face shield as shown in Figure 3. Elastic material can be used for people who has smaller head circumference. Figure 4 showed a sample of 3D printed face shield wore by the researcher.

FIGURE 3. Full face medical shield.

After the printing process, the 3D printed face shields were gone through the postproduction cleaning and sanding. This will remove all the debris, burrs and dirt. According to Prusa Research [15], the 3D printed face shield can be clean using various method such as hot air dryer, hand rub disinfection, Isopropanol, household bleach, UV-C Ethanol, Hydrogen Peroxide and soap and hot water. Due to the reason and lock down during the movement restriction control, some solutions are quite difficult to obtain. As such, the 3D printed shield was wash and clean with combination of soap and warm water based on the process described by Prusa Research [15].

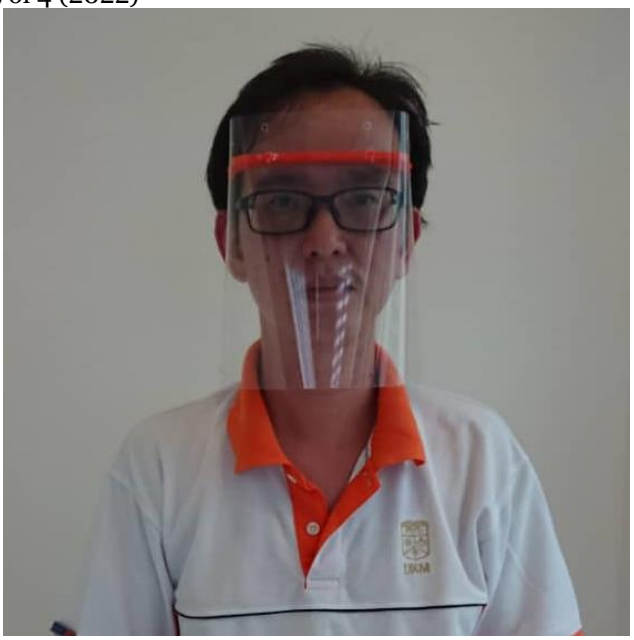

FIGURE 4. 3D printed face shield as wore by the researcher.

III. RESULTS AND DISCUSSIONS

In this works, Polylactic Acid (PLA) filament was used to produce 3D printed Face shield. It is relative cheaper compared to Polyethylene Terephthalate Glycol (PETG) filament and easily to obtain at that time. The PLA filament has a lower printing temperature, does not require to heat up the printing bed and does not warp easily. It is more suitable for rapid production of 3D printed face shield and one time used application.

Furthermore, to ease of frontliner usage, the 3D printed face shields were fully assembled and packed in ten per set. All face shields were check for its quality, warpage, and its cleanliness before packing. The frontliners can use it directly without the need to punch the holes and assemble the face shields. The assembly and quality checking process only be done at single place and all volunteers wore mask and glove. This minimized the contaminations and contact points.

To date, we have produced 1834 pieces of 3D printed face shield and delivered to various hospital and health clinic in Malaysia based on the demand. The recipients of the 3D printed face shield are from 18 hospital and health clinics around Malaysia.

To enable tracking and recording the receiving health clinics and hospital, a simple database and visualization have been developed using Google Map (Google LLC). The hospital and health clinics who received 3D printed face shield is show in Google Map (Figure 5). It showed that PPEs were high demand in hospital and clinics around Klang Valleys from April to July 2020.

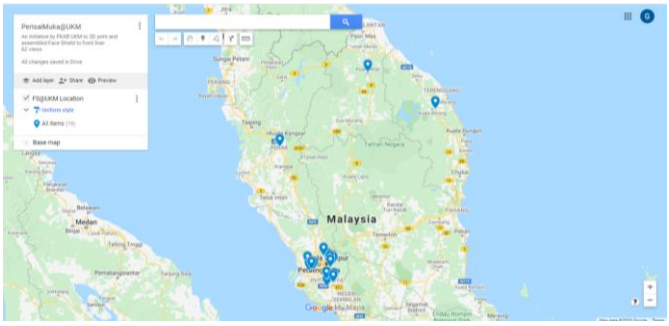

FIGURE 5. 3D printed recipient's location in Google Map.

Besides that, we received feedbacks from doctors and front liners that the 3D printed face shields are comfortable and less fogging on the plastic sheet. The frontliners who received the 3D printed face shield were satisfied with the material quality and its functionality. Figure 6 showed a group of Emergency Doctor at Hospital Raja Permaisuri Bainun, Ipoh, Perak received 3D printed face shield from UKM.

FIGURE 6. 3D Printed Face Shield received by a group of Emergency Doctors at Hospital Raja Permaisuri Bainun, Ipoh, Perak.

IV. CONCLUSION

Different type of printers has been used for 3D printed face shield with help from colleagues and friends. To date, we have produced a total of 1834 pieces of 3D printed face shield for 21 hospital and health clinics during COVID19 Pandemic. We received feedbacks from doctors and front liners that the 3D printed face shields are comfortable and less fogging on the plastic sheet. Rapid prototyping tools such as 3D printer can be quickly deployed to create useful device like Face Shield for emergency used.

From this 3D printing face shield initiatives, we learned the important of the community lead efforts, the power of open-source data sharing in face shield design and optimization in handling the PPE shortage. The

technical lesson such as usage of 3D printer, cost-benefit optimization, and disinfections will be a good reference to achieve more pandemic resilience and sustainable community in future [16].

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AUTHOR CONTRIBUTIONS

Kok Beng Gan: Project Administration, Supervision, Writing – Review & Editing.

CONFLICT OF INTERESTS

No conflict of interests were disclosed.

ETHICS STATEMENTS

Our publication ethics follow The Committee of Publication Ethics (COPE) guideline. https://publicationethics.org/

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