IJPTL

International Journal of Practices in Teaching and Learning (IJPTL)

Published: February 2021

Utilizing Teaching Laboratory to Produce Face Shields for Front Liners during the COVID-19 Pandemic

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***Abstract*—** Coronavirus infection was declared a pandemic by the World Health Organization (WHO) on March 11, 2020, after a sharp increase in cases all over the world. UiTM Pulau Pinang Branch staff had the initiative to produce face shields for front liners to combat the disease in the communities. The team started the Community Social Responsibility (CSR) project by producing face shields (FS) using three-dimensional (3D) printer machines. The production of FS is changed to injection molding (IM) to overcome the lagging in supply to the problem. The main objective for this initiative is to supply FS to front liners including schools for teaching and learning purposes. Nearly 12,000 FSs were successfully sent to front liners, including hospital staff and health clinics, schools, the police, civil defense, veterinarians, and others.

***Keywords*—** *coronavirus, COVID-19, 3D printer, injection molding, face shield.*

I. INTRODUCTION

The global pandemic of coronavirus 2019 (COVID-19) infection has been going on for nearly a year. Although all preventive measures have been taken to curb the spreading, new cases continued to increase worldwide to the number of 29 million cases when this paper was written. In Malaysia, the Malaysian Ministry of Health (MOH) and the National Security Council (MKN) play an essential role in overcoming this problem. Besides, to ensure Malaysians' safety, front liners such as hospital health personnel, schools, the military, the police, and the civil defense department have work diligently to curb the spreading of the disease. Responding to the community social responsibility, the FS manufacturing project was started by the UiTM Penang branch staff to support Malaysia's front liners.

The main problem that prompted this CSR team to be established was the shortage supply of FS for front liners' usage. It is also compulsory for students to wear face shields in school in order to reduce transmission of the virus. According to World Health Organization (WHO), the limited supply of FS was not only faced by Malaysia but all over the world [1]. A press statement issued by the Malaysian Ministry of Health on April 14, 2020 said that the Malaysian government faced a shortage of FS stock for front liners' use, with FS which could only last for 25 days [2]. According [3], a survey conducted on pediatric otolaryngology specialists to assess their usage and access to personal protective equipment during the COVID-19 pandemic showed 91.6% from a total of 96 respondents used FS consistently.

Meanwhile, [4] conducted a survey on 296 institutions which covered core facilities and affiliated hospitals of the obstetrics and gynecology training programmes and to hospitals of the national perinatal medical liaison council in Japan, and it was revealed that 65.0% of facilities for doctors and 73.5% of facilities for midwives used PPEs beyond the standard gowns or aprons, surgical masks, goggles or face shields during labour of asymptomatic women. In addition, the running stock of FS was noticed at 2.7%. As a consequence, the 14% of facilities had to do re-sterilization and re-used the FS to cope with the shortage of PPE stocks.

The problem while using the PPE is also noticeable and this affects health workers' performance. A web-based survey was conducted regarding the availability and usage of personal protective equipment (PPE) of health workers to

deal with COVID-19 patients. It was reported that FS or visors were used by 62% of 2711 respondents. They also agreed with the duration of a median of four hours comfort level of wearing PPE. Adverse problems of using PPE include heat (51%), thirst (47%), pressure areas (44%), headaches (28%), inability to use the bathroom (27%) and extreme exhaustion (20%) [5, 6].

In addition, [7] investigated the physical problem faced by nurses when using PPE. 47.9% of the users informed that they experienced vision problems when wearing goggles or FSs. In addition, the research also concludes that four hours maximum use of PPE is recommended to avoid discomfort. They suggested further improvement on PPE quality, characteristics, efficacy, and optimal uses are necessary to maintain a healthy workforce.

The additive manufacturing technologies can be used for fabrication of protective FSs for Covid 19 front liners. [8] applied Ender 3 Pro 3D printer to produce face shield headbands. Although the printing process is slow, they managed to produce 126 face shields in four weeks which were then delivered to hospital wards, thus easing the shortage of PPE [8]. In the meantime, [9] also joined the FS fabrication using 3D printer Gtmax3D Core H5 and were able to produce single FS in three hours and 44 minutes using ABS material. They claimed the product is feasible and reduces cost, adding to the list of possibilities to produce PPE to fight Covid-19 pandemics.

II. METHOD

There are two phases in the manufacturing of the FS: the first phase uses a 3D printer, and the second phase of manufacturing uses an injection molding machine. The use of 3D printer machine in producing FS started on March 27, 2020, until April 18, 2020. The manufacturing of FS using an injection molding machine started on 19 April 2020 until now.

A. 3D Printer

In the beginning, the CSR team used 3D printer machines to produce FSs. The polylactide (PLA) material was used as raw material and the 3D machine printer operates for 18 hours per day. A total of four 3D printer machines were used simultaneously. On average, the 3D printer machines have a capability to produce 80-90 FSs in a day. The process of producing a FS takes about 35-45 minutes. About 1400 FSs have been successfully produced using 3D printer machines.

B. Injection Molding (IM)

Due to the time-consuming process of producing FSs using 3D printer machines, the team look for other high productivity manufacturing method. In addition, the demand for face shield is rapidly increasing as the number of cases became more widespread in Malaysia. The shift from 3D printers to plastic IM process was the best solution. The new mold for FSs was made and installed to the IM machine. The polypropylene (PP) granules was used as the raw material as it provides greater stiffness and flexibility. The PP material was contributed by Petronas while the cost of FSs mold was financed by Tasek Gelugor Member of Parliament.

The process of making FS using plastic IM machine needs to go through several phases, namely:

1. The plastic pallet (polypropylene, PP) material is mixed with colorant.
2. The plastic pallet is sucked into the hopper of the IM machine.
3. The PP pallet is heated and forced into the mould by rotating a screw inside the barrel.
4. After solidifying, the mold is opened and the FS headband is ejected by ejector pin.
5. The finished product is sent for the disinfection process. The product is soaked in the disinfectant for five minutes.
6. The cleaned and disinfected FS is dried between one hour to two hours.
7. After drying, the FS is packed neatly and ready for delivery.

The comprehensive production process flow in producing FSs is illustrated in Figure 1. Meanwhile, the activities involved in disinfection process is extensively illustrated in Figure 2.

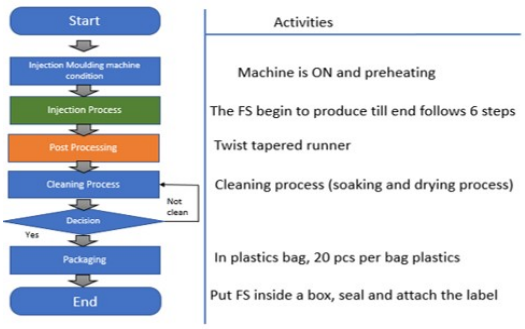

Fig. 1. Face shield headband production process flow using plastic injection moulding machine

Fig. 2. The flow of disinfection process of FS.

The disinfection process was done with a team member from the Faculty of Health Sciences, Bertam campus. The preparation process comprised of several stages. This process requires a mixture of bleach with at least 5% Sodium Hypochlorite and water with the mixing ratio of 1:9. This process requires the team members to wear gloves, apron, mask, and goggle. They need to wash their hand before and after the disinfection process. Then, the drying process took place in a non-contaminated area at normal room temperature. Finally, the FSs were labeled and packed neatly in boxes ready for delivery.

III. RESULT

The process of producing a face shield using a 3D printer machine was very time-consuming. Figure 3 shows the productivity of face shield on weekly basis. It was noticed that the high productivity of face shield happened in week 2 and week 3. The high productivity was mainly influenced by the machine reliability and the optimization process taken to reduce the printing time. Meanwhile, the lower productivity which occured in week1 and week 5 was influenced by the machine breakdown and maintenance.

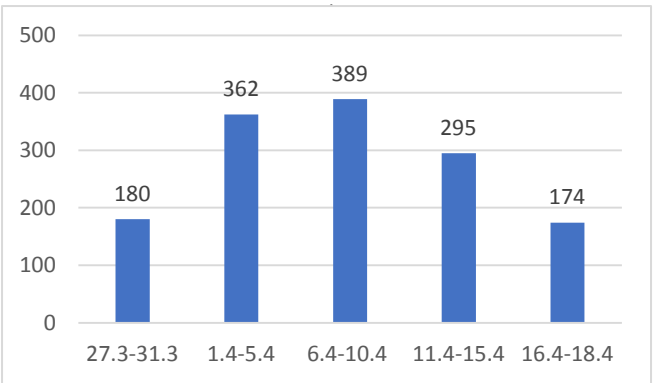

Figure 3. The number of FSs produced using 3D printer machines on weekly basis.

Referring to Figure 3, the amount of FSs produced in the beginning and in the end using 3D printer machines was relatively low due to several factors. In the first five days (March 27 to March 31), the team was on trial. Some improvements were made so that the process of producing the FSs could be improved. In the final weeks of using 3D printer machines, the output of the face shield was relatively low because the team was transitioning to the use of IM machines in full.

Using the IM machine, the production of the face shield increased compared to using 3D printer machines. A unit of FS took about 27 seconds to produce. Hence, the productivity had remarkably increased whereby 1200 pieces of FSs could be produced in a day. This achievement had successfully helped to reduce the shortage of FS stock in Malaysia as required by the front liners.

Schools staff and students were also required to use face shields for teaching and learning purposes. Thus, thousands of face shields had been distributed to schools. Besides, school students were more comfortable wearing the face shield compared to the face mask. The schools which benefitted from this initiative were Sekolah Kebangsaan Kebun Sireh and Sekolah Kebangsaan Seberang Jaya.

Figure 4. Picture of a teacher and a student wearing a face shield.

IV. CONCLUSION

In conclusion, many parties play a role in the production of the FS in terms of money donation, time and energy for the project to be carried out successfully. This project was to provide as much assistance as possible to the front liners facing the fight against Covid19. A total of 21 hospitals had benefitted from this project, with a total delivery of 11909 units. Simultaneously, contributions to health clinics, schools, police departments, civil defence, and others reached 5569 units. This contribution figure will continue to increase over time, depending on the current pandemic situation. This is also one way to ease the process of teaching and learning for school teachers and school children when they must conduct the face to face sessions in the classrooms.

ACKNOWLEDGMENTS

Appreciation goes to the former Campus Rector, Associate Prof. Ts Dr. Mohd Hisbany Mohd Hashim, for allowing the team to start the CSR project. Also, Tasek Gelugor Member of Parliament, Datuk Haji Shabudin Yahaya, who

contributed financially for the team to start the IM machine production of FSs.

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