To attempt the scope of contamination due to unavoidable touching of public surfaces within the educational campus mitigating the spread of covid infection

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Abstract. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is transmitted through close contact, air droplets, and contacting contaminated surfaces. Commonly touched surfaces in public places direct or indirect pose a greater challenge for the rapid transmission of the virus. This paper attempts to look into the scenario of disease transmission and to bring upon design ideas to create potential solutions that could help reduce the direct transmission of the virus. Participant observation is made among educational campuses in the Ahmedabad region along with expert interviews. The clusters for transmission were identified. Design ideations were made and the Pugh-chart method is used to evaluate design concepts based on usability, safety, feasibility, and affordability. The paper showcases some potential solutions to mitigate the spread of covid infection primarily among educational campuses while coming in contact with a positive surface.

Keywords: Design for Pandemic • Design Evaluation • De-Contamination

1 Introduction

COVID-19 is a viral respiratory disease caused by the virus SARS-CoV. It is transmitted through droplets through the air, direct contact with the person, or surface contact. In this project, we have researched how the transmission of viruses through contaminated surfaces poses a problem and how we came up with

potential solutions. The type of surface, temperature, humidity and UV radiation are all the major factors for the survival of the virus on public surfaces. The best way to prevent and slow down transmission is to be well-informed about the disease and how the virus spreads. However, by knowing these facts, we saw a lot of places on and around campus where we observed that the contamination was due to unavoidable touching of public surfaces.

In relation to the above-mentioned background information, the literature review is as follows. Acute respiratory tract infection due to SARS- CoV-2 is currently spreading rapidly worldwide and has become a public health concern. Since there is no definitive cure for SARS-CoV-2, all measures to supply public health rely on preventing the spread of the virus by droplets and close contact and contaminated surfaces [1]. Droplets and contact with contaminated surfaces are the most frequent transmission modes of COVID-19 [2]. One of the surfaces with high contamination risk is the door handle in any public area. [3]. Environmental measures can be used and are aimed at reducing the risk of transmission of SARS-CoV-2 to individuals through contact with infected subjects, objects, equipment, or contaminated environmental surfaces. [4]. Laboratory evidence suggests that SARS-CoV-2 can survive on dry surfaces and in aerosols for days to weeks, particularly on nonporous surfaces. Furthermore, SARS-CoV-2 RNA has been detected on surfaces and in the air in hospitals where COVID-19 patients are being treated [5]. Necessary precautions to prevent person‑to‑person transmission should be employed in clinical practice throughout the pandemic, and patients should be reminded to maintain good hygiene practices [6]. Direct contact with devices such as elevator buttons, beepers, telephones, computer mice, and keyboards can contribute to the spreading of viral diseases. 3D-printed objects such as door openers, door hooks, or button pushers can be designed and produced to intend to lower the risk of COVID-19 contamination [7].

This research aims to prevent the spread of the COVID-19 virus through the unavoidable touching of contaminated surfaces. The objective of this research is to develop a possible solution that helps prevent the spread of the virus through contaminated surfaces.

2 Methodology

The contextual inquiry is made by visiting a nearby village and observing the people and their lifestyles. We had interesting conversations with the villages and identified problems that could provide us with scope for research. We then conducted our contextual Inquiry in and around the Karnavati University campus.

During our study, it was interesting to note that some of the problems we identified in the college were similar to the ones identified in the village. Based on our findings and the observations made, we conducted a card sorting activity to group all the various observations made into categories as shown in fig.1. These categories formed the basis for us to choose the most prevalent problem at hand and frame the research statement. Based on the results of the card sort activity, we saw the problems majorly inclining towards health and sanitization of public surfaces. We then inferred our research statement accordingly.

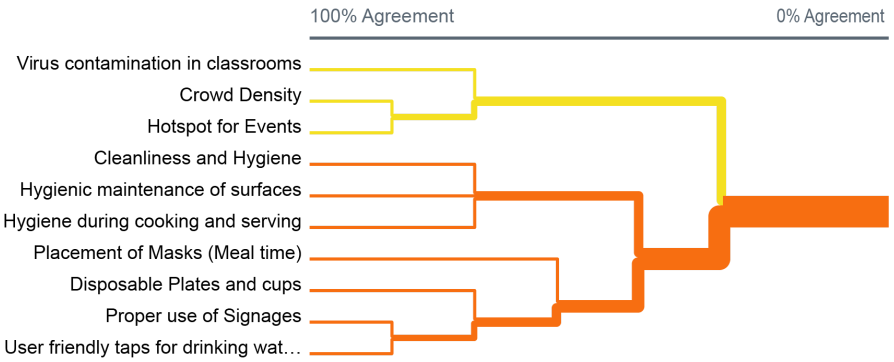


Fig. 1. Analysis of Card Sorting

Our interviewee is Dr. Devender Sardana who is a general surgeon practicing for more than 18 years. The key takeaway from the interview is that it takes 10-12 mins for the coronavirus to contaminate any surface. The virus lasts on the surface anywhere between 2hrs to 7 days depending on the type of surface. Improper sanitization and not using masks is the main cause of surface contamination. Our immune system also plays a major role in this context.

The research statement for the paper is summarized as to attempt the scope of contamination due to unavoidable touching of public surfaces within the educational campus mitigating the spread of the covid infection primarily among students.

The primary data collection is made on the field. The spread of the coronavirus through surface transmission occurs mainly when droplets from the infected person fall on a surface and an uninfected person touches that surface. The virus can survive on a variety of porous and non-porous surfaces. On porous surfaces, studies report an inability to detect viable viruses within minutes to

hours; on non-porous surfaces, viable viruses can be detected for days to weeks. The apparent, relatively faster inactivation of the virus on porous compared with non-porous surfaces might be attributable to capillary action within pores and faster aerosol droplet evaporation. [8] Covid Activity on Common Surfaces like paper is 3hrs, copper is 4hrs, cardboard is 24hrs, wood is 2 days, plastic is 2-6 days, stainless steel is 2-5 days, glass is 4-5 days and money notes are up to 4 days. The Centers for Disease Control advises that frequently touched surfaces and objects need routine disinfection. This includes door handles for interior and exterior doors that require users to pull to open. However, commonly touched surfaces like bathroom door handles and other door handles can't be disinfected every time they are touched [9]. According to Case Studies In 2014, a study done by researchers at the University of Arizona showed that just a single doorknob can spread germs throughout office buildings, hotels, and health facilities within hours. In that study, researchers applied samples of a virus to doorknobs and tabletops. Within two to four hours, the virus had been picked up by 40 to 60 percent of workers and visitors in the facilities and could be detected on other frequently touched objects. [10]

2.1 Brainstorming and Problem Solving

Based on the primary and secondary research conducted, we went on to prioritize a specific surface that we will be working upon. We decided to work on brainstorming solutions to minimize surface transmission of viruses through door knobs. Some of the existing solutions are studied as follows. Elbow Door Opener: Eliminates the need to touch or grab the handles of doors which helps in reducing the spread of germs/viruses and prevent cross-contamination. Accessed with the forearm of the user since it is the only part of the hand that is in the least contact with the face. It is fixed onto the doors [11]. Zero Touch Key: Easy and handy to carry. The key is in direct contact with the door knob to open/close the door. One end is used to unlock/lock doors. Another end is used for push/pull doors. Edge is used to press lift buttons [12].

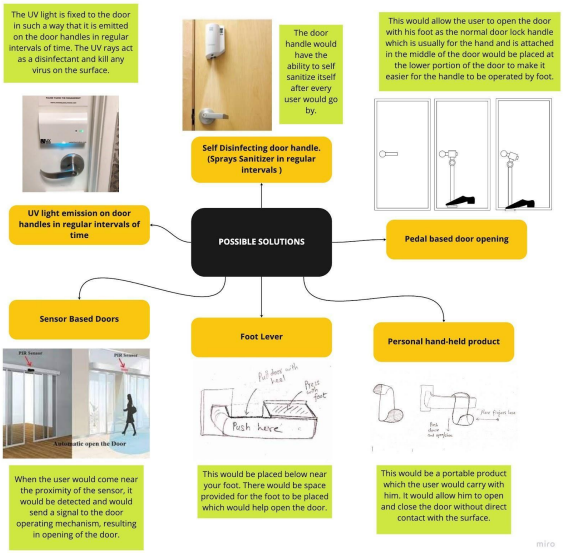


Fig. 2. Brainstorming on possible solutions

Based on the brainstorming as shown in fig. 2, we ideated a few possible solutions which could be potentially implemented. After consulting with the stakeholders and users, we then moved on to shortlist them based on their priority.

3 Results

The following shortlisted solutions are discussed ahead. The Foot Lever is attached to the bottom of the door as seen in fig. 3. The user presses the lever with a foot to unlock and uses the front portion to push the door away. The cavity in the middle is used to pull and close the door.

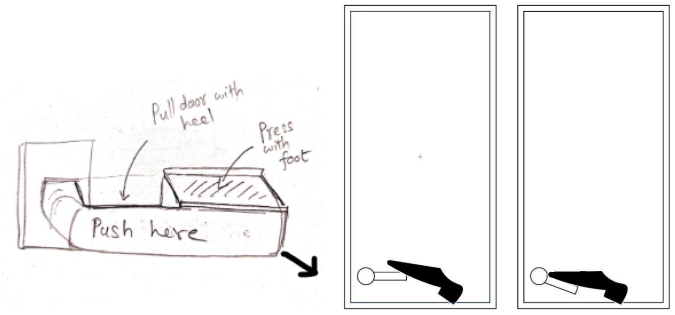


Fig. 3. Working of the Foot Lever

The Foot Pedal System is attached to the door handle as seen in fig. 4. Once the foot pedal is pressed downward, the joint helps the handle to move diagonally. This is easy to install and can be fixed onto most existing doors with a similar handle. It is also intuitive to use.

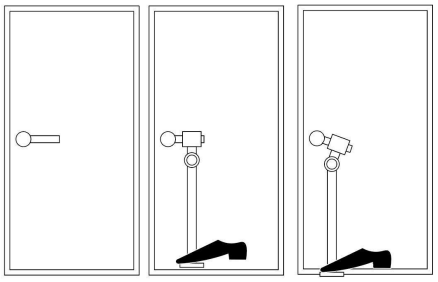
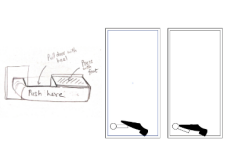
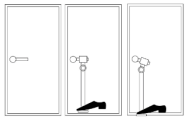
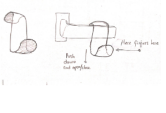


Fig. 4. Working of Foot Pedal system

Portable Door Opener: This is easy to carry in a pocket/portable. One end can easily grip onto the door handle and the other end grips fingers. Its wide surface enables users to provide more pressure while pressing. It can be used in all directions. It can be used for holding railings in a bus and holding other handles and rods. Opening car taxi doors.

User testing is done by adopting a weighted matrix tool known as Pugh chart. It is a useful decision-making tool that helps to evaluate multiple entities based on specific evaluation criteria weighted by importance. This helps us to choose which solution to go forward with based on direct evaluation by the users themselves as shown in Table 1. The scores given by the users also help in rethinking the design process and facilitate iteration. This enables us to come out with a well-performing product that is up to the user's expectations as shown in fig. 5.

Table 1. User testing weighted matrix by user 1

				
3 OPTIONS / 5 CRITERIA	Weightage	Foot Lever - ₹850	Foot Pedal - ₹1200	Hand-Held Personal device - ₹350
Ease of Use	0.2	20	50	80
Cost Effective	0.2	30	50	100
Safety	0.2	20	40	90
Problem Addressability	0.2	20	50	100
Portability	0.2	0	0	100
TOTAL		**18**	**38**	**94**

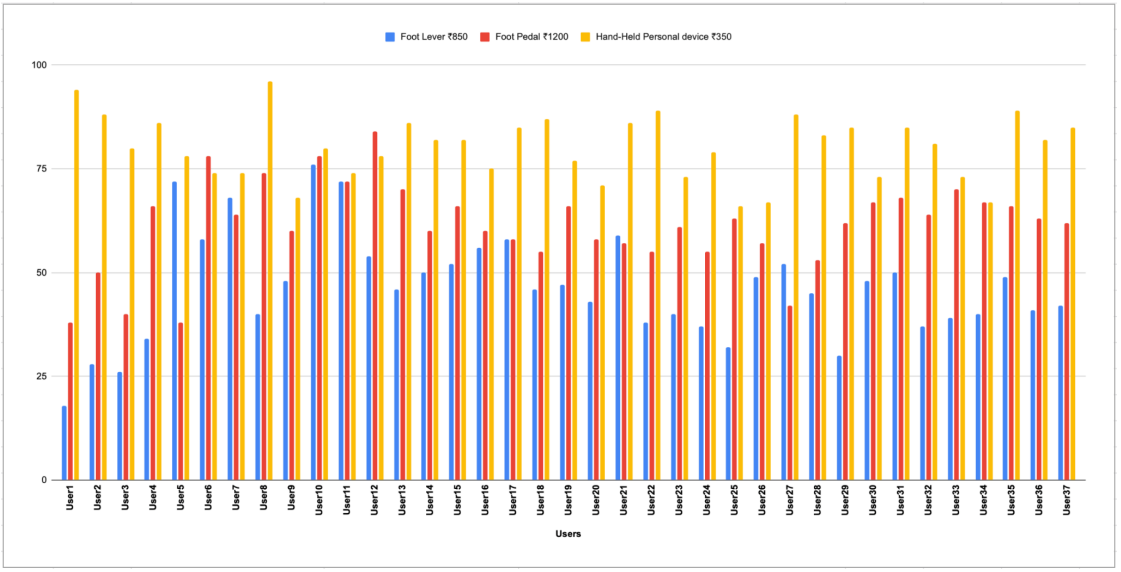
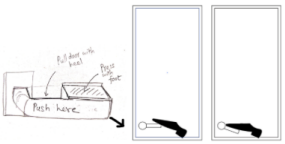
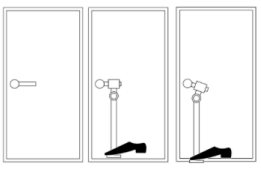
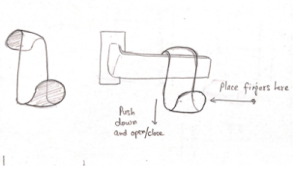


Fig. 5 . Bar graph of product comparison

We conducted a survey among 37 students in and around the educational campus who were selected through a random sampling method. The students are from different urban cities in India. They were asked to evaluate the three proposed concepts based on five criteria namely - ease of use, cost-effectiveness, safety, problem addressability, and probability. Table 2 shows the results of the weighted matrix along with the pros and cons.

Table 2. Results analysis of Pugh matrix

Concepts	Concept Illustrations	Description	Pros	Cons
Foot Lever		The user presses the lever with a foot to unlock. He uses the front portion to push the door away. Use the cavity in the middle to pull the door closed.	No direct contact with skin. Safe to use and convenient foot rest on lever to press open and close. Portable and can be easily installed on doors.	Less ease of use as users are required to balance on one foot and requires effort to turn open the lever. Not cost effective and can only be used for doors with a hand lever.
Foot Pedal		The foot pedal is to be pushed downward and the joint helps to press open the handle.	No direct contact with skin. Very easy to use with a push down motion. Can operate from both the side and front angle. Cost effective solution. Safe to use for all age groups.	Not easily portable. The foot pedal might be unstable and dangling if not fitted properly. Can get dirty easily. Can only be used for doors with a hand lever.
Hand-held personal device		One end easily grips onto the door handle and the other end is used to grip fingers. Its wide surface enables users to provide more pressure while pressing. It can be used in all directions.	Very safe ,easy and intuitive to use. Highly cost effective. fantastic problem addressability. Easily portable and can be carried in a pocket or pouch. No direct contact with skin.	Difficult to grip onto large door handles.

In our survey, we identified that the highest value which was 62.7% was given to the handheld device by the users. While 12% was given to the Foot lever and 25.3% to Foot Pedal.

4 Conclusion

Designing a physical intervention as a user-centered portable door assistance device as shown in fig. 6 to facilitate the opening and closing of doors to minimize human contact with public surfaces and therefore reduce the spread of COVID-19 through contaminated surfaces.

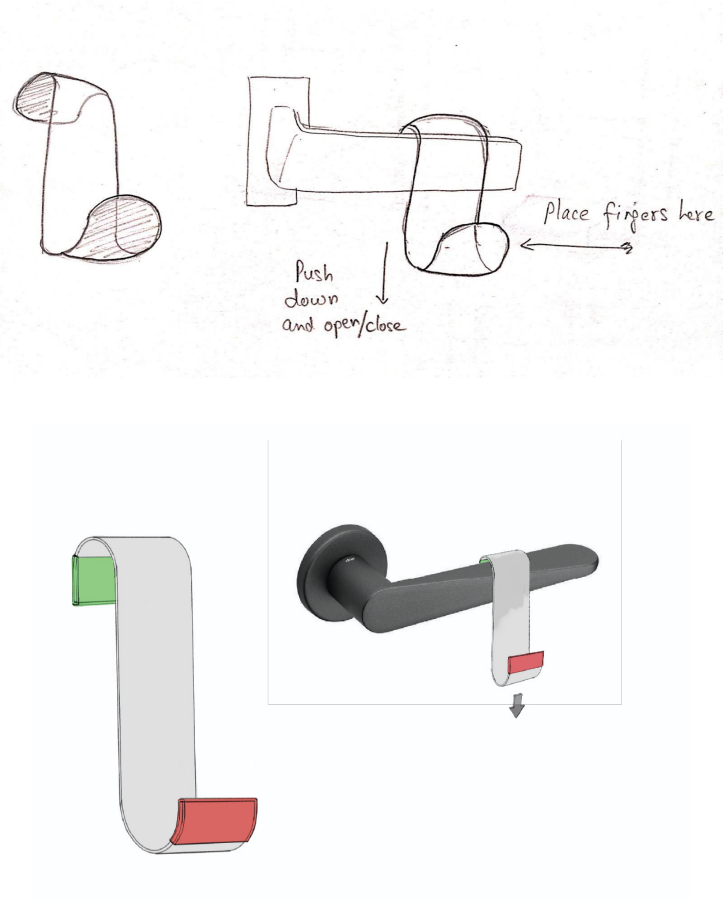


Fig. 6. Basic solution sketch

Product Description and Features: Easy to carry in a pocket / Portable. One end can easily grip onto the door handle and the other end for grip fingers. A wide surface enables users to provide more pressure while pressing. Can be used in all directions. Used for holding railings in a bus. Used for holding other handles and rods. Opening car taxi doors It is an intuitively usable product. It proves to be very easy to use for all age groups and can resonate with a wide variety of audiences. One end of the product is used to grip onto the surfaces such as door handles and railings while the other end is where the user holds and applies pressure to press open the door. There is a clear distinction for both these ends so that only one of them comes in contact with the surfaces. It is a cost-effective product and very easy and handy to carry.

Research on the spread of COVID-19 and its transmission through surfaces has given us the scope to learn and come up with potential solutions. The portable door opener is the outcome of layers of research techniques applied to bring out a product that is the need of the hour and meets the expectations of the user.

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