Designing a ramp for canteen accessibility

Project Work 2018

Group 11-02

Ng Rei Shuen 3O1 (17) (L)
Bryan Ng Luo Yi 3P2 (02)
Khoo Sheng Feng 3A3 (16)
Low Jun Hao 3P1 (18)

Hwa Chong Institution (High School)

Abstract:

The aim of our project is to improve the accessibility of our school canteen. Due to the current design of our canteen, the only path from the collection area to the washing area is bound by a flight of stairs, hence canteen vendors have to lift the full weight of the buckets (ranging from 10 - 20 kg) of cutleries up the stairs daily. The act of bending one's back to lift objects causes numerous long term health implications [1], which we would like to mitigate. Hence, our proposed solution would be a ramp which the canteen vendors would use to transport the buckets of cutleries with. Our initial design was a temporary ramp which lay along the steps of the stairs, however it was unfeasible due to the steepness of the stairs which did not comply with the Building and Construction Authority's (BCA) safety regulations. Hence, our current solution would be to install a permanent concrete ramp with a gradient of 1/12, following BCA's requirements. We took measurements and created an accurate 3D replica of the canteen, trying out various orientations of our ramp. We concluded that due to the physical constraints of our canteen, minor hacking of the canteen would be needed for the installation of the ramp. This ramp would fit the dimensions of a wheelchair ramp, allowing for the usage of the ramp by persons with mobility issues. This would make our canteen more accessible and also solve our problem of helping the canteen vendors with their work.

Introduction:

Initially, our project was centered around helping the school canteen vendors with the transportation of cutleries. In our school canteen, used cutleries are placed in buckets at the collection area. We observed that these buckets are then transported to the washing area behind the canteen stalls at certain periods in the day, usually up to 3 - 4 times a day. For our study, we based it around the Stall 2 (purple plate economical rice) canteen vendors. Upon interviewing them, we realised that the canteen vendors have been taking on the same job at Hwa Chong Institution for the past 30 years. We have also come to the understanding that a portion of their job which includes the transportation of buckets is indeed a tedious and strenuous task [6], with some of the canteen vendors revealing to us about the back aches they go through on a regular basis. This is due to the cutlery collection area being on a lower floor than the washing area (Fig 1.1), resulting in the need for canteen vendors to lift the bucket up a flight of steps. We analysed their lifting form and found that they were lifting the buckets with an improper lifting form (Fig 1.2). This habitual motion may eventually cause long term health implications. However, the problem of back strain cannot be solved solely by correcting their lifting form as they would still have to bend down to pick up the buckets [7], which weighs about 10 - 20 kg (Fig 1.3). Ultimately, the full weight of the buckets are still resting on their spine. Hence we came to the conclusion that providing them with the proper equipment to aid them in transporting the buckets would be the best solution for our identified problem [5]. Initially, we angled our design of the ramp around the flight of stairs (Fig 1.4), hoping to implement a ramp which followed the gradient of the stairs and is foldable[8]. However, upon further consultation with the school's estate officers, we understood that given the strict regulations set by the BCA, our prior design (Fig 1.5) had to be ruled out as the gradient of the stairs were too steep (stairs gradient: 1/3).

We had further discussions with the estate officers and came to the conclusion that building a permanent concrete ramp which followed BCA requirements would be the best solution. BCA requires any constructed ramp to be at least 1:12 in dimensions. This translates into a ramp with a gradient of at least 1/12 which is a slope gentle enough for wheelchair usage. Through the ideation of our project, we realised that an idea created initially to help the school canteen vendors could also benefit those with mobility issues. This multipurpose ramp can be utilised by both the canteen vendors as well as wheelchair users. The implementation of this ramp would require minor hacking and reconfiguration of the canteen but as a first step to making HCI a more accessible campus, we believe that the benefits of the ramp would outweigh the cost and effort put into constructing it.

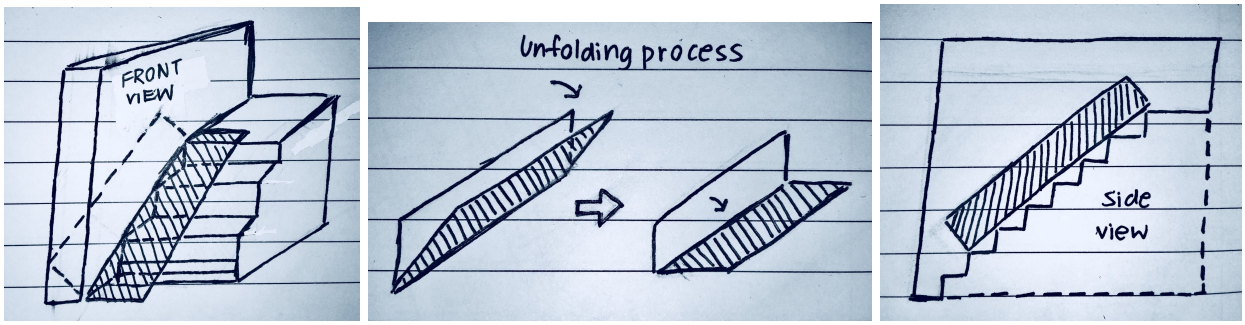
Figure 1.1: Cutlery collection area

Figure 1.2: Lifting form of Stall 2 canteen vendor

Fig 1.3: Weight of buckets

Fig 1.4: Initial target staircase

Fig 1.5: Initial proposed design



Solution design

BCA requirements :

Firstly, the prerequisite to building any structure is safety regulations. In this case, the Building Construction Authority (BCA) of Singapore does enforce construction rules on any construction project within Singapore. In the context of accessibility ramps, the BCA has drafted a “code on accessibility” document, which states the minimum safety features of a ramp [3] . A minimum gradient of 1/12 is required with a ramp of run not more than 9 m (Fig 2.1), and compulsory landings of dimensions 1.5 m by 1.2 m are required at the top and bottom of each incline (Fig 2.2). In addition, handrails are a necessary safety feature of a ramp, with a minimum height of 80-90 cm above the surface of the ramp. These were all guidelines that we followed strictly when planning our ramp design.

Fig 2.1 :

Gradient of ramp	1:12 – 1:14
Intervals (maximum length of horizontal run in metres)	9

Figure 2.2 :

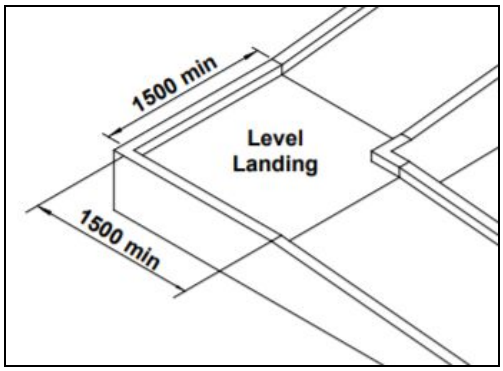
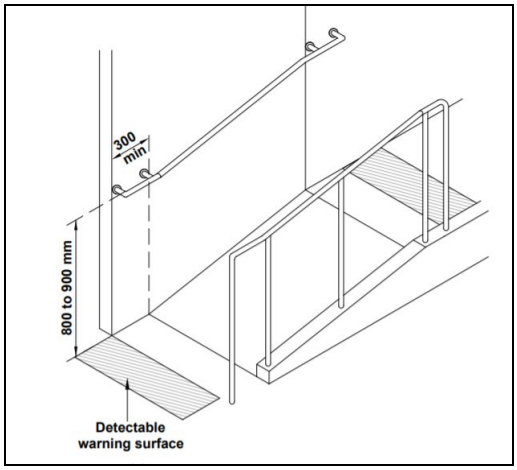


Figure 2.3 :



Prototype designs :

Working to design a permanent concrete ramp, we had to ensure that our ramp could fit within the physical constraints of the canteen. Hence, we decided to build a 3D model to accurately test different orientations and ramp designs (Fig 2.4). Due to a lack of a specific floor plan (Figure 2.5), we carried out fieldwork which involved taking various measurements of different parts of the canteen, recreating it as accurately as possible.

Following all BCA requirements as mentioned before, we embarked on our prototyping phase. With the main factors for consideration being the ramp's design and orientation. Our prototypes also take in other factors into account , all with the final goal of allowing for the most efficient flow of human traffic (Fig 2.6) , in other words, providing the most convenience to its users.

Figure 2.4:

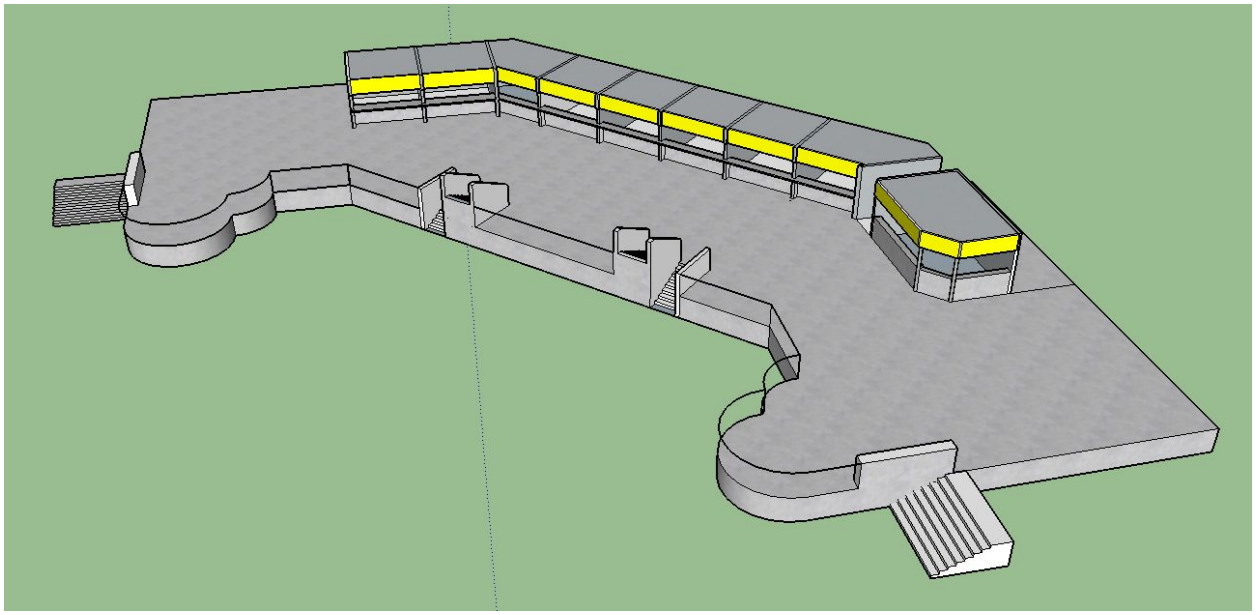


Figure 2.5: Floor plan of the high school canteen

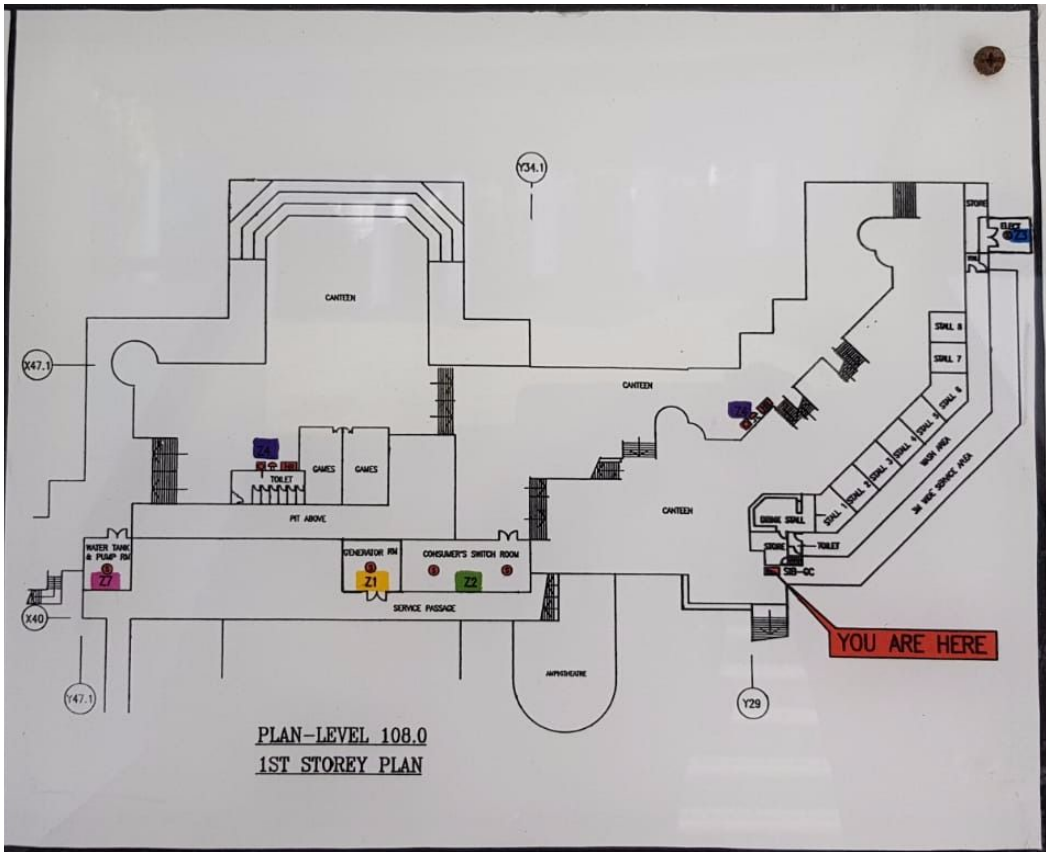
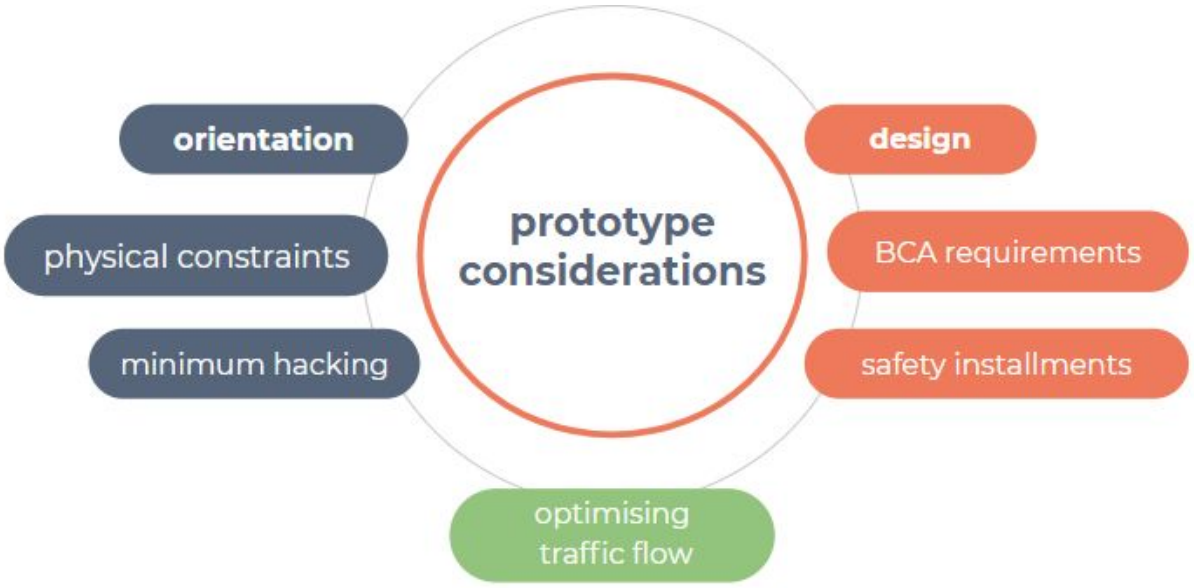


Figure 2.6 Factors taken into consideration:



Ramp design and dimensions :

Our final design followed the BCA's dimensional requirements of a ramp, one with a rise to run ratio of 1 : 12. To properly fit the physical constraints of our canteen, we decided to design a two fold ramp, with each inclined surface of the ramp having a rise of 0.5m and a run of 6.0m. The two inclines of the ramp were accompanied by landings of 1.2m x 1.5m on the top and the bottom of each incline. Hence, this results in a ramp with a total run of 9.0m, a height of 1.0m and a width 2.4m (Fig 2.7) Handrails are also an integral safety feature of a ramp, and hence will be included. Taking into consideration factors such as durability, maintenance cost and overall aesthetics, we have designed the handrails to be made of aluminium or steel. Anti-slip is not a necessity for indoor ramps as according to the Singapore standard, SS 485's regulations [2]. The final ramp would look like the one designed in Figure 2.8.

Figure 2.7 Ramp structure :

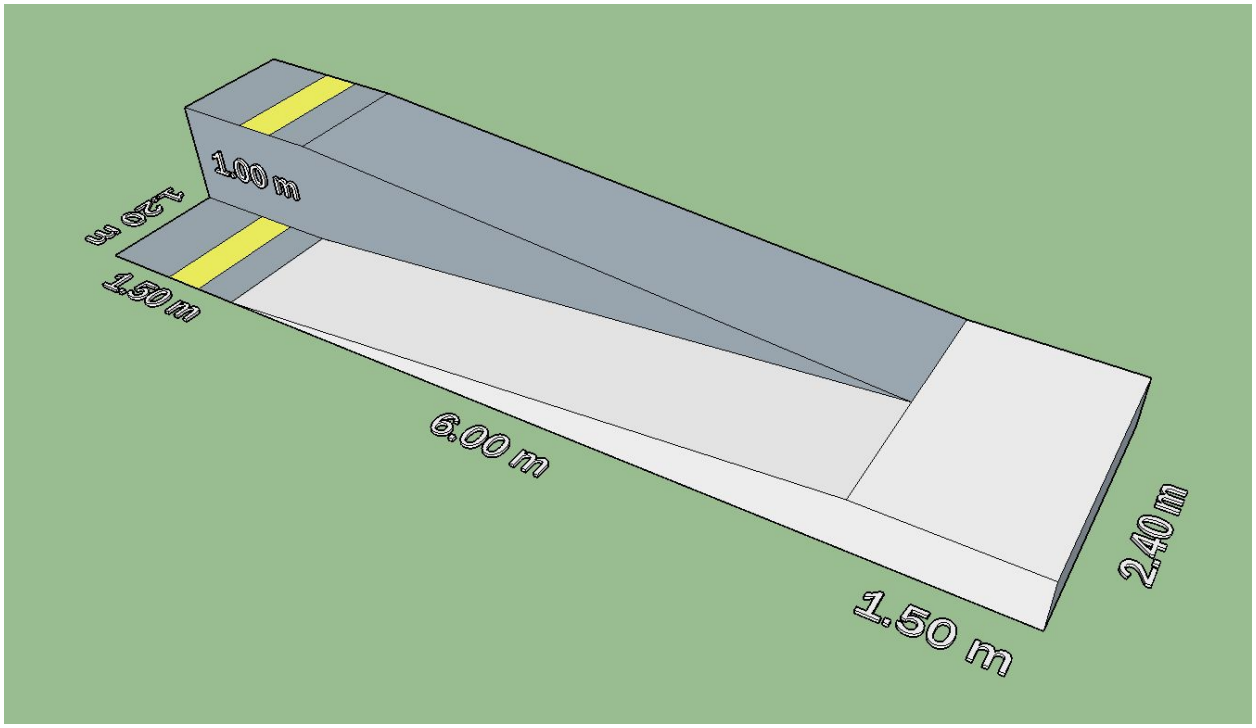
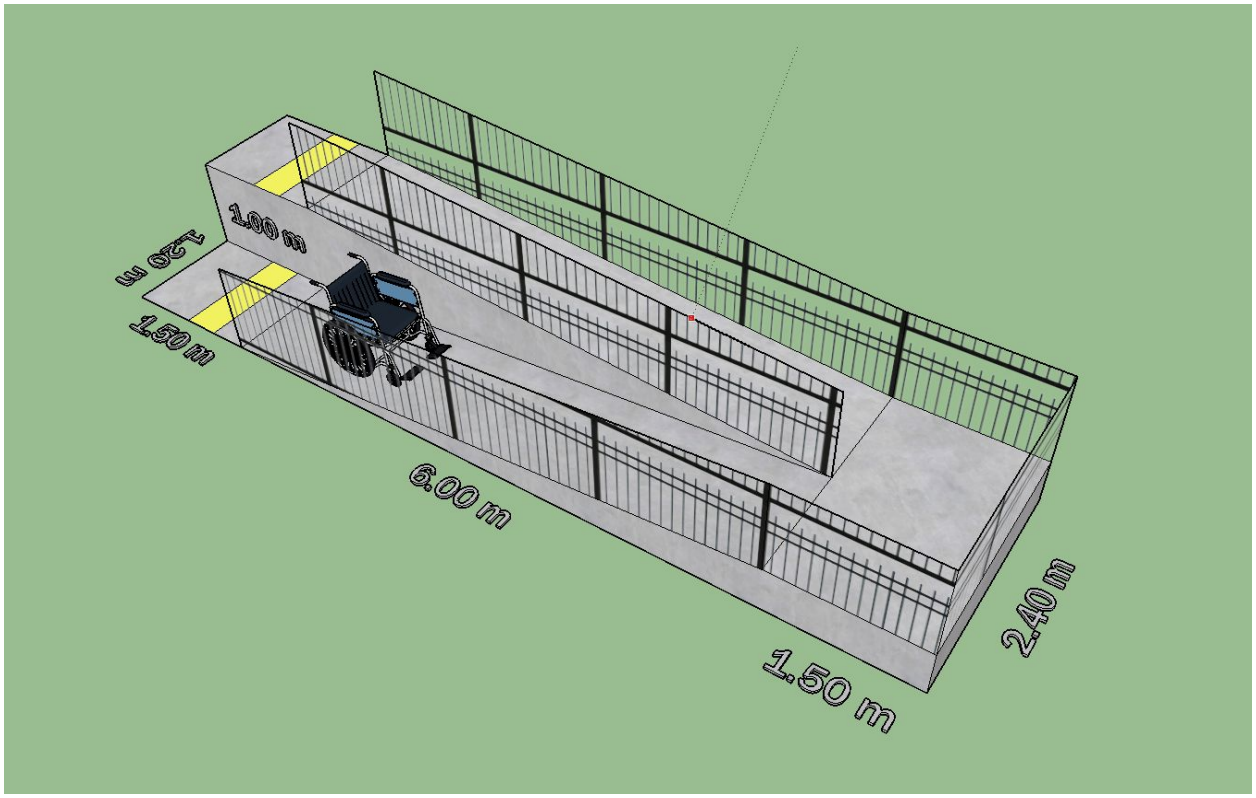


Fig 2.9 Final ramp design:



Ramp position:

With the limited amount of spaces viable for the placement of a ramp within our canteen, we had to weigh the pros and cons of various ramp positions, based on the criterion of optimising human traffic flow. Hence, to position the ramp for the maximum convenience to its users, we have decided to position the ramp at the right side of the canteen, as it is closer to majority of the canteen stalls as well as the main entrance of the canteen. (Figure 2.9) Being closer to the main entrance of the washing area which is most commonly used by vendors, it will provide a shorter walking distance from the cutlery collection point to the washing area, hence bringing convenience to the canteen vendors. Furthermore, by being closer to the main entrance of the canteen where HCI students and staff usually enter the canteen from, would provide any student, staff or guest with mobility difficulties with an accessible. Hence benefitting both the canteen vendors and people with mobility difficulties visiting the canteen.

Figure 2.9 Canteen, post construction:

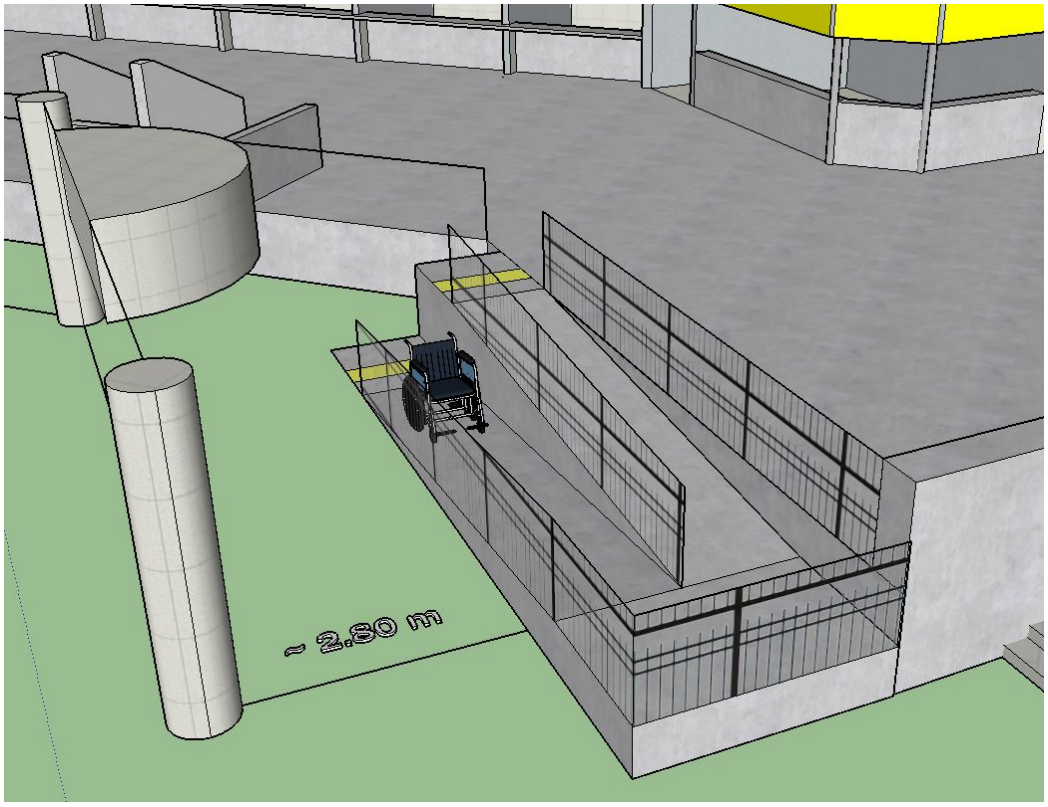
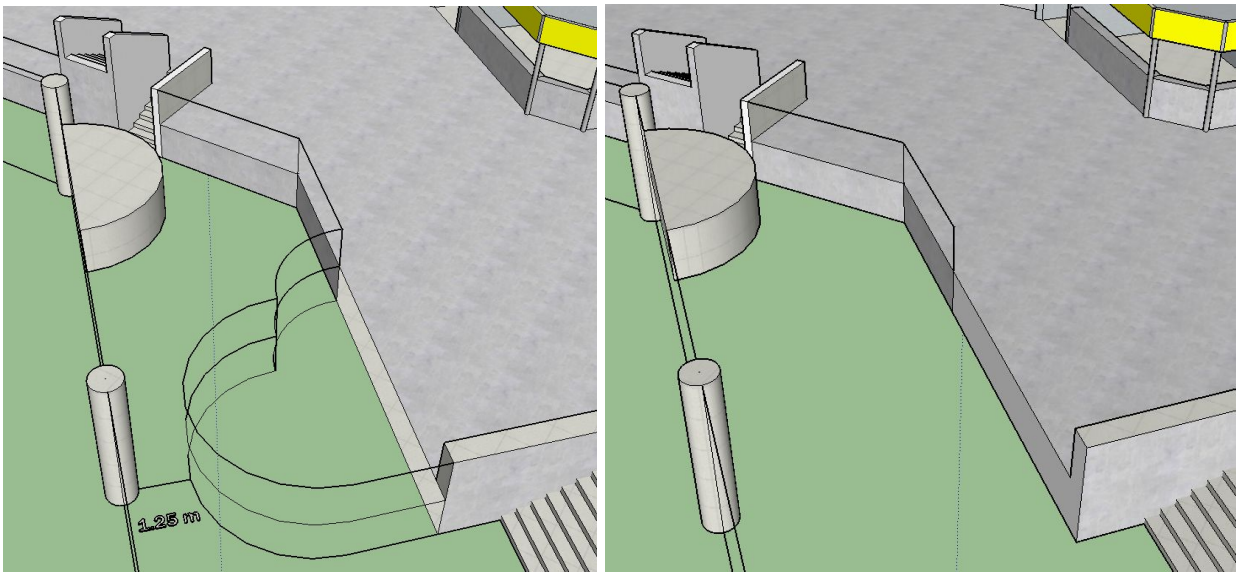


Figure 2.10: Phase 1 (Before intervention/ Original look)

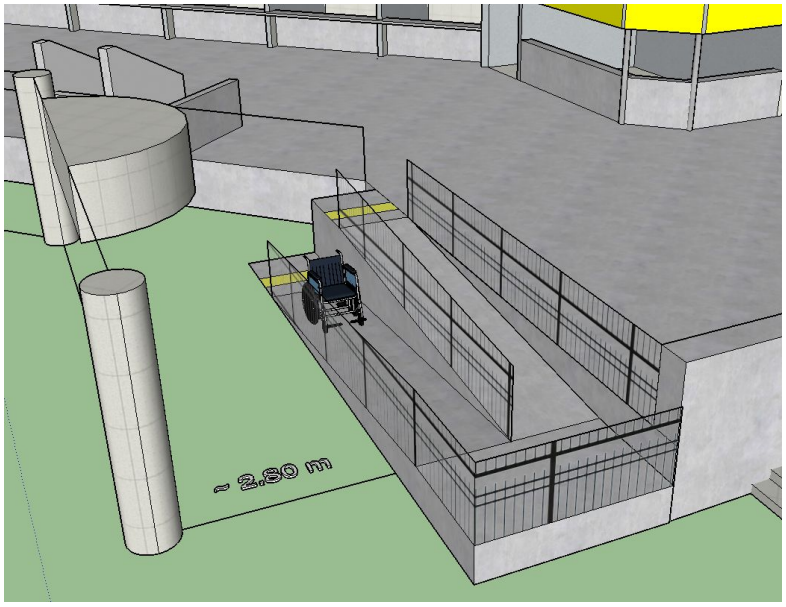
Phase 1 shows the state of the canteen before any hacking is carried out. An important detail to note is that the walkway is currently only 1.25 m wide. Hence, the walkway is quite narrow.

Figure 2.11: Phase 2 (Hacking and end product)



Carrying on to our next phase, the physical constraints of our canteen has brought about the need for hacking a certain portion of the canteen. A concrete chunk of about 18.0 m^3 is hacked and the end product is a smooth surface, contrary from the arcs that were present prior to hacking. The walkway width is also increased.

Figure 2.12: Phase 3 (Post-construction)



Finally, phase 3 shows the canteen after the installation of the ramp. An obvious increment of corridor space, to around 2.5m is observed (Figure 2.12) after the construction process of the ramp, which is a change that benefits the optimisation of human traffic. Furthermore, as seen in the model, the ramp is clear of any type of ceiling that might be of obstruction.

Results & discussions:

After consultation with the estate officers, it was made known to us that the entire process would take anywhere from 9 to 12 months. This includes the time taken to submit an application to relevant authorities before and after building the ramp as well as the time needed to hack the canteen and build the ramp. Also the estate officers also told us that the project would cost around $80 000.

Through consultations with the estate officers, they surfaced several limitation of our project, providing us with an insight on the details and the background work that has to be carried out for the implementation of a ramp. One limitation our project face is that it cannot be built within the course of our project or within. An estimated timeframe of about 9 months to a year to complete the project is one of the problems, as such construction plans have to be submitted directly to the BCA, often taking 4 - 6 months to be vetted and approved. The canteen would have to be closed for about 2 months for construction, which might affect the canteen vendors' business and those who frequent the canteen such as students and staff. Outsourcing our project to external vendors

and hiring an overall consultant is mandatory. However, these take time and money. With an estimate provided by the estate officers, it would cost about $70,000 to $80,000 [4,5].

Much rearrangement within the current canteen will be needed, especially for the tables, chairs and the metal containers of stalls 1-4, which are currently in the place of the desired position of the ramp, too. Events and sales may be disrupted by the construction process of the ramp. For example, the table allocated to the Parent Support Group (PSG) sales would need to be reallocated. This brings about much change to the canteen as a whole.

Pertaining to the design of our ramp, we have carried out a case study on MRT ramps (Figure 3.1) and neighbourhood ramps created for elderly residents. We found that these ramps have an average gradient of 1:12.5 and an average width of approximately 1.3m. Thus, our ramp is to an extent, largely similar to those we have studied. MRT ramps are usually built in spatial constraints and are compact yet practical. Such qualities were needed for our ramp, hence the two fold design of most MRT ramps proved to be a space efficient design for a ramp. Hence on the basis of our fieldwork, we determined the effectiveness of our proposed solution.

Figure 3.1:

Conclusion:

From the beginning, our problem identification is a significant part of our project. As we embarked on this journey, we found out that not many people realised the seriousness of our problem identified. Everyday, the canteen vendors serve food for students and staff. Everyday, they carry the heavy buckets filled with plates and cutlery. Everyday, we see them when we buy food or even when returning our plates and cutleries. However, very few recognise that the canteen vendors place so much stress on their health, especially their backs by serving the school population, even after many years of service here in Hwa Chong. A vital aspect when identifying this problem and embarking on this project is also the development of empathy for the group of people who have provided service for a high population for a long period of time.

Another significant point is complying with the BCA's requirements of a ramp, for it to be wheelchair-safe. Beyond this, it is about taking a step towards being a wheelchair-friendly society, where most if not all places are accessible for the wheelchair-bound citizens. This may allow for a more cohesive society where there is less discrimination around and equality is achieved.

In addition, when we researched and studied on the feasibility of building a ramp in the canteen, we uncovered flaws within the design and structure of the canteen. To begin with, there is not a ramp in the canteen to facilitate transportation of the buckets like at the Hwa Chong Junior College canteen. Next, there is limited space in the canteen which leads to less options for the positioning and construction of the ramp. Much space cannot be utilised for the ramp as blockage of the walkway for students and staff will occur. Finally, the metal containers which are used to store the buckets for plates and cutleries cannot be moved to the top level as it significantly reduces queuing space for the students and the staff.

In conclusion, we aim to provide an effective solution that mitigates the problem and hope that our study would be of much assistance when considering this method in solving the problem. This is because the school has the final say in the construction of this ramp. Despite the costs in terms of time and money, we strongly believe that they are worth is as the long-term benefits that this ramp would provide outweigh them.

References:

1. Lerche, O. (2017, November 06). Back pain symptoms - THIS could be a sign your fcondition is SERIOUS. Retrieved from https://www.express.co.uk/life-style/health/800789/lower-back-pain-symptoms-side-serious
2. Singapore Standards eShop. (n.d.). Retrieved from https://www.singaporestandardseshop.sg/product/product.aspx?id=78cf2f27-0720-4b97-bbb8-a75dbb04cfca
3. BCA Code on Accessibility in the Built Environment 2013. (2013, August). Retrieved June 4, 2018, from https://www.bca.gov.sg/BarrierFree/others/ACCESSIBILITY_CODE_2013.pdf
4. Parker, M. (2018, March 08). What to Know Before You Tear Down That Wall. Retrieved from https://www.houzz.com/ideabooks/21682450/list/what-to-know-before-you-tear-down-that-wall
5. Learn About Force And Its Effects On Objects In Motion. (n.d.). Retrieved from https://www.hopespeak.com/learn-about-force-and-its-effects-on-objects-in-motion-m2d1779i1333
6. Hazards and risks associated with manual handling in the workplace. (n.d.). Retrieved from http://www.osha.mddsz.gov.si/resources/files/pdf/E-fact_14_-_Hazards_and_risks_associated_with_manual_handling_in_the_workplace.pdf
7. Centre for Occupational Health. (2018, August 03). Back Injury Prevention : OSH Answers. Retrieved from https://www.ccohs.ca/oshanswers/ergonomics/inj_prev.html

---

Acknowledgements:

Our mentor, Dr Kelvin Tan for his support, patience and guidance. Even when we made mistakes, he continued to mentor us well and lead us from a stage to another without much problems.

The estate, Mr Ng and Mr Koh for their valuable advice and lending us a helping hand in this field of study where we have inadequate knowledge.

The teachers for their constructive feedback and criticism especially about areas for improvement.

The SRC lab staff for providing facilities and aiding us in constructing our prototypes.

The canteen vendors for participating without hesitation in our interviews and helping us with our research.