*Children waiting for food.* *Fig. 1*

*Source: newseastwest.com*

## 2. Introduction :

India, a country with a population of over 1.2 billion people, has witnessed massive economic growth over the past few decades driven by the expansion of services. Inspite of a whooping increase in the Gross Domestic Product (4.5 times) and per capita consumption (3 times) in the past two decades, according to latest FAO estimates in 'The State of Food Insecurity in the World, 2015' report, 194.6 million people are undernourished in India and is the home to the largest hungry population in the world (15.2% of the population)[2]. One third of world's hungry live in India and it ranks 63 among 88 countries in global hunger index. With around 3,000 children in India dying every day from poor diet related illness [2], the food grain production reveals a completely different picture. India ranks first worldwide in farm output [3], largest producer of milk and second largest producer of wheat, rice, sugar, groundnut and inland fish.

Comparing these two disjoint set of facts it can be concluded that producing adequate amount of food does not guarantee food or nutrition security and is not the only criteria to eliminate hunger.

## Different stages of food waste :

Food supply chain is a set of processes the food goes through from the farm to the end users and every stage involves a certain amount of food waste. Agricultural production is the first phase of the supply chain where waste and losses result from mechanical damage, where farming equipment accidentally damage the fruits and vegetables. It also includes spills and attacks by insects and other diseases. Losses on animals resulting from diseases and deaths during breeding also fall under this category. Harvest, post harvest handling, storage losses results from handling of the food during harvesting, storage and transporting of the produce from farms to the processing centres. In India about 21 million tonnes of wheat annually perishes due to inadequate storage and distribution [26]. Processing like peeling, slicing, boiling, sorting, pasteurising, canning, smoking and salting also adds to the waste count. While distribution in wholesale and retail shops, foods reach their expiry dates and get thrown away. The final stage of food waste is by the consumer which involves pre and post cooking wastes. This project deals with the final step of food waste, i.e. leaving food on plate.

*Onions rotting in cold storage.* *Fig. 2*

*Source: ft.com*

*After a marriage ceremony in Srinagar.* *Fig. 3*

*Source: news.nationalgeographic.com*


*Chutneys from farm rejected fruits and vegetables.* *Fig.5*

*Source: rubiesintherubble.com*


*Solidarity Fridge, Spain* *Fig.6*

*Source: eyeslikeplates.com*


*Love Food Hate Waste Campaign, UK* *Fig.4*

*Source: ace.org.uk*

Multiple attempts have been taken to address food waste problem in different stages. Food and Agriculture Organisation (FAO) [27] has started a global initiative on Food Loss and Waste Reduction. Other initiatives include Farm to Family (USA) [31], Love Food, Hate Waste (UK & Australia) [28], Solidarity Fridge (Spain) [29, 30], Rubies in the Rubble (UK) [32], tray-less cafeterias (USA and Canada) [33] and many more.

While these solutions to reduce wastage is working well to manage unused or excess food in different stages, leaving food on the plate is a behaviour that needs to be changed at an individual level. Behaviour theories and persuasive design techniques were studied to understand the psychology of people.

## Interactive Installations :

Erika Suderburg has defined installations as “The art form that takes note of the perimeters of space and reconfigures it”. The definition was further extended by Suderburg and Rush as “physical interfaces (often on a large scale) involved in digital technologies that can reconfigure a space”. It facilitates both physical and emotional engagement of the audience and has created a strong impact on the HCI community [5]. The audience are referred to as ‘spect-actors' (Fig. 9), as they both observe and act [6]. According to Gaver et al. users can enjoy voluntary interaction and often obtain a deeper level of understanding of the system through ambiguous interactions (Fig. 7).

The parameters to be considered when designing proactive contextual interventions in a public space are the location, prominence of spectacle, length of interaction and spatial distribution of focal points [7]. These focal points are areas of the technology embedded into the reconfigured environment that are appealing, having a higher likelihood to grab the audience's focused visual attention [8]. In [7], the authors have broadly categorised interactive installations as Performative, Immersive and Ubiquitous. While in performative installations, the audience assume temporary roles for themselves [9], people's attention is centred on the environment itself as opposed to 'audience as performers' in ubiquitous installations [10]. Immersive installations involve physically involved spaces and enables embodied interactions. In incidental installations, interaction between the installation and the audience can become active if the viewers realise that they are affecting the behaviour of the installation (Fig. 8).

*Please Smile* *Fig.7*

*Source: Hye Yeon Nam 2012 CHI Conference, Austin*

*A Delicate Agreement* *Fig.8*

*Source: Designing the Unexpected, TEI 2015*

*Access* *Fig.9*

*Source: Marie Sester, 2003*

Understanding the nature of public engagement with the installations is of utmost importance for their successful design given both the physical properties and social context of a location [11]. Authors in [7] have described honey pot effect as a phenomenon of how even one person's attention would attract other people to a large display which contributes to the social aspect of interactive installations, which can be leveraged while designing a performative installation. Flat arrangement creates the largest honey-pot effect while a hexagonal arrangement allows strangers to comfortably engage in interaction on adjacent screens [7].

Engagement of audience and passers-by are critical, specially when the installation is meant to invoke critical thinking [25]. It can be classified into initial and ongoing engagements and the former can be invoked by honey pot effect. Social situations where a participant engaged in interaction is not just interacting for themselves, but is also performing for an audience and is encouraged and motivated by their reactions. Social learning occurs only if spectators can see the effects of participants' actions on the screen and is strongest when both the manipulations and the effect can be seen [11]. The incidental and performative installations were designed keeping in mind the effects of space, social influence and engagement as discussed above.

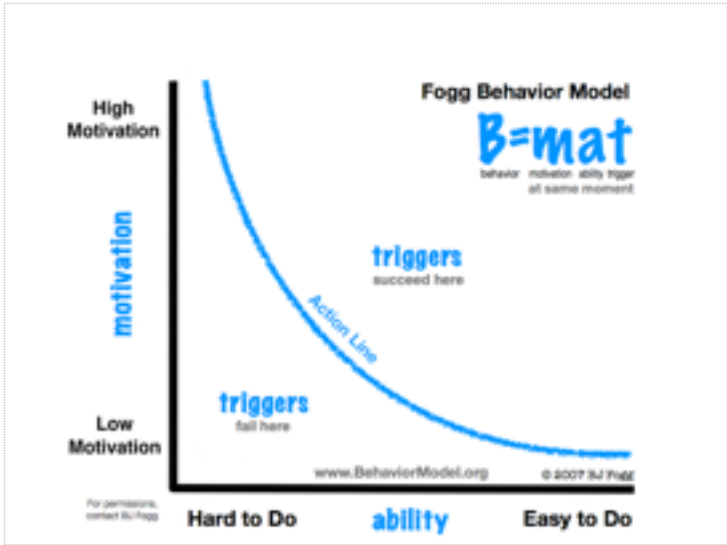
## Behaviour Change as a HCI problem:

Researchers in HCI and behavioural science are increasingly exploring the use and importance of technology to support behaviour change in various domains such as health (Fig. 10) and sustainability [4]. HCI researchers use behavioural theories mostly to make design decisions about the technical systems, to guide qualitative evaluation and to define target users [4]. In this project, behavioural theories were primarily used to address design of the installation and the space surrounding it. The topic is discussed in details in section 4.

Behaviour change and interactive installations have extensive literature which is further explored in section 3. The project started with literature review and understanding of existing work in in behaviour change, interactive installations and food waste. Secondary research was followed by user studies, which involved talking to the different stake holders of the mess and the insights collected were incorporated in the initial design ideas. Two pilot installations were put up to test the hardware, understand the logistics and layout of the mess and to get initial feedback and suggestion from the audience. Based on the feedback, the final installations were put up in two different messes, a performative and an incidental interactive installation and evaluated using statistical tests for parametric data.


*Piano Staircase* *Fig.10*

*Source: raisingthevolume.com*




*Fogg's Behaviour Model* *Fig.16*

*Source: www.behaviormodel.org*

## 3. Literature Review

Classical economic theory considers human beings as rational. Thus, human beings can act according to their own self interest regarding economic and sustainability decisions without external intervention. But in real life, human behaviour is mostly irrational and deviates extensively from the ideal [15]. Behavioural economists suggest that humans are not only irrational, their irrationality is highly predictable. Informing people about their own behaviour can improve the quality of rational decisions [12].

In multiple instances, behaviour occurs without conscious evaluation and is performed as a routine. These automatic behaviours in form of routines become habitual and are performed without active thinking. Habitual behaviour occurs when there has been a high- frequency history of the behaviour [12]. People do not pay much attention to food waste and it's disposal as they perform it as a routine task [14, 20]. In [12], the authors suggested a design approach of raising awareness through social influence and aversion effect, a two-way persuasive technology using cameras to capture and share pictures of the waste on an online social network. This results in self reflection and causes 'feeling of shame' due to social influence. The experiment was carried out within a closed homogeneous group. The system did not change their behaviour outright, participants believe that their recycling behaviour was as good as it possibly could be and that, as such, a persuasive system could not impact on their attitudes or behaviours.

Fogg's behaviour model [18] for persuasive design talks about the three factors essential to bring about a behaviour change, namely ability, motivation and trigger. In case of food, while individuals mostly possess the ability to reduce waste, they might not be

motivated to change their food waste behaviour. If individuals have both ability and motivation, placing and timing an effective trigger near the target behaviour location might induce the desired behaviour change.

Consolvo et al. [21] derived eight guidelines for designing technologies for lifestyle change. Such technologies, according to Consolvo et al., need to be abstract and reflective, unobtrusive, public, aesthetic, positive, controllable, comprehensible to users, and include historical data.

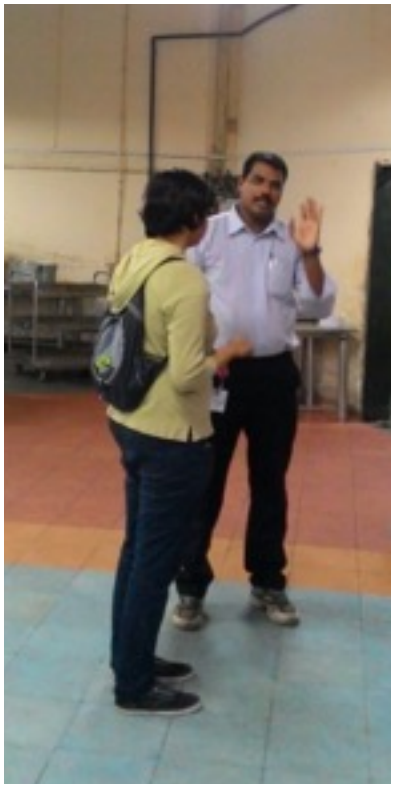
'Design with Intent' (DwI) [34] is another more recent approach where certain patterns help designers to 'Design for Behaviour Change'. 'Change the campus with fun' [17] is an implementation of DwI, implementing 'fun theory' in their service design, taking into consideration the social and sustainability factors. It suggests that gamification can induce playful triggers, which will not only help to achieve target behaviours but also make it habitual or customary. Awareness raising has also been identified as a key stage in the processes of behaviour change [13] as it stimulates self-reflection.

Ybarra and Trafimow [22] suggest that increasing a person's sense of group membership results in higher correlations between social norms and behavioural intentions and can be understood in terms of "social influence". Behavioural change also occurs through normative social influence, where the individual is motivated by the desire to obtain social approval and avoid rejection by others [23]. However, in such cases, individuals can behave superficially to comply with the social norms when under social surveillance. This might not result in true internal change in behaviour.

According to Fogg et al., persuasion should neither be coercive, nor manipulative or deceitful, but allow individuals to remain in control of their own actions [24]. Thus, persuasive technologies primarily reward individuals for performing desirable behaviours and avoid giving negative feedback to the users. While the use of coercion in persuasive technologies has been questioned and excluded by Fogg et al., Kirman et al. [] and Foster et al. [] have argued that constructive aversive feedback and light forms of punishment might not disengage users and can support behaviour change. However, the coercive strategies need to be designed carefully such that it does not threaten or intimidate the user.

Installations can act as an appropriate medium to trigger a signal or motivate people [18] to behave in a certain way. Instead of mandates, 'nudges' are often considered to be a soft, unobtrusive type of influencing people to change their behaviour [16]. 'Libertarian Paternalism' as coined by Thaler and Sunstein, suggests a suitable way of 'nudging' people, thereby helping them to use their 'Reflective System' of thinking (Rational, Controlled, Self-aware, Rule-following) while decision making. Installations can be used for playful persuasions [19], and are mostly non intrusive in nature. Hence, use of installations as a medium is a potential option for designing for behaviour change.

From the literature, it was observed that a trigger needs to be placed near the target behaviour location which led to layout study in section 6 and is applicable for the motivated audience. However, for people who are not motivated, it was necessary to talk directly to the users. Raising awareness adjoined with social influence and constructive aversive feedbacks seemed to be a possible persuasion technique to bring about a behaviour change.

*Interviewing the mess workers (left) and the Mess Manager (right)* *Fig.12*

*Picture Courtesy : Prasad Ghone*

## 4. Primary Research

IIT Bombay is a fully residential institute and all the students are accommodated in its 15 hostels with in-house dining. Hostels 12, 13 and 14 house the largest mess in the campus serving almost 2000 students. The mess is operated in a contract basis and the contractor provides all the amenities inside the mess except for procuring raw materials which is further outsourced to a vendor. The services provided by the contractor broadly includes cooking, distribution of food, cleaning and maintenance of the mess. The mess was selected for two primary reasons — it is the largest mess in the campus and the mess coordinators were already motivated to reduce food waste. A white board (Fig. 14) depicting the amount of food waste per meal is hung on the wall which is regularly updated by the mess workers. The mess has posters asking people to stop wasting food. From these evidences, it was concluded that certain stakeholders are motivated and a trigger in form of an installation might help in bringing about a behaviour change.

Before commencing user studies, different stakeholders of the mess and their roles were identified. The identified stakeholders were as follows:

a. Students
b. Mess workers
c. Mess Manager
d. Mess coordinators (also students)

Semi structured interviews were done with each of these stakeholders. seven students, two mess workers, one mess manager, one mess coordinator were interviewed. The key questions were different for each stakeholder.

## Interviews:

**“I did not like the taste of the food” — student statement**

Interviewing the students was a major challenge and they showed much resistance to answering questions about food waste. In an attempt to understand the primary reasons as to why students leave food on their plate, students throwing food in the bin were targeted and asked questions. In order to show empathy towards them, the conversation was initiated by asking if the food was not good. While most of them blamed the quality of food for the waste, a handful of them owned up to their mistakes of overestimating their eating capabilities. Students complaining about the 'taste' of food were further asked to objectify and categorise their disliking as salty, spicy, bland, sour etc. as the term 'taste' was perceived as subjective. The response received was mixed. Each interview did not last for more than 5-7 minutes suggesting that the students are not keen on spending a lot of time at the mess.

**“One must be a part of the system to understand the amount of effort put in to prepare the food” — mess coordinator statement**

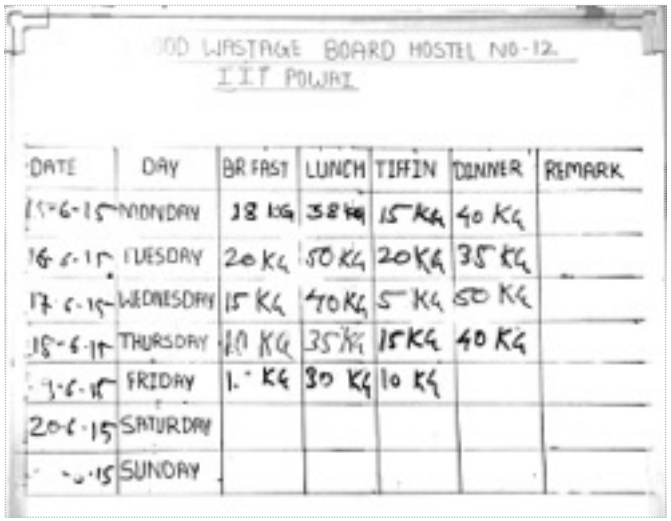
The mess coordinator was mainly asked about the initiative that they had taken to reduce food waste. Being someone who wasted a lot of food, he decided to join the council to understand the process and eventually started empathising with the workers who put in a lot of effort to prepare and serve food. In his individual capacity, he tries to explain the agitated students, complaining about the quality of food, the complexity of the mess management process and convince them not to waste food. One more unsuccessful instance of a motivated mess coordinator from another hostel was noted, where he would stand at the counter and personally request students not to waste food.

*Students wasting food, Waste Segregation*

*Fig.13*

**“Students do not respect food” — mess employee statement**

The mess workers work in two ten hour shifts and have different roles. The workers communicating with the students are the group that distributes and manages the official registers at the counter and are often exposed to harsh comments by students regarding the quality of food served. Mostly coming from different villages across Maharashtra, they are aware of the hardships the farmers go through and the recent scarcity of water in farming lands. They also maintain a track of food waste by documenting it on a wall mount white board. They feel that “the students do not respect food as they are unaware of the plight of farmers”.




*White board with food waste data* *Fig.14*

*Picture Courtesy : Prasad Ghone*

**“We distribute the excess food to the mess workers” — mess manager statement**

The mess manager was asked questions about the general process of mess management and food waste figures. The key questions were:

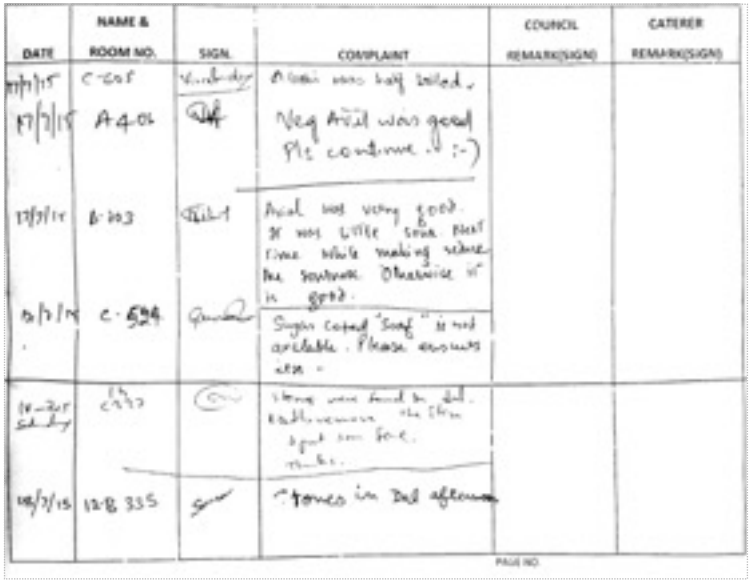
- How much food is wasted each day?
- What do they do with the excess and wasted food?

The process for handling excess and wasted food described by him is as follows :

- The excess food is distributed among employees at around 10:30 pm (post dinner).
- The wasted food is measured after each meal and written on a white board.
- All the wasted food is collected in the morning by a truck and taken to composting units.
- The waste is segregated and composted in the composting plants within the campus.

## Observations and Insights:

- The mess employees are keen on reducing food waste. They were open to suggestions by which they can reduce the amount of waste.
- A feedback book (Fig. 15) is kept at the exit counter and feedback written is not outrightly visible.
- The students write positive feedback as well highlighting a food item that they enjoyed having.
- The students have written comments about the bad quality of food on 'Stop food waste' posters.
- The quantity of extra item (students have to pay extra for the special item) is almost double of what an average male adult can consume and the entire item is given at one go.
- The counters are placed at extreme corners of the mess.
- The students do not consider tasting as an option before finally taking food and they take a lot of food at once to avoid queues and coming back to the counter for further helpings.
- Students eating in the mess do not get feedback about the food items which might help them to take decisions at the counter.
- The students do not have direct 'aversion to loss' [16]. They consider mess food as 'free' food.
- Every hostel participates in sports events termed as General Championship which is a huge success. A previous attempt was taken to popularise a general championship for saving energy which could not draw substantial attention due to the lack of gamification in the process.




*Feedback Book* *Fig.15*

*Picture Courtesy : Prasad Ghone*

## User Statements:

- “That food item looked good but when I started eating, it tasted awful.”
- “The green chutney was very spicy, I mixed it with my entire rice and had to throw it away.”
- “The food was not tasty (Not so spicy / salty / bland but yet not tasty).”
- “A student complained that the cucumber was not green enough. I had to ask the vendor to get green cucumbers.”
- “I did not even notice that there is a board that puts up food waste data everyday.”
- “IIT stopped donating food after a food poisoning incident.”
- “The Academic Office mentioned that media is always ready to defame the institute and hence distributing food is seen as a huge risk.”
- “We are trying to get in touch with NGOs who will take full liability if something goes wrong.”

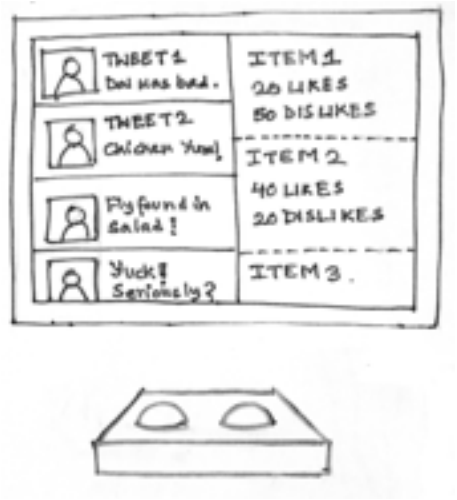
The key findings of this phase was that the students do not have loss aversion when it come to wasting the mess food. While some students are motivated to reduce food waste, they limit themselves to putting up posters, the scale and locations of which are not conducive to creating an impact. The observations and insights were analysed, collated and used to construct the initial design ideas. Each design idea intended to solve multiple problems identified during the primary research phase through the findings of the literature review, intuition and general observation.

## 5. Ideation

The initial design ideas were put forward based on the insights and observation from user studies  and validated against the behaviour patterns mentioned in Dan Ariely's 'Predictably Irrational' and 'Nudge' by Thaler and Sunstein. Taking cues from Fogg's behaviour model (FBM) (Fig. 16), the installation was considered as the trigger to bring about the change in behaviour, assuming they have the ability to reduce individual food waste. From user studies, it was observed that the mess employees and some of the students are motivated to reduce food waste. Their motivation can be leveraged to create a social influence on less motivated students. Both positive and negative ('Pleasure' and 'Pain') motivations were considered while ideating. Playful persuasion and gamification were also considered as possible options for intervention. Awareness raising has been identified as a key stage in the processes of behaviour change [13]. Hence the option of presenting facts related to food waste and hunger was also examined.

## Design Idea 1:

This design idea was an attempt to leverage the 'social influence' aspect of behaviour change. Individuals would have a 'feeling of guilt' about their behaviours in light of the presence of others [12]. The main idea was to place a weighing machine which would be taking wastage statistics for individual meals, post it on social media sites and put up in public displays across the campus. It would show encouraging messages for substantial improvements in wastage reduction as positive motivation and subtly shame and embarrass students when the amount of waste increases. The system would be highly integrated with popular social media applications like Facebook and Twitter and it would also enable students to give feedback on individual food items and lodge complaints which are to be displayed on a screen placed within the mess.




Feedback integrated with social media displayed. Users can also give feedback by clicking on the buttons.

## Possible Drawbacks :

Individual privacy would become a huge concern as social media is deeply integrated with the concept. This might also lead to defamation of the academic institution as a whole highlighting the large amount of food waste.


Aversive feedback by displaying statistical facts.

## Design Idea 2:

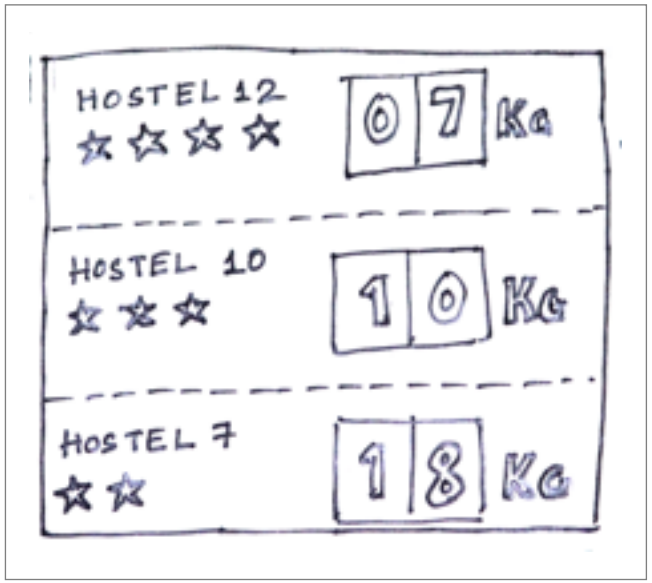
In this concept, a screen would be placed in front of the dustbin and will show individual and total food waste the moment someone drops food into the bin. Added visuals and text depicting the alarming statistics of food waste and hunger would be displayed along with the current wastage to induce shame (pain motivation), a prelude to self reflection. This installation would essentially make students aware of the current scenario with respect to hunger and waste.

## Possible Drawbacks :

Though aversive feedback can motivate individuals, the design should avoid making people feel unduly bad about themselves. Striking a balance between pleasure and pain motivators is of utmost importance, failing to achieve it might trigger arrogance and untoward behaviour.

## Design Idea 3:

In this concept, playful persuasion techniques were incorporated. The general championship concept was extended to a similar kind of competition between all the hostels, which will happen year long and the hostel having the minimum average individual waste will be felicitated with tangible rewards. The score tally would be put up in public places with the campus to increase awareness and competition, leveraging 'aversion to loss' psychology (**loss aversion** refers to people's tendency to strongly prefer avoiding **losses** to acquiring gains. Most studies suggest that **losses** are twice as powerful, psychologically, as gains) [16, 35].




Putting up displays in public places with hierarchy and statistical data.

## Possible Drawbacks :

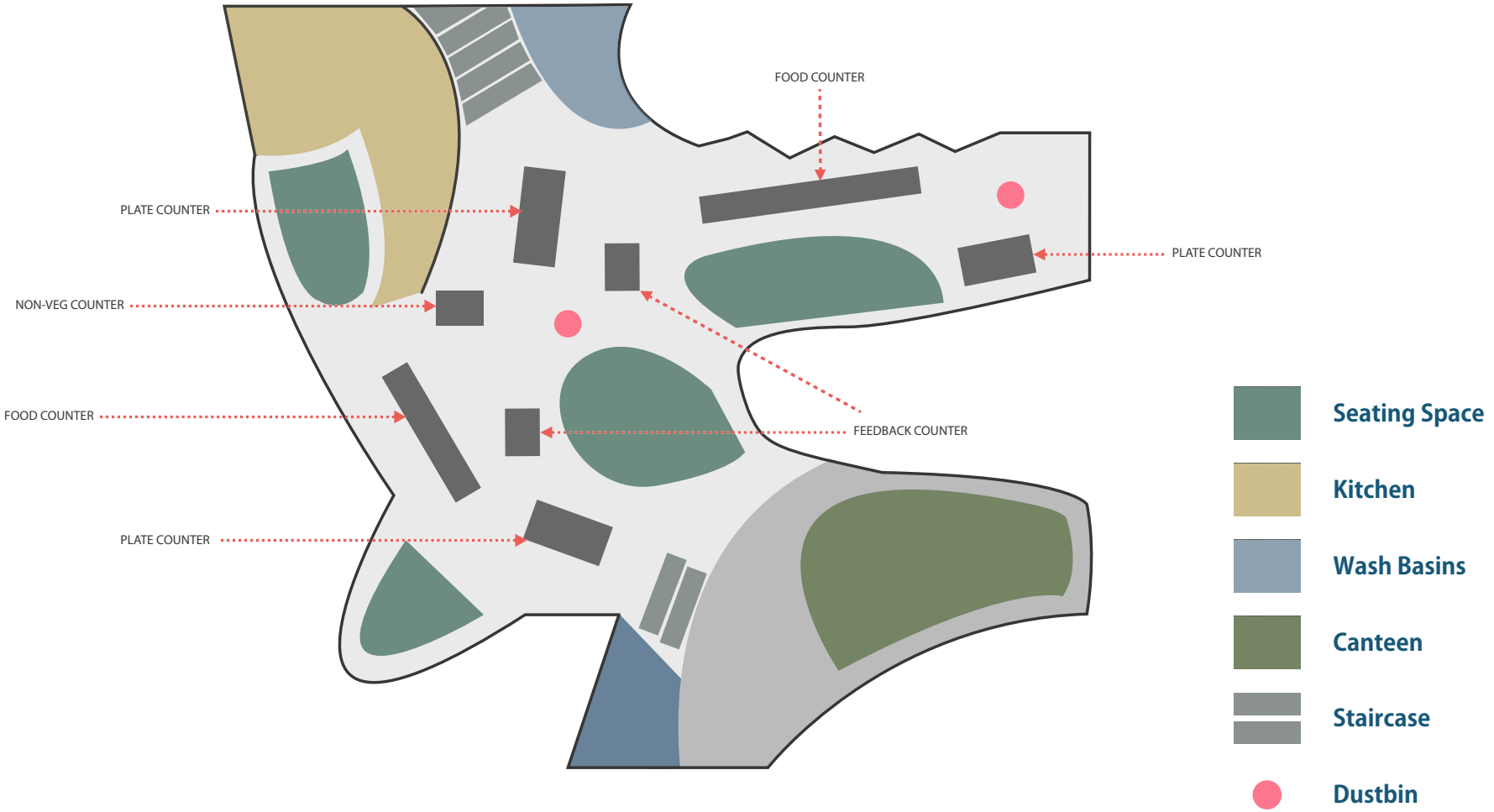
A general championship for food waste might not induce the expected amount of competitiveness among students as compared to its sports counterpart.

From the above design ideas, it was observed that the installation can be either performative or subtle in nature. Given the mess context, it was unlikely to take the audience through an immersive experience to incorporate subtle interactions. Hence, it became important to study the layout in order to understand the flow of users. The installations were broadly categorised as performative (inspired from the third design idea) and incidental (borrowed from the second design idea) and researched further in section 7.

*Hostel 12, 13, 14 combined mess* *Fig.17*

## 6. Layout Study

Interactive installations are known to 'reconfigure spaces'. The layout study was important to identify intervention locations and positioning triggers for target behaviour. The layout with all the entry and exit points were studied to identify the focal points for the installation. The mess had two dustbins, out of which the one which was placed at the centre of the mess was targeted. The other dustbin was placed at the extreme end of the mess and hence its physical location was not conducive to putting up the installation. One of the major constraints was the relative distance between the power source and the dustbin. User journey was also taken into account while finalising the position of the installation. The placement of trigger had two potential options, near the dustbin or near the food counter. While placing it near the food counter would ideally motivate them to take food wisely, the queue and space crunch was a huge drawback. It was observed that the users do not like to spend a lot of time near the counter and a crowd gathering (honey pot effect) would add to the chaos during rush hours. However, the possibility of a focal point near the food counter was not completely eliminated and could be explored further and used to put audio feedback.




*Layout of Mess - Illustrated Top View*

*Fig.18*


*Layout of Mess - Panoramic View*

*Fig.19*

# 7. Pilot Implementation

## First Pilot:

## Objective:

The second design idea was further elaborated and carried out as the first pilot implementation. The installation was an attempt to instil the importance of food. The primary objectives of the pilot were as follows:

- To test the hardware integration.
- Getting initial feedbacks / suggestions from users.
- Acquaintance with the layout and logistics.
- Positioning of the installation.

The questions that the pilot was expected to answer were:

- Can installations be used to solve food waste problem?
- Is it creating interest among users?
- Is it acting as a trigger for already motivated users?

From the technical point of view, it was important to understand the changes that are necessary in the code and hardware to make the installation reliable and robust.

## Design:

The design decisions for the installation were taken to facilitate awareness about the ill effects of food waste. The psychological theories applied were 'gaze effect' (Gaze Effect — the awareness of any object can induce an awareness of also *being* an object) **[39]** and 'panopticon' (Panopticon — a feeling of being observed, under surveillance) **[38]**. While selecting the visual for the pilot, the filters used were —poor, Indian, hungry, child, staring at the camera. The child in the image stared at the camera to induce a sense of being observed as an object. The character in the image was chose to represent the hungry population (Fig 20).

The messages were designed such that it would evoke pain and gives a moderate level of aversive feedback. The changes in the messages were kept subtle with an aim of making the installation incidental in nature. The statement used for negative motivation were an attempt to articulate the behaviour of students towards food as understood during user studies and are as follows :

A child dies every 5 seconds as a result of hunger…

> And you take more than what you can eat,
>
> Eat till you are full…
>
> And throw away the rest.

The experiment was performed across three meals — lunch, snacks and dinner. During lunch the data was captured without the display. This data was treated as pre assessment data or control data. The installation was put up for the next two meals, snacks and dinner and the data collected during dinner was treated as post assessment data.


*Visuals and message for pilot implementation* *Fig.20*

## Hardware:

Scalability is always a concern while prototyping a solution involving hardware. Involving a computer is inevitable to cope up with the amount of processing a complex installation needs. All the components were selected such that the cost of the system is minimal. The hardware components used were:

- Raspberry Pi 2 Model B 1GB RAM
- Weighing Machine with 89C52 micro-controller (1 gram accuracy)
- 23 inch LED Monitor

Raspberry Pi is a credit card sized computer with General Process Input Output pins which can directly read sensor data. The sensors involved were initially proximity and weight, but assuming that a person needs to be in close proximity of the dustbin in order to throw waste, the proximity sensor was eliminated. The weighing machine's micro-controller was tapped, from which the transmitted signal (Tx) was directly feed into the receiving port (Rx) of Raspberry Pi through serial communication.

## Logic:

Processing of the received signal was done using Python. The received data was checked against a minimum threshold and a set of ranges were mapped to different messages to be displayed on the screen. It also saved cumulative waste added to the bin in a text file.

The logic of the code was :

```
Always Displayed :

       Image (Fig. 21) + Total waste

Disappears after 5 seconds :

       if (waste in 5 seconds < 100 grams)

              display amount of food wasted in 5 seconds

       if (waste in 5 seconds > 100 grams)

              display 'negative motivation' message

              display amount of food wasted in 5 seconds
```

*Visual - 1st Pilot Implementation* *Fig.21*

## Observation, Insights and Feedback:

Inspite of the fact that the quantitative data captured before and after the installation was not significantly different, the pilot attracted a lot of attention. The audience showed interest in the idea of putting up an installation. They were also interested in the technical nuances and enthusiastically gave suggestions as to how the hardware and visuals can be further improved. They gave references of professors within the institute, working on waste management. Motivated audience exchanged numbers and formed a group to scale up the initiative. Some of the insights were as follows:

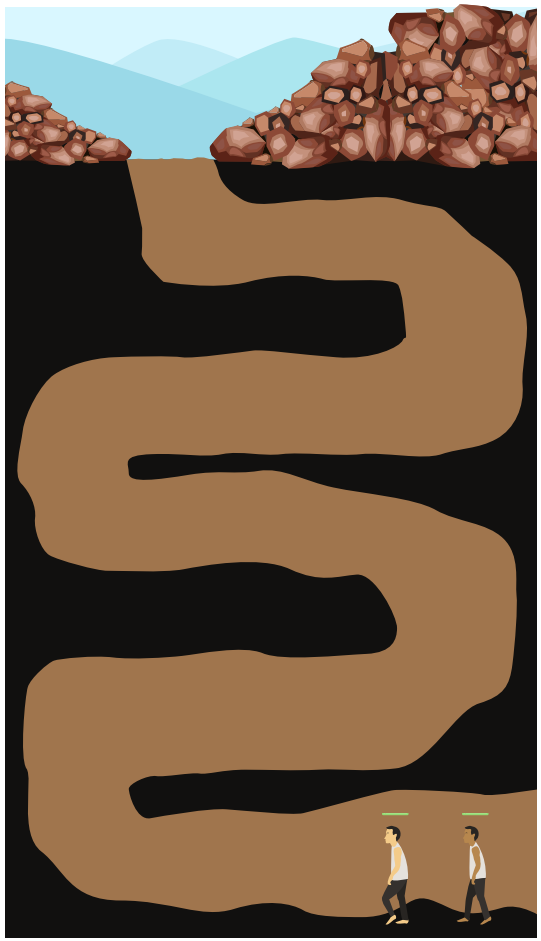
- Enhance the interactivity by adding suitable hardware.
- Adding sound to increase cause and effect mapping.
- Triggering the changes when there are onlookers or bystanders.
- Bigger font size for numeric data.

The insights to enhance the hardware system were —

- Need to include proximity sensor along with weight sensor.
- Displaying facts when people are at a certain proximity.
- Increasing the surface area of the weighing machine.
- Abstracting the hardware.

In an attempt to understand whether the level of engagement and audience participation changes with the type of installation, the second pilot was carried out.

*Honey pot effect - Pilot Implementation* *Fig.22*



*Visual - 2nd Pilot Implementation*

*Fig.23*

## 2nd Pilot:

Playful persuasion techniques were leveraged while designing the second pilot. This installation, as compared to the other pilot implementation, was more interactive and performative in nature and was referred to as performative installation. The primary objectives of the pilot, inspired from the third design idea, were as follows:

- To check the effectiveness of the gamification.
- To test the hardware integration.
- Getting initial feedbacks / suggestions from users.

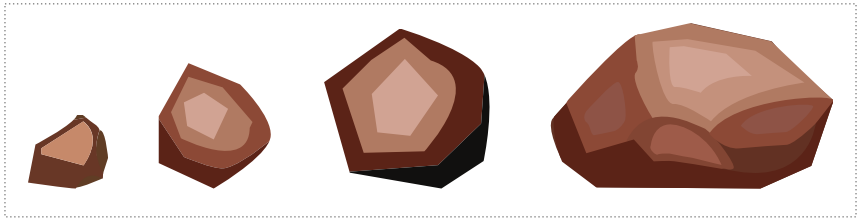
## Design :

The major question that was needed to be answered was the relative effectiveness of the two installations. The previous pilot was intended to create awareness by giving direct messages. To make the cause and effect mapping more direct and evident, possibilities of gamification was explored. The preamble to the game was chosen as miners, trapped inside a mine (Fig. 23), the exit of which is in between two mountains, were trying to reach the end of a tunnel in order to save themselves. The gameplay was such that when food gets dropped into the bin, boulders of different sizes are spawned, which hits the miners and reduce their strength or health (Fig. 24a). The miners also try to break these boulders (Fig. 24b, 27) to make path and in the process lose out on energy, which eventually kills them. The objective of the game was to save at least half of them which was decided to be the winning condition. The winning condition could be manipulated further to control the amount of waste subject to the effectiveness of the game. The metaphor of the mine and the boulders were chosen to abstract the motive of reducing food waste. The duration of the game was spread across the entire meal.

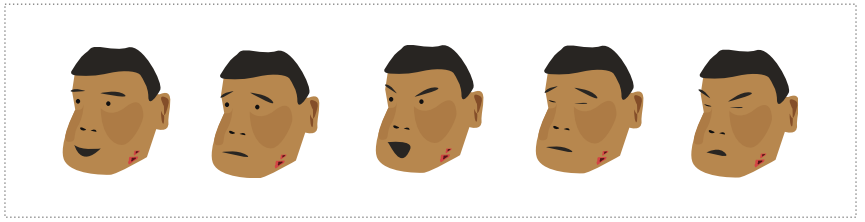
The pilot implementation had four types of boulders (Fig. 25), which would be generated based on how much food is being dropped at that instant. A count of the number of miners that were saved was projected as the score. The spawning has a lower and upper threshold of 50 and 500grams respectively, and hence nothing would be spawned if the food wasted was less or more than that threshold. It was assumed that any individual will not be wasting more than 500grams and any individual waste above that would be considered as outliers and hence rejected.

*Health* *Fig.24a*

*Miners breaking boulders* *Fig.24b*



*Boulders* *Fig.25*



*Expressions* *Fig.26*

The characters were given different expressions (Fig. 26) namely happy, sad, shouting, praying, dying. Each expression was associated with a verbal articulation of their state of mind. The sad, shouting and praying expressions were played each time a boulder was spawned, the happy expression when the miner climbed out of the mine and the dying expression right before the miner died. Other sound effects added were rolling and breaking of the boulder. They were used to attract attention of the audience. The rolling of boulders was used to trigger the initial engagement and facts were used to give aversive feedback. The feedbacks were seamlessly integrated with the game and yet indirectly discouraging the audience not to waste food.

The statements used for each boulder (smallest to largest) were finalised and recorded after taking feedbacks from avid gamers :

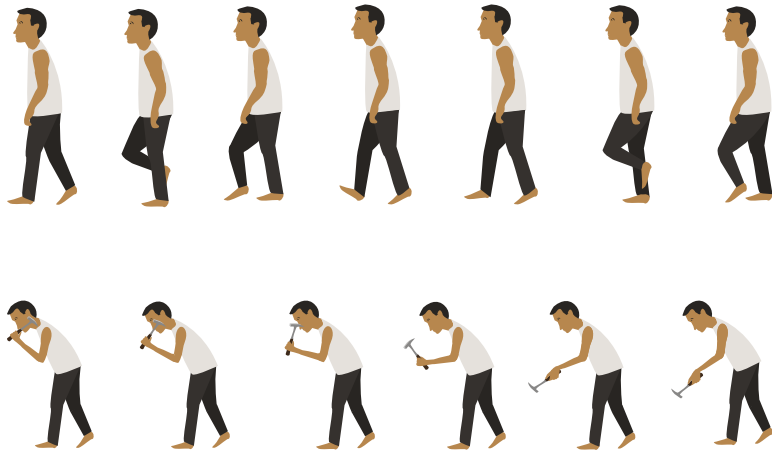
- Boulder 1 : “Stop doing that!” (Annoyed tone)
- Boulder 2 : “Are you kidding me?” (Annoyed tone)
- Boulder 3 : “Please save us!” (Prayer tone)
- Boulder 4 : “No no no…Aaaaarrrrggghhhh!” (Angry tone)

Social influence was considered as an important aspect as the game was spread across the entire duration of the meal. It was expected that the audience would try to follow the social norm and work towards winning the game as a single entity. Though social interaction around the installation was not necessary for the incidental installation, it was important for the performative installation, hence a flat arrangement was selected which would maximum induce honey pot effect and foster social learning [11].

The audience, in this case can also be referred to as “spect-actors” or “performers” as they would be actively contributing to the installation.

## Technology :

The game was developed using Unity3D game engine and coded using C#. A new weighing machine, with an accuracy of 10grams, was used to support bins with a bigger surface area. The data was received from the serial port by an Arduino Uno, which was finally fed to Unity for further processing. The display was kept the same as the first pilot. Individual waste was saved in a local file for further analysis and evaluation.



*Walking and Boulder breaking sequences* *Fig.27*

## Observations and Feedback :

Due to chronic hardware constraints, the pilot could not be put up for the entire duration of the meal. The major issue was the different operating frequencies of the weighing machine, Arduino and Unity. However, some important observations were made based on the engagement of the audience.

The game was not that effective because of its complexity and multiple factors influencing the health of the miners subdued the cause and effect to a great extent. Moreover, the form of the tunnel required the boulders to travel for a substantial amount of time before hitting the miners which broke the initial engagement and never led to a honey pot effect. The hardware lag also added to the confusion and further negated the cause and effect relationship. Some of the audience gave positive feedback about the visuals of the game.

The 50 grams threshold did not seem to work well as the effect was not evident when the food wasted is less. A positive motivation or appreciation could be used but giving a feedback should be a mandate.

Taking cues from the failed pilot, it was concluded that the game needed to be more simpler with minimum active components to attract immediate attention as the audience are not used to spending a lot of time near the bin. From the technical point of view, it became important to measure the reliability of hardware.

The observations and drawbacks of both the pilot implementations were analysed and necessary changes were incorporated into the final concepts.

*Second Pilot Implementation ** *Fig.28*

*Photo Courtesy - Prasad Ghone*

*(*The screen was turned off and rotated against the audience in a attempt to debug a hardware problem, but people showed interest in understanding the objective.)*

# 8. Final Concept

The pilot implementations were executed to understand their individual effectiveness of motivating the audience. With an aim to perceive the efficacy of interactive installations towards behaviour change, it was necessary to define the type of installation that would be more powerful in bringing about the change. The installations had very distinct approaches of addressing the problem of food waste and it became imperative to compare the performance of both the installation in solving the problem. The final concepts were directly inspired and build on top of the pilot implementations and the transition of concepts from the pilot to the final implementation have been elaborated in the following sections.

The two concepts put forward were :

- The Darker Side: An Incidental Interaction.
- The Hunger Pit: A Performative Installation.

## The Darker Side :

The Darker Side is an incidental interactive installation highlighting the ignored and less explored facts surrounding food waste and hunger issues in India. The facts which are relatively less familiar, might often come as a surprise to the audience are aimed at creating awareness and evoking self reflection.


*The Darker Side - An incidental interaction* *Fig.29*

## Design :

The Darker Side had three components :

1. Awareness facts
2. Contextual data
3. Interactive visuals

The awareness facts talked about the plight of farmers, children suffering from severe malnutrition and the hungry population in India with numbers in bold and large fonts (100 points). It also raised questions about the attitude of the students towards mess food, who are a privileged section of the country. The messages (Fig. 30a, b, c, d) were aimed at giving aversive feedback and was constructed such that it highlights and puts across the target behaviour (in red).

The font used was Source Sans Pro with the following font styles :

1. Awareness text — Regular, 48 points
2. Numbers — Black, 100 points
3. Target behaviour — Black, 48 points (colour: #F977878)

The contextual data projected the total and individual waste at any particular point of time. This data reinforced the need of cognisance and the urgency to change the behaviour of wasting food on plate.

It takes **140** days on an average to harvest any major crop...

and we do not even **think twice before throwing** it away.

*Awareness facts and aversive feedback - Farmer* *Fig.30a*

**100**gms of rice needs **249** litres of water for harvesting...

And we fail to **see the amount of effort** that goes into the process.

*Awareness facts and aversive feedback - Farmer* *Fig.30b*

**1** in **4** children are malnurished in India...

and we think, **no**w that it's paid, we own the **right to waste**.

*Awareness facts and aversive feedback - Child* *Fig.30c*

**3,000** children in India die every day from poor diet related illness...

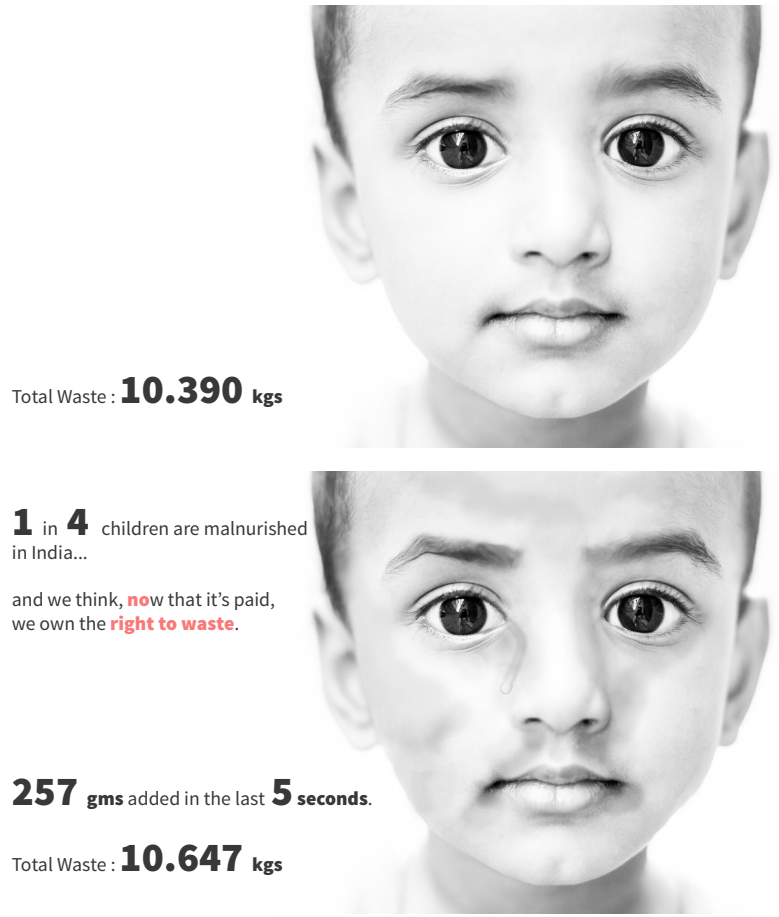
and we complain about the **taste** of **the food**.

*Awareness facts and aversive feedback - Child* *Fig.30d*

The visuals were images portraying the under privileged population and complimented the awareness messages projected along with. The subjects, being close up portraits of people staring at the camera, if closely observed were not static in nature. The visual changed based on the amount of waste thrown into the bin. This contributed to the incidental attribute of the installation. The facial expression of the subjects metamorphosed (happy to sad, healthy to malnourished) depending on the amount of food thrown into the bin. The time of the transformation could be manipulated by observing the average attention span of the audience, five to eight seconds for the mess under consideration. The backdrop was kept white and the images were converted to grayscale images to reduce multiple elements which might shift the audience's focus from the main subject.

The reason behind choosing faces of children (Fig. 31a, 31b) and farmers (Fig. 32a, 32b) as visuals and highlighting their misery to raise awareness are as follows:

1. People tend to be more concerned about children than adults [29] considering the plethora of international charities for children.
2. Recently suicide of farmers gained a lot of attention and Marathwada in Maharashtra has been mentioned as India's emerging farmer suicide capital [36].




*Visuals - Child* *Fig.31a (top), 31b (bottom)*

*Image Source: flickr.com*



*Visuals - Farmer*

*Image Source: flickr.com*

*Fig.32a (top), 32b (bottom)*

The installation was designed to detect proximity and faces of the audience to prevent the visuals from changing without any onlookers. The contextual data were taken from the weighing machine through Raspberry Pi and projected on a wall mount display. The size of the display could vary depending on the the physical space. For the mess, the minimum screen size needed to be 40 inch, an observation made during the pilot implementation. A concave arrangement for the screen was aimed at creating lesser honey pot effect and facilitate self reflection through the awareness facts, contextual information and visuals.

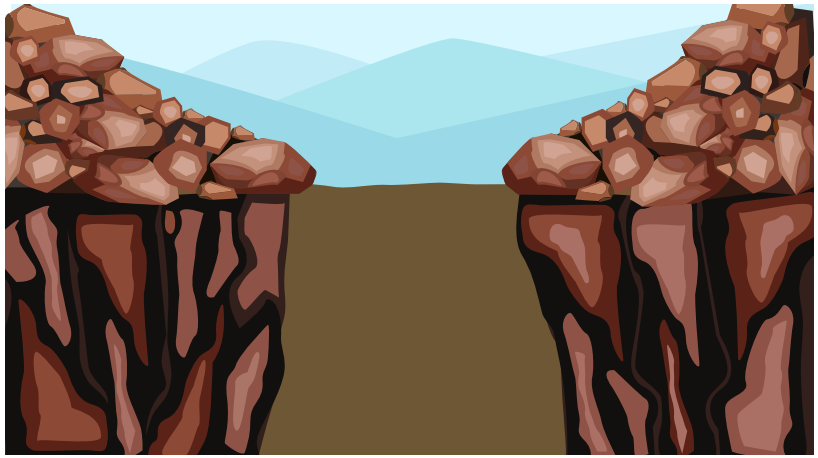
## The Hunger Pit :

The Hunger Pit is a performative installation which aims to gamify the objective of reducing food waste. An approach, very similar to that of the second pilot was taken, improvising the game to achieve a better mapping between cause and effect.


*The Hunger Pit - A performative installation* *Fig.33*

## Design :

From the observations made during the pilot implementation, the duration and paths were removed (Fig. 34) to simplify the game play. The metaphor of the game was also refined and miners were replaced with hungry people. These hungry people would be spawned every time someone is at a close proximity to the bin. A boulder would be spawned, as in the case of the second pilot, if food is dropped into the bin. Each boulder, associated with a mass, would reduce the health of the human and is mapped from lowest to highest level of energy drop for increasing masses of boulders. The scores would have both the number of people killed (negative score) and saved (positive score). The spawned human would escape the pit if the boulder does not 'kill' the human (fails to reduce the health to zero) and would add to the positive score. If the human gets killed, it would add to the negative score. The winning situation could be manipulated by studying the historical data and might be gradually increased to achieve different targets of food waste reduction. A tangible reward, in the form of a special food item was also associated to motivate the performers.



*Visuals of The Hunger Pit* *Fig.34*


*The Hunger Pit poster* *Fig.35*

The design decisions taken were directed towards making the game easily comprehensible. Considering the fact that the amount of time the audience spends near the bin was less than a minute, the effective time to grab audience attention was too small to incorporate complicated strategies. But once the initial engagement was established, subsequent involvement were manipulated through the visuals and sound effects.

The game spawned 5 types of boulders (Fig. 37), sized according to the amount of food wasted. Boulders were spawned even if the food wasted was less than 50 grams, unlike the pilot implementation. However, the upper limit was considered important to eliminate erroneous readings.

Each boulder was again associated with a sound effect, this time for low food waste (0-50grams), the performers got a positive feedback of the human escaping the pit and a 'thank you' note which appreciated them for wasting no or very less amount of food.

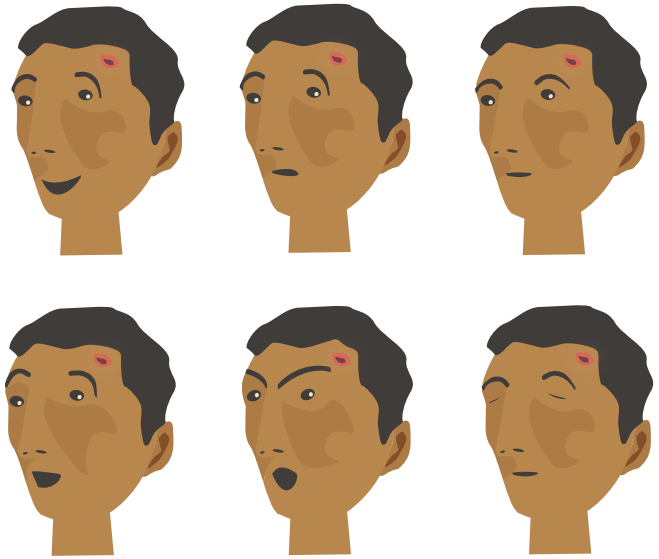
The statements used for each boulder (smallest to largest) were finalised and recorded after taking feedbacks from avid gamers and the language was selected in accordance with existing commercial games [37]. The messages with expressions (Fig. 36) are as follows :

- Boulder 1 : "Finally we can see the light!"
- Boulder 2 : "Stop doing that!" (Annoyed tone)
- Boulder 3 : "Please let us live!" (Prayer tone)
- Boulder 4 : "No no no…aaaaarrrrggghhhh!" (Angry tone)
- Boulder 5 : "Oh my freaking God! Who are these people?" (Angry Tone)

The installation detected the proximity of performers to spawn humans and sensed changes in weight of the bin to create boulders. Serial to usb converter module was used to eliminate the use of Arduino. While the size of the screen was the same as that of the incidental installation, a flat arrangement would help in gathering spectators and will contribute to initiating social interactions.

The interaction of the user with the space has been discussed in details in Section 9. Since the effect of two different installations were studied, considering the fact that the first installation might skew the results of the second installation, it was necessary to put up these installations in two separate messes. Hence, the mess council of hostel 15 was also approached and the layout was studied to identify possible trigger locations. The implementation and evaluation of final installation have been elaborated in Section 11.

*Spawned Boulders* *Fig.37*



*Spawned Human Expressions* *Fig.36*

## 9. User Journey

The entire user experience within the space was planned to 'prime' the audience before finally arriving at the primary focal point (the installation). The space and contextual constraints were studied to enhance the possibilities of convincing the audience towards the target behaviour.

During layout study, the possibility of embedding focal points at the food counter was explored. However, it was understood that visual triggers might not work as the physical space is crowded and chaotic during peak hours. Hence, audio feeds would both prevent the users from unnecessarily gathering near the counter and putting across messages at a very crucial location. The audio system can be eventually be integrated with the feedback system in section 10, where crowdsourced ratings of individual food items would be projected. The rating should be placed such that it avoids clutter near the counter.

The user spends maximum time on the table while having food and these locations can be targeted to convey longer messages. For the performative installation, the game play, in the form of three dimensional short posters, can be displayed on the table surfaces. This will reduce amount of the time taken by the performer to understand the objective and then react at the primary focal point.

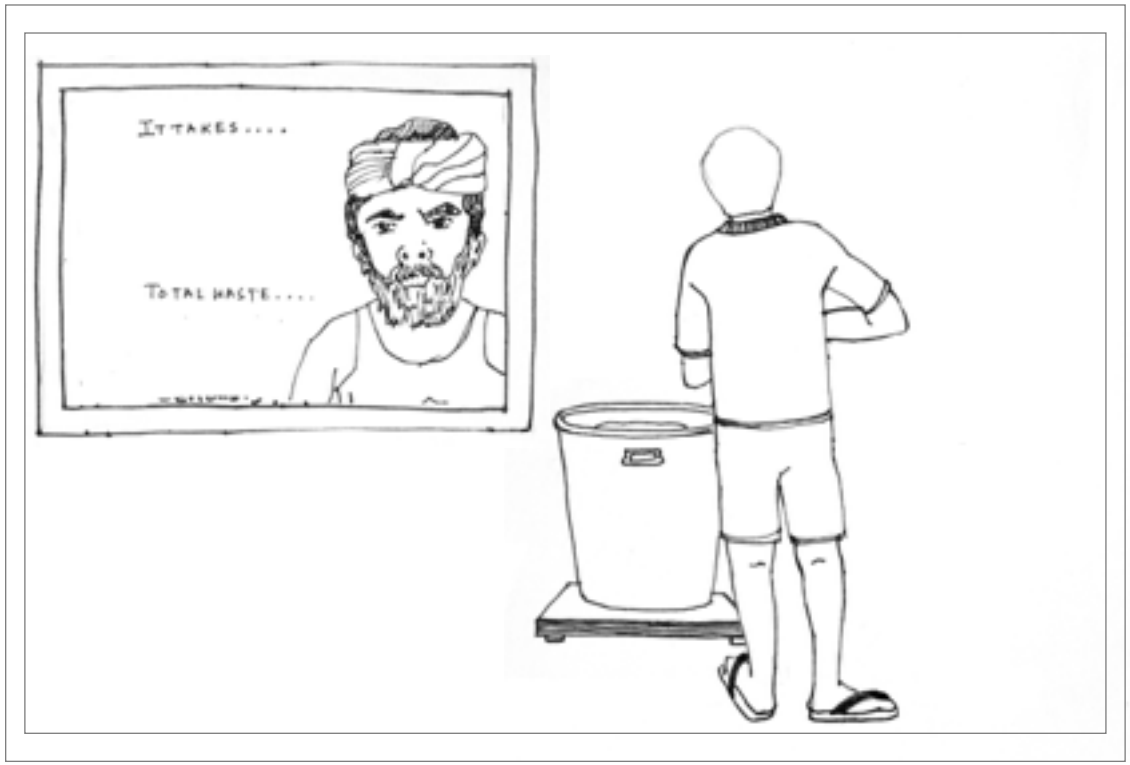
1. The student is on his way to the mess.


2. He checks the crowdsourced ratings and comments of food items from an mobile application.

(Part of the Feedback System from Section 10)

3. He takes food while the audio system primes him by suggesting that he can come back later for a second helping.

For Incidental Installation:

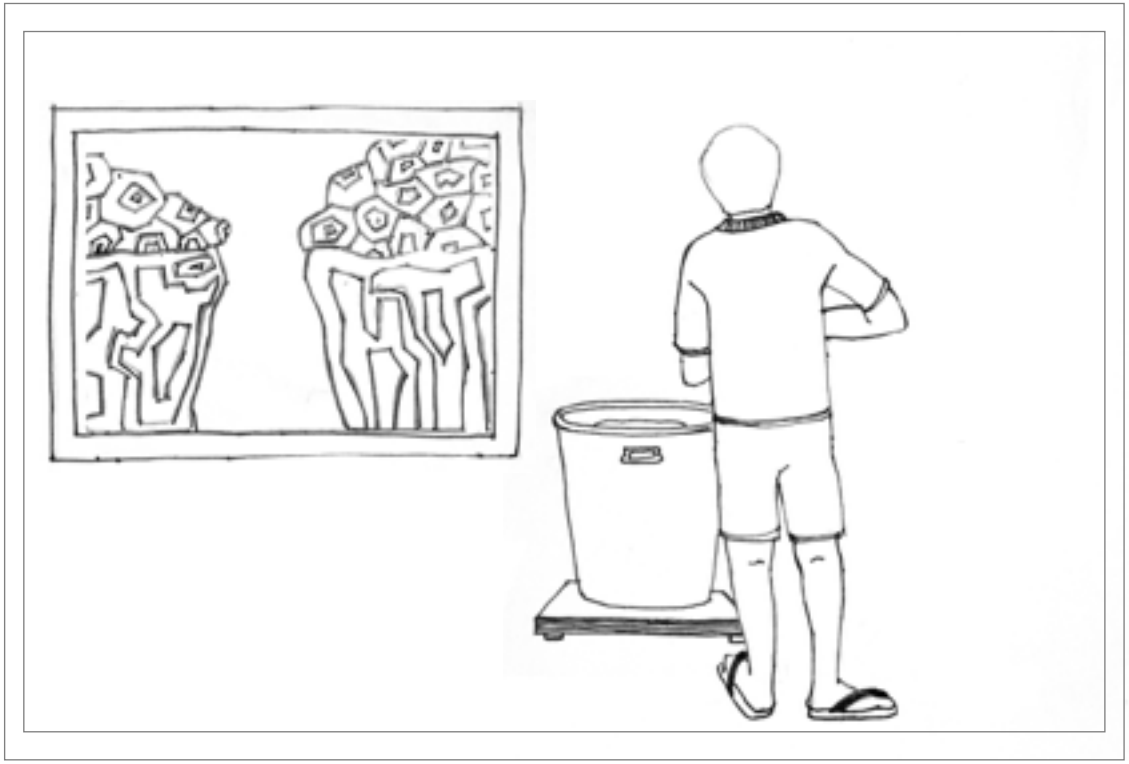



4i. He goes to the bin and the bin detects his presence. When he looks at the screen, the bin detects his face and shows him the amount of food he has wasted. He reads the message and feels bad about himself.

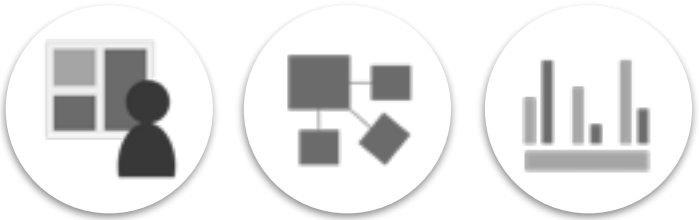
For Performative Installation:

4p1. He eats food and learns from a poster on the table that they will get his favourite sweet item if their mess can win a game called 'The Hunger Pit'.

He also goes through the brief game play.



4p2. He goes to the bin and helps the hungry man escape the pit. He increases the score for his mess. He requests his friends to waste less food so that they can get the special item the next day.



INSTALLATION INFRASTRUCTURE FEEDBACK SYSTEM

## 10. Building an Ecosystem

The main objectives of the project were :

1. To reduce the amount of food being wasted at IIT mess.
2. To investigate whether installations can bring about behaviour change.

The installation mainly aims at spreading awareness on food waste and emphasises on changing the way people behave. However, from primary research and layout study it was understood that there are multiple intervention points which can be leveraged to prevent food waste in the current context. Hence, a system design approach was taken to address food waste in the mess. The system has 3 components

1. Interactive Installation
2. Feedback System
3. Infrastructural Solutions

## Interactive Installation

The installation is the primary component of the system and is the focus of the project. It aims at creating awareness, introspection and self reflection through the messages, visuals and interactions. It also gives real time data of food waste that can be used for reports and analytics.

## Feedback System

Through user studies it was observed that the students tend to highlight the inability of the mess to serve quality food when asked about why they waste food. The students also mentioned that sometimes the looks of the food items are deceiving. It is only after they take food on their plate, they realise that the taste was not as expected. The layout of the place, time constraints and long queues cause a hindrance to tasting food before finally taking it. Initially, the feedback system was thought of as a tangible visualisation, but keeping scalability in mind it was later decided that a mobile application would be more convenient. To address this issue, a crowdsourced feedback system of individual food items for each meal was proposed where students residing in the hostel would be able to like, dislike and/or comment on a particular food item from their mobile phones through a mobile application and the feedback will be displayed on a screen  placed beside the food counter. This would help students to decide what they would like to take on their plates and would prevent considerable amount of food waste.

## Infrastructural Solutions

The infrastructural solutions mostly deals with suggesting layout and infrastructural changes to the mess council to enhance the experience of students in the mess. It also tries to address the excess food issue by collaborating with NGOs for channeling the excess food to the needy.

Some of the infrastructural solutions proposed were as follows :

- Reducing the number of food items for lunch in weekdays.
- Serving food items like bread and rice on tables.
- Decreasing the size of ladles and plates.
- Bringing the food counter closer to the sitting area.

# 11. Evaluation

In order to understand the effectiveness of the installations in reducing food waste, it was important to evaluate the experiments both quantitatively and qualitatively. The two installations are aimed to be evaluated against each other.

## Evaluation Protocol :

- The evaluation should be done with each installation having minimum four sets of data, one as pre and post assessment each, and two during the installation.
- Individual and total wastes for each set should be recorded for quantitative evaluation.
- Validation of quantitative data should be done through an online survey with both open and closed questions.
- If the hardware fails, the same test needs to be repeated for that meal the very next day.
- If the parametric evaluation and the survey fails to show significance difference, the open ended questions can be analysed to conclude the results.

## Evaluation Techniques :

Two different evaluation plans were devised before implementing the final installations. The most suitable quantitative evaluation method for this dataset, assuming Normal Distribution would be Repeated Measures ANOVA with two parameters, days and type of installation and recording total waste for seven consecutive days during dinner was targeted for each installation (Table 1). Both pre and post assessments would have to be done separately for a week before and after the installation. The null and alternate hypotheses in both the cases were :

### Null Hypothesis ($H_0$)

Installations (Performative / Incidental) have no significant effect in changing food waste behaviours.

### Alternate Hypothesis ($H_1$)

Installations (Performative / Incidental) have significant effect in changing food waste behaviours.

Table 1: Total amount of food wasted for 7 consecutive days.

| | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 | Day 7 |
|---|---|---|---|---|---|---|---|
| P* | 126 | 102 | 148 | 111 | 135 | 127 | 150 |
| I** | 113 | 148 | 136 | 144 | 126 | 130 | 133 |

*(The values are indicative of the total food wasted for a meal and are randomly generated for mock test purpose)*

However, considering time limitations, a second evaluation plan was fabricated and was taken forward. One way ANOVA on individual wastes over a span of 4 meals for each installation was finalised (). The first day would be treated as control data where the installation will not be put up, followed by two days of data collection with the installation and finally one day of post assessment (similar to control data collection technique).

Table 2: Individual food wasted for 4 consecutive days for each installation.

| Control | Day 1 | Day 2 | Post |
|---|---|---|---|
| 187 | 75 | 68 | 57 |
| 89 | 128 | 209 | 81 |
| 198 | 121 | 137 | 140 |
| 196 | 240 | 80 | 129 |
| 235 | 194 | 68 | 163 |

*(The values are indicative of the individual food wasted for a meal and are randomly generated for mock test purpose)*

*Performative
** Incidental

## Survey:

The survey was designed to validate the quantitative data and the questions were designed mainly to evaluate the effectiveness of installations as a medium to change behaviour and the change in behaviour, if any.

The survey (Section 13) had both open and closed questions, the closed questions mostly asked in the form of a 5 point likert scale which can be quantified and evaluated using chi square test for independence (Table 3). The questions can be broadly categorised into the following :

Table 3: Survey measures and question mapping.

| Measures | Closed | Open | Test |
|---|---|---|---|
| Awareness about Food waste (Motivation) | 4,5,6,7,10,11 | | chi square |
| Change in Behaviour | 12,13,14,15 | | chi square |
| Effectiveness of Installation as a medium | 8,9,10,11,12,13,14,15 | 16,17 | chi square |
| Demographics | 1,2,3 | | |

*(The values are randomly generated for mock test purpose for 50 surveys)*

## Survey Evaluation:

The likert scales were quantified, assigning 5 to most favourable and 1 to least favourable answers. 10 point likert scales were clubbed to form a 5 point scale with 9–10 as most favourable to 1–2 as least favourable and was evaluated using Chi Square test for Independence. Effect of installations on behaviour (Table 4) and effect of awareness on behaviour (Table 5) were evaluated.

Table 4: Chi square test for Effect of Installation on Behaviour. *

| | Positive Behaviour | Negative Behaviour | Total |
|---|---|---|---|
| **Installation Effective** | 18 | 11 | 29 |
| **Installation Not effective** | 9 | 12 | 21 |
| **Total** | 27 | 13 | 50 |

Table 5: Chi square test Effect of Awareness on Behaviour. *

| | Positive Behaviour | Negative Behaviour | Total |
|---|---|---|---|
| **Positive Awareness** | 18 | 11 | 29 |
| **Negative Awareness** | 9 | 12 | 21 |
| **Total** | 27 | 13 | 50 |

## Other Evaluation Possibilities from the Survey :

Using the demographic information of the participants, several other inferences can be drawn by evaluating the following :

- Change in behaviour against age.
- Change in behaviour against geographic location.
- Awareness against age.
- Awareness against geographic location.

## Implementation of the Final Installations :

The final installations would be put up for two days in two different messes during dinner and individual wastes are to be recorded in the local system as data files. Prior to putting up the installations, pre assessment would be done which will act as control data. Similarly, on the fourth day, individual and total wastes would be recorded and treated as post assessment data. These data sets needs to be cleaned by eliminating the outliers normalised and are to be evaluated using one way ANOVA in Microsoft SPSS 22.0.

The surveys would also be mailed to the entire hostel in the post installation phase through an existing google group id and evaluated as mentioned in Table 4 and Table 5.

# 12. Conclusion

The final results of the study are still awaited. However, based on the reviews of the pilot implementations, it can be concluded that installations have the potential to bring about a behaviour change.

Some of the major challenges include finding a sustainable solution to the food waste problem, expansion and scaling up in different contexts, attracting and retaining attention of the audience when implemented over a span of time. Care needs to be taken while fabricating the messages such that individual privacy is not breached or the messages do not hurt the sentiments of the audience.

The future scope of work include implementing the ecosystem as mentioned in Section 10 and also look for possible ways by which the cost of the setup can be further reduced. The final target is to develop a model which can be implemented in several other messes across the country.

# 13. Appendix

## Survey Questions :

## Section A

* 1. What is your age? (radio button)
    - 18 to 24
    - 25 to 34
    - 35 to 44
    - 45 to 54

* 2. State or part of the country you come from? (dropdown)

* 3. You are currently pursuing (dropdown)

## Section B

* 4. How concerned are you about food waste?

| Not at all concerned | Not concerned | Neutral | Concerned | Highly concerned |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

* 5. How informed are you about the effects of food waste?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

* 6. How often do you waste food?

| Always | Often | Sometimes | Seldom | Never |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

* 7. Were you taught as a child not to leave food on your plate?

| Yes | No | Not Sure |
|---|---|---|
| ○ | ○ | ○ |

* 8. Did you come across the food waste installation that was put up in your mess?

| Yes | No | Not Sure |
|---|---|---|
| ○ | ○ | ○ |

* 9. How interesting and innovative did you find the installation?

| Not at all interesting | Not interesting | Neutral | Somewhat interesting | Interesting | N/A |
|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ |

* 10. Do you think that the installation was effective in spreading awareness?

| Strongly disagree | Disagree | Neutral | Agree | Strongly agree | N/A |
|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ |

* 11. Do you think that the installation made you more informed about food waste?

| Strongly disagree | Disagree | Neutral | Agree | Strongly agree | N/A |
|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ |

* 12. Do you think it motivated you not to waste food?

| Strongly disagree | Disagree | Neutral | Agree | Strongly agree | N/A |
|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ |

* 13. Do you get reminded of the installation when food waste is being discussed?

| Yes | No | Not Sure | N/A |
|---|---|---|---|
| ○ | ○ | ○ | ○ |

* 14. Do you get reminded of the installation when someone wastes food?

| Yes | No | Not Sure | N/A |
|---|---|---|---|
| ○ | ○ | ○ | ○ |

* 15. Do you think the system has helped you to take informed decisions regarding food waste?

| Strongly disagree | Disagree | Neutral | Agree | Strongly agree | N/A |
|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ |

16. What suggestions do you have to improve the installation?

17. Did you like the installation? Yes or No, why?

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