Career Episode Three

Introduction

CE 3.1.1

In my career episode three, I am describing the detail of my academic project which was part of the course work of Municipal and Hazardous Waste 7th semester. I was enrolled in my Bachelor of Technology in Environmental Engineering at [redacted] at that time. The duration of this project was [redacted] months starting from [redacted]

Background

CE 3.2.1

The project kicked off when we realized that in our university campus itself there were some points of improvement regarding pollution and waste disposal. I knew that [redacted] lacks waste collection and management practices. Even in our campus, I noticed that only the first step of waste handling was implemented i.e. waste collection. The collected waste from urban areas in [redacted] is usually dumped in open areas outside the cities. These practices pose a wide variety of environmental and health hazards.

CE 3.2.2

I conducted a literature survey at the beginning of the project to understand the problem better and to come up with solutions as per standard environmental engineering practices. I knew from my course work that poor waste disposal can result in a number of problems for the surrounding populace, including

1. Bad odor caused by the production of H2S and also from other volatile organic compounds (VOCs)
2. Solid waste dumped on land, into water bodies causing soil contamination and disturbing aquatic ecosystems
3. Solid waste-related diseases that cause millions of deaths in in Nepal every year
4. Dump yards become breeding sites for rats, vermin, and flies
5. Harm caused to the scavengers who collect the waste glass waste if it is not segregated at the source
6. Solid waste becoming airborne through dust and emissions of greenhouse gases (GHG) via degradation at either landfills or other dumping sites including:
    i. 55 % methane emissions from landfills
    ii. 35 % carbon dioxide
    iii. other gases in smaller amounts

CE 3.2.3

Hence, the idea for this project emerged. We aimed to analyze the solid waste being generated at two sites at least, quantify it, determine the current waste disposal methods and suggest solutions for improvement. This project was performed in a group of 3 members, and I was chosen as the team leader. I assigned tasks to each member of the team so that efficiency could be achieved.

CE 3.2.4

I was part of the 3 member team that completed this project within the university premises. I have shown the reporting structure in the below image.

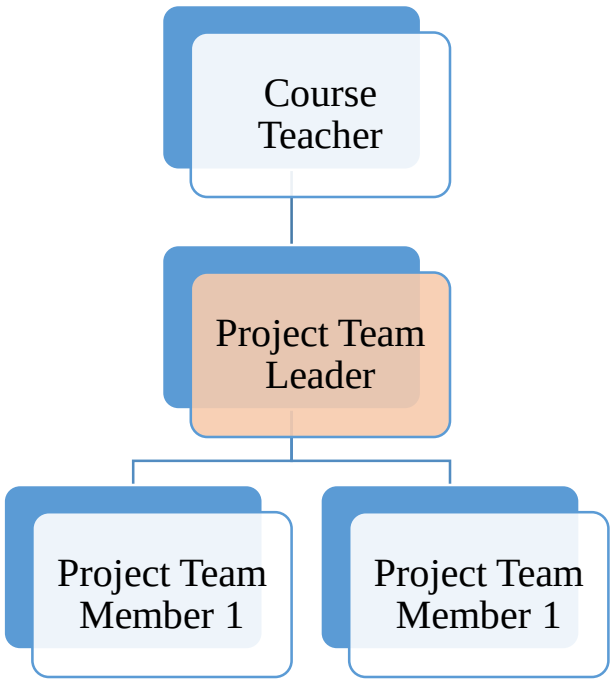

Figure 1: Project Reporting

Personal Engineering Activity

CE 3.3.1

I divided the project into two phases. To begin the project, I first decided that we would conduct an environmental audit of the KU Cafeteria. I chose the cafeteria because I knew from my research that according to the World-Wide Fund (WWF) 2.5 billion tons which constituted almost 40 percent of worldwide food production is either lost or goes to waste. A lot of resources and manpower are used in the production and transportation of food. So, I understood that the food losses should be minimized or at least the waste should be recycled to include it in the circular economy. The KU Café being one of the most popular socializing spots of [redacted] is the most preferred place at lunch and snacking hours for students. A huge amounts of diverse solid waste is generated from the café daily which needed to be disposed of off properly if not recycled.

CE 3.3.2

I surveyed the café along with my team members for 3 days continuously before making a conclusion. I documented the details of waste generated in the café throughout the day. We figured out that the types of solid waste generated included the following:

i. **Plastics** - packaging waste (chips, biscuits), plastic bottles (soft drinks, energy drinks), Styrofoam boxes and cups, disposable cutlery (spoons, forks, plates, cups), and plastic straws
ii. **Glass** - bottles (soft drinks), any broken material (bottles)
iii. **Paper, cardboard** - papers, brown bags, waste from various promotion events (decoration, pamphlets), cardboard boxes (food delivery, take in/ brought in food), receipts, tissues and napkins
iv. **Food waste** - leftover food waste from the consumer end, kitchen waste (peels, extra & pre-consumer waste), fruit waste (peels and pomace – pre-consumer waste)
v. **Tin cans** and others

Figure 2: Solid Waste at KU Cafe

CE 3.3.3

There was a construction going on at one of the campus buildings inside the university. I decided that we would perform our environmental audit at that place. The rationale for selecting that construction site was that from research I found out that [redacted] produces 4 million tons of construction waste per year approximately. I knew that construction waste is unique for an educational institution since it is not a year-round or regular waste, therefore I knew that a separate methodology is needed to handle this kind of waste. No management or plan already existed to deal with the construction waste and so I decided that it needs to be dealt with.

Figure 3: Construction Waste at Kathmandu University

I realized that the types of waste generated at construction sites included unused bricks, cement & concrete, wood, steel and packaging (paper).

CE 3.3.4

Next I analyzed the steps that were already taken by the university administration for the management for solid waste. Various types of collection bins were installed at all possible locations. Waste from playgrounds, around cafeterias, and different departments was collected by sanitary workers. The university had a contract with private waste collection service. The contractor sent in a collector on a tractor and trolley to collect all the waste.

CE 3.3.5

I determined that the next step towards making constructive suggestions towards the improvement of solid waste management was proper quantification of the generated waste. I along with my team members visited the site to identify various waste types. We counted the number of collection bins at the site, and determined that there were 15 waste bins in and around the café. I conducted key informant interviews where I talked to the administration. I asked about the frequency of collection from bins every day. I performed a preliminary analysis to quantify the amounts of different waste types inside the bin. Through the key informant interviews we determined the number of sales throughout the day. I used the average weight of each type of item and the sales made each day to calculate the weight of waste in each category.

Table 1: Bins Detail in and around the cafe

Sr. No	Bin size/liters	Waste Quantity /kg	No of Bins	Frequency	Bin description
1.	120	7	4	2	Large containers inside
2.	120	10	4	1	Large containers placed on sides
3.	45	3.5	6	1	Fixed containers placed on four sides
4.	18	1.5	1	1	Placed inside the café

Table 2: Waste Quantification

Sr. No	Waste type	Average weight	No of items	Total waste (kg/day)	Total waste (kg/year)
1.	Plastic cups	0.01	500	5.0	1825
2.	Disposable plates	0.005	800	4.0	1460
3.	Juice plastic	0.01	150 (in winter)	1.5	547.5
4.	Disposable food packaging	0.02	250	0.5	182.5
5.	Tins	0.015	100	1.5	547.5
6.	Paper bag	0.001	500	0.5	182.5
7.	Carton & cardboard waste	0.1	50	5.0	1825
8.	Plastic bottles	0.025	100	2.5	250
9.	Juice/Milk boxes	0.05	75	3.75	1368.75
10.	Glass bottles	0.345	30	10.35	3777.75
11.	Pre-consumer food waste	0.0799 (per customer)	200	15.96	5832.7
12.	Post-consumer food waste	29 % of served food	-	3	1095

Table 3: Total Amount of Waste Calculation

Sr. No	Bin size/liters	No of Bins	Frequency	Total Waste/m^3	Cumulative Waste Weight/m^3
1.	120	4	2	0.96	0.96
2.	120	4	1	0.48	1.44
3.	45	6	1	0.27	1.71
4.	18	1	1	0.018	1.728

I performed the following calculation based on the data I tabulated above.

Total waste volume per day = 1.728 m^3

Annual waste generation = 1.78 x 365

= 649.7 m^3

Table 4: Waste Quantities of Individual Components

Sr. No	Waste Type	Daily Quantity/kg	Annual Quantity/kg
1.	Food	18.96	6927.7
2.	Paper & Cardboard	9.25	3376.25
3.	Plastic	13.5	4015.025
4.	Glass	10.35	3777.75
5.	Tins	1.5	547.5

Total waste per day = 18.96 + 9.25 + 13.5 + 10.35 + 1.5

= 53.56 kg/day

Total waste per year = 53.56 x 365

= 19549.4 kg/year

I further performed the proximate analysis:

Table 5: Proximate Analysis

Waste Types	Moisture Content %	Volatile Matter %	Fixed Carbon %	Ash Content %
Food waste	70	21.4	3.6	0.2
Paper and Cardboard	10.2	75.9	8.4	5.4
Plastics	0.2	95.8	2	2.0
Glass bottles	2.0	-	-	96-99
Tins	5.0	-	-	94-99

Finally I did the Ultimate Analysis.

Table 6: Ultimate Analysis

Waste Types	Carbon %	Hydrogen %	Oxygen %	Nitrogen %	Sulfur %
Food waste	49.10	8.09	39.99	2.27	0.55
Paper and Cardboard	45.12	5.31	48.91	0.38	0.28
Plastics	86.06	6.27	1.93	5.73	0.01
Glass bottles	0.5	0.1	0.4	0.1	0.00

CE 3.3.6

Next we performed waste quantification for the construction site. My team members performed the quantification of construction waste by observation and literature references. The initial quantity of materials being used and time for construction was observed. The waste percentage was taken from the literature and tallied from the site survey. The quantification was done on the basis of literature on [redacted] construction sites. Detailed calculations were performed and the quantities of the solid waste generated was determined. I helped my team mates throughout the process of the research, observation and calculation.

CE 3.3.7

The final phase of the project was to suggest solutions for taking care of the generated waste. This was the most crucial part of the project and our grades heavily depended upon it. I along with my team mates spend considerable time coming up with practical solutions and performed the necessary analyses. First proposed solution was regarding the inorganic waste at the café. I proposed that we install bins in the cafe to collect different types of waste to ensure segregation at source. I further suggested that a small segregation plant should be set up near the composting site. The segregated waste i.e. plastics, glass, paper, and tins would then be transferred to a contractor who would use this waste as raw material for other recycled products. The establishment of a segregation facility would be beneficial both

economically as well as environmentally. It would also be a new way of profit generation. Also, it will reduce the amount of garbage that ends up in landfill sites.

CE 3.3.8

I suggested the Windrow composting method. I knew that the window composting method involves long rows of compost where the size and shape of the windrow depends on the feedstock and compost turning mechanism typically having a height of 6 - 7 feet and a width of 14 - 16 feet. In our case we had selected 6 ft height and 14 ft width. I divided the process into multiple steps:

Step 1: The first step would be the collection of organic fractions from the source and transfer to composting site and store in open field or bins.

Step 2: Shredding or pulverizing would be done to reduce the size of waste articles, this greatly speeds the composting process as microbes can consume waste more quickly. Size reduction would be accomplished with semi-wet materials crusher machine.

Step 3: The organic waste generated post the process of shredding could be combined alongwith certain supplementary material so that a decent condition of composting could be maintained, like woody waste from [redacted]

A better C/N ratio could be achieved, although the estimated C/N ratio was not very low. Also, the moisture content of hostel waste was already very optimal (70%). Next, the waste should be blended and thoroughly mixed to ensure a uniform composition.

Step 4: Then organic waste would be taken to the unit for the purpose of composting. For bringing an improvement in the product quality and increase the process speed, usual turning window (approximately two times per week) could be kept.

Step 5: The resulting mix would be transported to a different place and would wait to get post-fermented. This process would take around 25-35 days. Finally screening and bagging of the finishing composting product would take place.

Table 7: Design Parameters

Sr. No	Parameter	Values
1.	Length	4.5 ft or 1.37 m
2.	Width	2.5 ft or 0.76 m
3.	Height	1 ft 0.3048 m
4.	Days Required to be Compost	3-4 Weeks

Table 8: Techno Economical Analysis

Amount of Waste Processed (t/d)	**Scale Type**
5	Small
5-100	Medium
>100s	Large

Our Composting facility will be constructed on small scale.

Land Area Required:

18.69 kg would require 22.99 m^2 as per reference (22kg will require 26.6876 m^2)

Composting would be done for 4 weeks (28 days)

Area Calculations:

22.99 x 28 = 574.75 m2

CE 3.3.9

My team mates worked on the suggestions for construction site waste disposal. Although I had distributed tasks equally among all team members, some at the end of the day ended up doing more work than the others. However, that was not due to negligence or deliberate procrastination or work evasiveness. We all worked together and helped each other out in performing the project tasks and the success of the project was the success of each one of the team members, under my leadership.

Summary

CE 3.4.1

I was part of the team that performed the solid waste management part of environmental audit for [redacted]. It was an innovative project as we got to apply the learnings we got from the course directly to the university we were studying at. The course teacher was very helpful and supportive throughout the project duration and it was due to his kind guidance that we were able to achieve success. Leading my team in the academic project was a great learning experience for me.