

Redesigning waste: An exploration into the role of architecture in an integrated solid waste management system

Samdhen Lhendup¹, Jamyang P. Dorji²

Architecture Department

College of Science and Technology, Phuentsholing, Bhutan

lsamdhen@gmail.com¹, jamyangpdorji.cst@rub.edu.bt²

Abstract

The world is urbanizing at a pace never seen before. The UN estimates more than one third of the world's population live in urban cities and by 2050 it is estimated that more than half of the world's population will live in cities. With urbanization comes its fair share of problems. Solid waste is one of the biggest crises the world is experiencing due to urbanization. Every year the world produces about 2 billion tons of waste and 33 % of these wastes are seen to be mismanaged. These mismanaged wastes create hazards to humans, animals and more importantly irreversible damages to the environment. As waste management systems are designed to tackle these problems, it is seen that the architecture and architects have very minimal role in this waste management systems. This study delves into this predicament and studies how architecture used efficiently can help form an integrated waste management system. In the waste management industry creating awareness among people is the primary objective. So, this study proposes a waste center which would consist of a waste to energy plant, a material recovery facility and more importantly integrated public spaces that the public can access. Vibrant public spaces are seen to be the key to open up the closed process of the waste management and encourage public participation. Design features such as green roofs, green facades, natural sky lighting, jalis, water bodies are seen to create an aesthetically pleasing and serene environment. The role of architecture in waste management thus deduced was to create spaces that encourage deep reflection and thinking which in turn would change perceptions and actions and thus form holistic integration of the people and process. With grounds in that, the waste center is set to be a pioneering project that treats people's mindset as much as it treats the wastes.

Keywords: Architecture, Bhutan, Garbage, Waste Center, Planned obsolescence, Circular economy.

1. Introduction

We are living in the Anthropocene as researchers have documented a new geological epoch (Heymans et al., 2019). Human beings dominate most processes in the planet and have come to stand on the top of the food chain. The defining characteristics of this age is urbanization. The world is urbanizing at a pace never documented before. "In 2015, more than half of the world's population lived in urban areas, and by 2050, it is expected that two-thirds of humanity will call a city home" (UN ,2016). Although urbanization in itself is not a negative phenomenon it has numerous negative impacts. Negative impacts include urban sprawl, poverty unemployment, housing shortages, infrastructure shortages but most importantly harmful

environmental impacts (Zhang, 2016). Solid waste is one of the main consequences of urbanization that has a serious adverse effect to the environment. Solid waste is defined as material that no longer has any value to the person who is responsible for it (MoWHS,2011).

The world produces about 2.01 billion tons of waste annually. 33% of these wastes are said to be mismanaged and potentially harmful to the environment (World Bank,2018). Mismanaged wastes have numerous negative effects to both the environment and human beings. These include contaminating the world's ocean, clogging drains and causing floods, transmitting diseases via breeding of vectors, harming animals and affecting economic developments such as through diminished tourism.

Bhutan is a small country in South Asia with a population of about 720000 people. Although small the country is also facing the advent of a waste crisis. As the country moves towards a new age of development and prosperity, consumer trends tend to move toward the production of more and more biodegradable wastes. The per capita waste generation was seen to be about 0.253 kg per person with urban households producing about 0.7 kg and rural household about 0.5 kgs of waste every day. (NWIS,2019) 428 tons of medical wastes was seen to be produced annually with an annual increase of 15-20%. Commercial establishments produced 2.401 kg/commercial unit while offices were seen to produce about 0.207 kg/staff /day (NWIS,2019). Industrial waste amounted to about 520 tons annually (NWIS,2019). All these wastes were to be increasing every year. In total the country produces about 172 tons of waste daily. Most of which were seen to be produced from residential and commercial establishments. Thimphu, the capital city produces about 40 tons of waste daily. Illegal and indiscriminate dumping of wastes were seen in open spaces and rivers banks according to the national newspaper Kuensel. The second largest city Phuentsholing disposed of 20 tons of waste every day. However, 5- 10 tons of waste is illegally dumped every day and general awareness on waste is seen to be low among the people As Bhutan moves away from being an Agrarian society, the waste generated shows that non-biodegradable wastes are growing to be the prominent composition. As these collect over time, they don't decompose and hence are more likely to harm the environment.

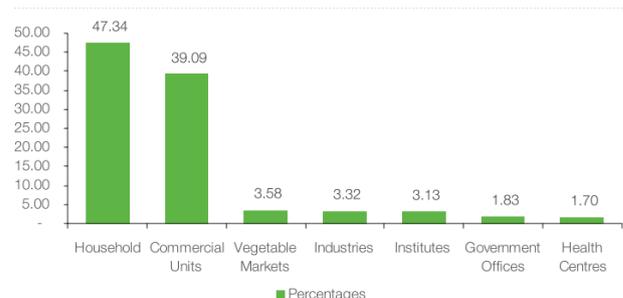


Figure 1 Waste produced by different establishments. Source: NWIS 2019

As of now, Municipal solid wastes are primarily dumped in sanitary landfills. It is estimated that about 80 % of the managed waste are dumped in the landfill sites. Landfills make up for the chief waste treatment technology with about 25 landfills around the country (Kuensel). However, the according to reports by the world bank, landfills in Asia and Africa are not up to standards on best practices from a design or managerial standpoint and cannot compare to the North American or European standards (World Bank, 2005). And true to that, Sanitary landfills in Bhutan are seen to be inadequately planned and improperly constructed (Kuensel). And since Bhutan is also a country with lots of mountainous terrain, there is a shortage of land to build required landfills (10th FYP).

The general problem with landfills as the primary waste treatment system also lies in the fact that they produce large quantities of methane, so they are far from environmentally friendly. According to the Environmental protection agency of the United States of America, Landfills are the third largest cause of anthropogenic methane production or methane produced by men (EPA,2019).

2. Methodology

The study will follow a Qualitative method with mostly case studies and literature reviews. The three aspects of the study will include Solid waste management and awareness strategy. Open and transparent architecture for industrial building and the physical aspects of a waste center. The study comprises the four phases seen in figure 2.

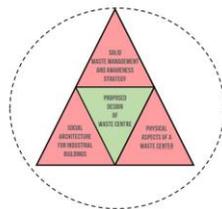


Table 1 Methodology

PHASE 1	PHASE 2	PHASE 3	PHASE 4
BACKGROUND STUDY	AREA STATEMENT	CONCEPTUAL DESIGN	WRITE UPS
1. SELECTION OF TOPIC	1. SITE VISIT	1. CONCEPTS GENERATION	1. REPORT WRITING
2. LITERATURE REVIEW	2. DESIGN INVESTIGATION	2. CONCEPTUAL DRAWINGS	2. PRESENTATION
• SOCIAL ARCHITECTURE FOR INDUSTRIAL BUILDINGS	• SITE STUDY AND ANALYSIS	3. ARCHITECTURAL DRAWINGS	3. SHEET WRITE UPS
• PHYSICAL ASPECTS OF A WASTE CENTER	• AREA PROGRAMMING	4. MODELING	4. COMPILATIONS
• WASTE MANAGEMENT STRATEGIES	• NEED FOR PROJECT		
3. HYPOTHESIS	3. ZONING		
4. SPACE ORGANODRAM	4. BUILT UP AREA		
5. SELECTION OF SITE			

Figure 2 Aspects of the project

The main focus of the research is on the role of architecture in the waste management system. The following questions reflect the general theme of the research.

- What role does architecture play in waste management?
- Why does the nature of industrial architecture be rethought upon?
- Can public spaces be used to connect people to industrial structures and more importantly industrial processes?
- How can we incorporate public spaces in industries to make industries more people friendly?

3. Literature Review

3.1. Concept

In economics and industrial design, planned obsolescence refers to the predetermined disintegration of the design after which it fails to function. Companies usually use

Samdhen Lhendup/B.Arch/CST/2021

planned obsolescence as a means to introduce new products overtime which means existing products are bound to become wastes over time and it is a planned process. Ironically in the context here however, planned obsolescence will be used here to disintegrate the structure thus it will be used to reduce waste not to generate it. The idea is the disintegration of the function of the structure as a waste treatment plant into a public friendly park and education center.



The main idea behind the waste center was to treat waste and generate awareness without harming the environment. Since public participation was a crucial aspect of the waste center initially the idea was to create a treatment plant which would be connected to the public spaces through open and green spaces but slowly it evolved into a much more integrated form. The gardens and public spaces were integrated into the design of the treatment plants. The ultimate goal in this case was the functional engulfment of the waste to energy plant through time and awareness. It symbolizes the disintegration of the structure to make way for Mother Nature. And true to that the structure integrates the surrounding environment and various other design features into its form.

3.2. Massing and form derivation

The massing was based on the concept of open and transparent architecture. The central space was used as a public plaza. The structure will open unto the public plaza, the north facing facades of the structure will have large windows to promote the interaction of public and process. Landscape here acts as the link between the different components of the waste center. It is not just another component of the waste center but inter twines with all the others and hence act as the spine of the design that supports all the others.

Kaileshwari hill and ammochu view this side

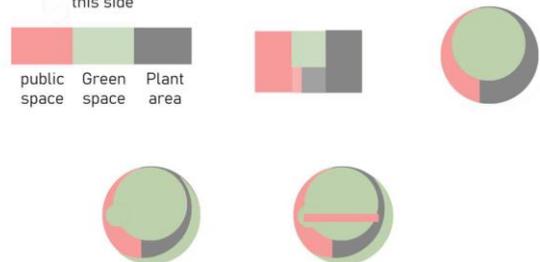


Figure 3 Massing of the waste center

3.3. Public spaces

Safety and functionality of industrial architecture has always been of the highest quality. The social and aesthetic aspect of these structures however are always found to be lacking. This kind of architecture also face severe discrimination as compared to other mainstream forms of architecture as people always looked at it with disdain, due to banality of the mass-produced structures. This has have led to consequences in the

perception of industrial architecture and have made most of them uninviting and cold.

The need for change here occurs in sectors like the waste management system where the interaction of people and the process is crucial. The now closed process has to be an open process which invites people to participate and contribute to the waste management system. For those public spaces that integrates the process and public spaces are necessary. They can contribute to erase negative stereotypes of the industrial architecture and promote people to interact with these processes. These can also lead to wonderful iconic blend of public spaces and industrial architecture.

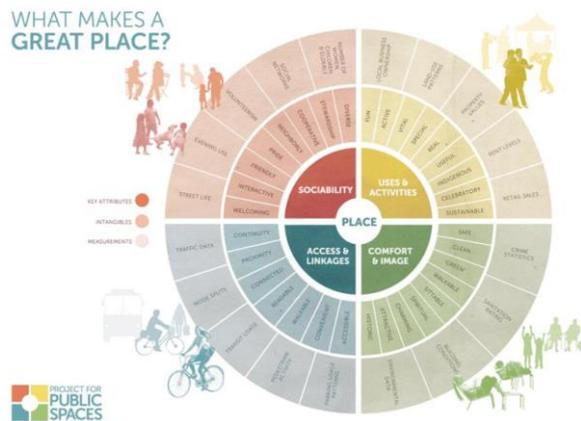


Figure 4 What makes a great place? Source: PPS

Great public places according to the PPS (project for public space) is where celebrations occur, there is exchange in social and economic activities, where people meet and interact and an exchange of culture is noticed. Public places make stages where people can gather and socialize. Researchers in the PPS after evaluating thousands of public spaces around the world have concluded the following four characteristics of a public place that make it successful. They are:

1. Accessibility

This denotes the connection to the surrounding context. How easily people can arrive and return are key to know how often people will use it. Visually the place should be unobstructed and be visible from a distance and in closer perspective. Access to public transit is also preferable and the edges of the place are important. Interesting features on the edge aside from blank walls are preferred.

2. Comfort and image

The way people perceive the place is an important component of a public space. It is often misjudged how people prefer to have a place to sit. A good image meaning a clean and healthy surrounding combined with safety and places for people to sit make up for a perfect public space.

3. Uses and activities

Activities are the primary reason why people visit public spaces. They decide why people come and why they leave. They could also be the reason people return to the spaces after they visit. Activities can make a public space special and unique. A lack of activities means people hardly ever visit the public space.

4. Sociability

Human beings are social beings who have to

constantly interact with others. A public space should promote social interactions and foster them. Although hard to attain if a public space is able to achieve it, it creates bonds and emotions that will inevitably attach to the place itself

3.4. Case studies

1. Copen hill

Reason for Selection: Copen hill is the start of the hedonistic sustainability movement which combines sustainable practices with social and aesthetic appeals.

The Amager bakke, also known as the Copen Hill designed by BIG (Bjarke Ingles Group) integrate the latest technologies in waste treatment and energy production making it the cleanest waste to energy plant in the world and connects the community and the environment with the energy plant, turning Amager bakke into urban recreational landmark. The most unique feature of the plant that makes it unique from any other plant in the world is the utilizing of the rooftop to create an artificial mountain slope where people can actually ski from.

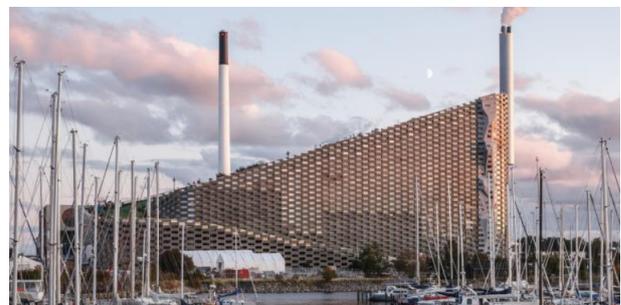


Figure 5 Copen hill

2. Bozen Waste to energy plant

Reason for selection: The waste to energy plan has an open system where the general public can be educated and participate in the working of the plant. They also have education rooms and exhibitions which creates awareness. The plant also utilizes sustainable features such as green roofs and green courtyards.



Figure 6 Bozen WtE Plant

The Bozen WtE plant is a power plant located near the entrance of the Italian city of Bolzano. The architects have used the beautiful site and surrounding context to derive the motifs for the form of the structure. It features sustainable roofs and courtyard, lively interiors for the workers and visitors and an open system which incorporates public awareness and education in the waste treatment process.

2. Incineration Line in Roskilde

Reason for selection: This incineration plant incorporates the use of heavy architectural symbolism to bring about the message of change in a historical City. The structure represents the transition into modernity through technology.



Figure 7 Incineration line at Roskilde

The plant is located in an industrial and historical zone at Roskilde, Denmark. It is located on flat landscape surrounded by commercial buildings. The aluminum perforated façade of the plant symbolizes the plant's purpose of energy production. The plant function as a glowing beacon for the city. The plant is a step towards a superior hyper modernism in a traditional city representing a gradual movement into the new age of technology.

Other case studies were also done on modern industrial buildings. Modern buildings which include

1. *Inotera Headquarters & Production Facility / tec Design Studio*
2. *Gas Kompressor Station Egtved / C. F. Møller Architects*
3. *Chayi Industrial Innovation Center / Bio-architecture formosana*
4. *Bresco WfE power plant*

These structures were studied to infer qualities and elements of a modern industrial buildings which will be used for the creation of the waste center.

4. Inferences

CASE STUDY ANALYSIS AND EXAMPLES	DESIGN FEATURES AND COMPONENTS	PUBLIC LIFE ORIENTED
<ul style="list-style-type: none"> • A strong identity • Tasteful aesthetics • Effective circulations at all levels • Large open work areas • Blend with the environment • Open friendly and playful • Exciting form • Integrated process 	<ul style="list-style-type: none"> • Architectural Symbolism • Green roof and gardens • Micro climate creation • Large open public space • Green Facades • Transparent and open architecture • Public plazas • Water bodies 	<ul style="list-style-type: none"> • Accessible • Sociable • Comfortable • Blend with environment • Plenty of sun • Sitting space • Food • water

The elements and components of great industrial architecture was derived. Great industrial architecture was shown to have a strong identity that blended with or juxtaposed the surrounding contextual environment. The aesthetics were also seen to be a crucial element and exciting forms could encourage people to visit these structures. Large open areas to work and an open and transparent system that was well circulated and friendly are necessary.

Aside from that element of public design that should be incorporated was also obtained. A good public space should be accessible, sociable comfortable and incorporate social interactions. To make a good public space and to attract more people it was seen that the sun, wind, trees, sitting

space, water bodies, and food were a factor.

From these studies various design features and components were also attained. These included architectural symbolism where architecture can be used to spread ideas and spaces could be designed based on that. Green roof, green facades and gardens that create sociable environments and microclimates for the structure. Public plazas with large open spaces can help attract people to make a transparent and open system which will align with the objectives of this study.

Additional studies were also conducted for the design of the waste center which include.

1. Area programming

The spaces are acquired from the hypothesize and conceptualized from a case study done of the B.R.E.S.C.O power plant. Various architectural standards from Neufert and time savers were used to extract the required areas for the spaces. The main components of the waste center inferred are:

Material recovery Facility plant	Waste to energy power plant	Public spaces	Offices
<ol style="list-style-type: none"> 1. Collection depot 2. Segregation point 3. Recycling plant 	<ol style="list-style-type: none"> 1. Truck parking 2. Waste stockpile 3. Furnace 4. Boiler 5. Turbine 6. Generator 7. ash collection space 	<ol style="list-style-type: none"> 1. Awareness center 2. Waste exhibition hall 3. Conference Hall 4. auditorium 5. Data room 6. Entrepreneur hub 7. Public parks 	<ol style="list-style-type: none"> 1. Offices 2. Monitoring room 3. Server rooms 4. cafeteria

Figure 9 Space organogram

2. Site analysis

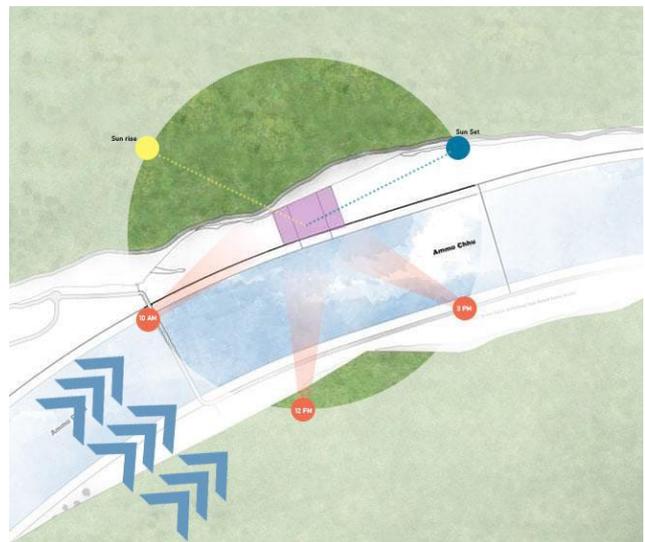


Figure 8 Site sun path and wind diagram

The site selected is on the utility precinct of the UV1 high density mixed used precinct of the Ammochu township development. The township falls under Phuentsholing Thromde, one of Bhutan's four class A thromde under Chukha dzongkhag. Selection of site for a waste to energy plant is a crucial step towards the success of the project. According to Wu considerations of site selection mainly can be summarized into business operation, government intervention, natural environment, and social influence. The study for the site is done in four main levels; City Level Analysis, Precinct Level Analysis, Site Level Analysis and SWOT Analysis. This will provide the contextual understanding of the site for the design process.

5.Application

This section focuses on the various analysis and inferences drawn from the earlier sections to design the waste center.

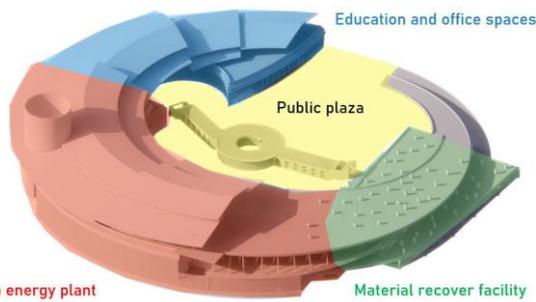


Figure 11 Components of the waste center

5.1. Design Translation

The four main components of the waste center will be

1. Material recovery facility
2. Waste to energy plant
3. Education and office spaces
4. Public Plaza



Figure 12 Site plan

The total site area is 8.02 acres. The structure plinth area is about 2.2 acres with a built-up area of 23195 m². This means that the structure covers 27.4% of the total site area and has a FAR of 0.69. The entrance of the structure falls on the northern side of the site. Four main entrances have been provided for the structure. This is to differentiate the different traffics of: people, vehicles and waste trucks. Underground basement parking has been provided for both the public and Garbage trucks. The main entrance opens up to a large public plaza which becomes the connecting space for all the other spaces.

5.1. Design Details

The following features and components have been implemented into the design of the waste center. It features a central public plaza for an open and transparent architecture. Green open spaces will be utilized to bind all these together as well as act as a component itself. Circulation of people and waste trucks are differentiated to prevent accidents.

The structure has a strong identity. Traditional

Samdhen Lhendup/B.Arch/CST/2021

Bhutanese iconography is embossed into the concrete as well as create the patterns of the jail. The roofs are a highly

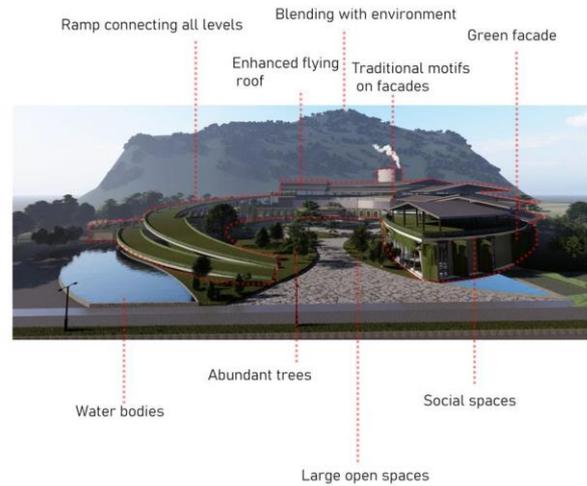


Figure 10 Implemented components and elements'

exaggerated version of the Bhutanese flying roof. Aside from that, the most prominent feature of the design is the engulfment of nature. Looking at the structure from a distance reveals the facades shrouded in nature. Landscaping and the structure here become one. These was mainly done to create a micro climate and make the structure aesthetically pleasing. Water bodies and trees are also a big part of the structure. These two feature compliments the structure at every side. The form of the structure also strays away from conventional Bhutanese form, this is done not only to create an exciting and unique form but to accentuate the views of the Kaileshwari hill and take advantage of the wind and sun to its maximum. A circular form encourages open and transparent architecture. The center will also have green roofs which people can access through the large green ramps that connect all levels of the design



Figure 13 Elevation of the waste center



Figure 15 Main entrance view

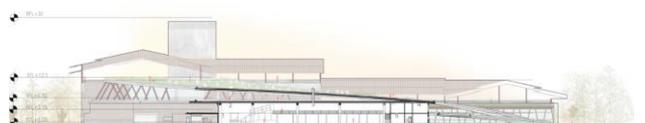


Figure 14 Section through material recovery facility



Figure 16 View of Public Plaza



Figure 17 View of ramps

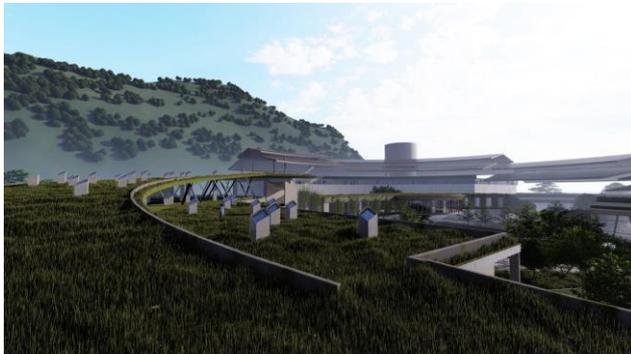


Figure 18 View of Green ramps and rooftop gardens

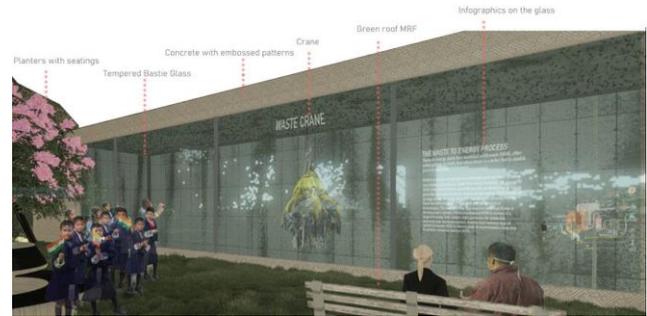


Figure 19 View of second public entrance

The Phuentsholing waste awareness center will be a facility aimed at the aversion of a waste crisis in Phuentsholing and in Bhutan. It aims not only at treating of the waste in an environmentally friendly processes and generating commercial value for wastes which are considered a nuisance but also at creating awareness about waste and an indoctrination of a new waste culture. This thus fulfils the 3 pillars of sustainability the economic, commercial and social aspects. Hence the project is a part of sustainable development. The center will also be equipped with various education and awareness-oriented spaces. These spaces include

1.Crane theatre

The space acts as a place to relax as well as a place to learn. The people will be able to see the waste crane picking up the waste and the start of the waste to energy process. Infographics about waste management and the process will be printed on the Bastie/tempered glass.



2.Reflection space

The reflecting space is a space floating in the center of the public plaza. Makes use of the open space and abundance of natural light and greeneries to create a deep deflection space in both a metaphorical and real sense. It becomes a reflecting space where people get to know where we are and where we are headed to. It is the focal point of the center and signifies the start of the journey of the waste management in an individual and in the society. It is adorned with waste infographics on the glasses.



3.We are Here room

The we are here room or the waste theater is a room where we get to see the stockpile. It showcases the waste that we produce collectively and is aimed at shocking people. It is expected to create questions in the spectators' mind of where we are and where are headed to with our present waste culture. This room also helps us to have a collective goal that we as a community can align to so that we can reach a targeted goal indicator that will change every year.

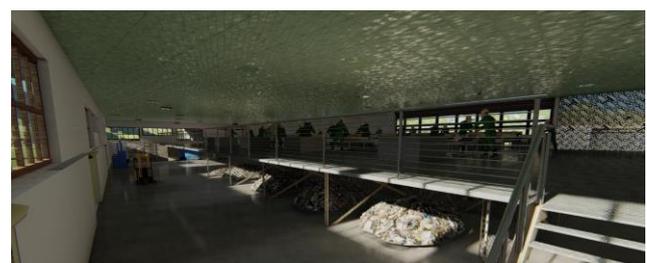


Figure 20 Interior of the MRF

Conclusion

Waste management is a multidisciplinary approach however since the undertaking of this research the primary question has always been what the role of architecture is in this system. The role of architecture it seems is to create meaningful space that have the ability to change mindsets, perceptions and most importantly cultures.

Although Bhutan cannot be said to be undergoing a waste crisis, it is a possible future. The present waste culture and lack of awareness is of the greatest concern. Aside from that the treatment of waste in Bhutan is inadequate and that leads to mismanaged wastes that can potentially harm the environment.

The proposal of this waste center in the new Ammochu Township development will act as a pilot project where the three aspects of environment, commercial and social are integrated into the waste treatment to form a holistic development. Aside from that it will also create awareness and change people's perception to the stereotypical notions of waste and thus aim at solving the problems rather than treat the consequences.

As of now, Waste treatment hand waste management has always been a closed process. People produce waste and dump it into the garbage trucks and that is the end of the waste management process in the perspective of the general public but the actual process happens behind all this. An open and transparent system is necessary for an integrated waste management system. Architecture can be a helpful tool to create this open and transparent system.

Research shows that a big part of the mind set and indifference that people have about industrial buildings is part of the problem. Industrial architecture prioritizes safety and function over social and aesthetic appeals. Hence the creation of a holistic facility that will not only focus on the safety and efficiency of the plant that will treat the waste but also have good aesthetic and social appeals will help people to participate in the waste management system. Aesthetic and social appeals can be introduced through various means in industrial architecture but vibrant public park and emphasis on open and transparent architecture has shown to be effective.

Through the studies carried out, it is expected that it can help people realize that the role of architecture in waste management is to create structures that change people's perception and thoughts. These are the key to a sustainable world where everyone lives in harmony with the environment.

Further Research

This study has hypothesized a waste center that is expected to not only treat the waste that people produce but also the mindsets and perception of waste in peoples' mind. The main focus of this study has been on the architectural and spatial aspect of the waste management system. Further studies can be carried out to explore on the technical and financial aspects of the waste center. Aside from that it is recommended that the following areas be looked upon in any future study:

- Feasibility studies of a WTE plant
- Further studies on technical and financial aspects of a waste to energy plant
- Investigation into the use of public spaces to retrofit already existing industrial architecture
- Public space design standards for industrial buildings
- A Bhutanese industrial architectural guideline

Reference

- ADB. (2013). Solid Waste Management in Nepal: Current Status and Policy Recommendations. In Asian Development Bank (ADB). Buildings, C. (n.d.). Space Guidelines for Recycling, Organics and Refuse Services.
- Asian Development Bank. (2018). Bhutan: Phuentsholing township development project. May.
- Bylinsky G. (1995). Manufacturing for reuse. *Fortune* 131: 102–103.
- EPA. (2020, March). *National Overview: Facts and Figures on Materials, Wastes and Recycling*. Retrieved from <https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials>
- EPA. (n.d.). *Basic Information about Landfill Gas*. Retrieved from EPA: <https://www.epa.gov/lmop/basic-information-about-landfill-gas>
- Ganser, A. (2017, January 18). *High Line Magazine: BIG DA+A and Parks*. Retrieved from Official Highline website: <https://www.thehighline.org/blog/2017/01/18/high-line-magazine-big-daa-and-parks/>
- Global Waste Management Outlook. (2016). In *Global Waste Management Outlook*.
- Gyelmo, D. (2018, April 6). *Bhutan economy boost brings a rising waste problem*. Retrieved from The third pole: <https://www.thethirdpole.net/en/pollution/bhutan-waste/>
- Han, R., Liu, D., & Cornaglia, P. (2020). A Study on the Origin of China's Modern Industrial Architecture and Its Development Strategies of Industrial Tourism. *Sustainability*, 12(9), 3609.
- Humes, E. (2012). *Garbology: Our dirty love affair with trash*. New York: Avery
- Jevremovic, L., Vasic, M., & Jordanovic, M. (2012). Aesthetics of Industrial Architecture in the Context of Industrial Buildings Conversion. *PhIDAC, September 2012*, 80–88.
- Ministry of Works and Human Settlements. (2007). *National Strategy and Action Plan on Integrated Solid Waste Management*.
- Royal Government of Bhutan. (2017). *Population & Housing Census of Bhutan*.
- Royal Society for Protection of Nature. (n.d.). *Policy Framework for Solid Waste Management*
- MoWHS (2018). *Strategic Environmental Assessment for the Thimphu Structure Plan*. June.
- Ministry of works and human Settlement. (n.d.). *Presentation on Solid Waste Presentation overview*.
- Ministry of Works and Human Settlements. (2007). *National Strategy and Action Plan on Integrated Solid Waste Management*.
- Ministry of Works & Human Settlement. (2013). *Phuentsholing structure plan-2013-2028 (Vol. 01). 01*, 1–163.
- Muller, J. A. (2016). *THE ARCHITECTURE OF WASTE Creating New Avenues for Public Engagement with Trash*. Maryland: University of Maryland.

- Norbu.K., Tenzin,T.Wangmo,S & Karchung (July,2020). Analysis of Energy Potential in Municipal Solid Waste of Bhutan and Exploration of Alternate Power
- NWIS. (2019). Nation's waste on the scale.
- Phuntsho, S., Dulal, I., Yangden, D., Tenzin, U. M., Herat, S., Shon, H., & Vigneswaran, S. (2010). Studying municipal solid waste generation and composition in the urban areas of Bhutan. *Waste Management and Research*, 28(6), 545–551.
- PPS. (n.d.). What Makes a Successful Place? Retrieved from Project for public space: <https://www.pps.org/article/grplacefeat#:~:text=In%20evaluating%20thousands%20of%20public,one%20where%20people%20meet%20each>
- Rai, S. Bi. (2015). UNDERSTANDING THE EFFECTIVENESS OF THE CURRENT WASTE MANAGEMENT SYSTEM IN THIMPHU CITY, BHUTAN (Vol. 49, Issues 23–6).
- Ramos, S. (2015, October 21). You might be a NIMBY. Retrieved from Buildings are cool: <http://www.buildingsarecool.com/new-blog/you-might-be-a-nimby>
- Rönn, M. (1996). Award-winning Industrial Architecture. *Nordisk Arkitekturforskning*, 1, 37–51.
- Royal Government of Bhutan. (2017). Population & Housing Census of Bhutan.
- Royal Society for Protection of Nature. (n.d.). Policy Framework for Solid Waste Management.
- Schübeler, P. (1997). A conceptual framework for municipal solid waste management in developing countries. *Waste Management and Research*, 15(4), 437–446. <https://doi.org/10.1006/wmre.1997.0098>
- Settlements, M. of W. and H. (2018). Strategic Environmental Assessment for the Thimphu Structure Plan. June.
- Silpa Kaza, Lisa Yao, Perinaz Bhada-Tata, and F. V. W. (2018). What a waste 2.0. In World Bank Group
- TCB. (2018). Bhutan tourism monitor 2018. 1–60. www.tourism.gov.bt
- Tshering, N. (2020, June 11). Dustbins and Landfills – a thing of the past. Retrieved from Kuensel: <https://kuenselonline.com/dustbins-and-landfills-a-thing-of-the-past/>
- Tsheringt. (2016). Bhutan State of the environment report 2016 National Environment Commission Royal Government of Bhutan 2016 Bhutan State of the Environment Report 2016.
- Tshomo. U, Dorji .C & Dahal.Y (2020), integrated waste management in Bhutan. Circular economy: Global perspective.
- UN. (2018, May 16). *68% of the world population projected to live in urban areas by 2050, says UN*. Retrieved from n.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.hre
- Whyte, W. H. (1980). The social life of small urban spaces. Washington, D.C: Conservation Foundation.
- Wu, Y., Qin, L., Xu, C., & Ji, S. (2018). Site selection of waste-to-energy (WtE) plant considering public satisfaction by an extended vikor method. *Mathematical Problems in Engineering*, 2018(ii).
- Zhang, X. Q. (2016). The trends, promises and challenges of urbanisation in the world. *Habitat International*, 54(November 2015), 241–252.
- Zannon.D. (2016). *A Model for Estimating Urban Park Visitation A Model for Estimating Urban Park Visitation. June 1998*.

