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Empowerment through recycling

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2022

Empowerment through Recycling

Architecture- ARPL 7003A

James Ndeda
2178165

This document is submitted in partial fulfilment for the degree:
Master of Architecture [Professional] at the University of the Witwatersrand, Johannesburg, South Africa, in the year 2022.

DECLARATION

I, James Ndeda, 2178165 am a student registered for the degree M.Arch(Prof) in the year 2022. I hereby declare the following:

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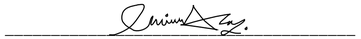
James Ndeda 20/09/2022



ABSTRACT

THEORY STATEMENT

Through blending and integration of Architecture as a device for transformation of non-formal settlement, this thesis looks at the possibility of transforming waste material into building materials and, in the process, mitigating two major crises; poor housing conditions and unemployment among the youth of Alexandra.

CONTEXT STATEMENT

The Project is located in Alexandra, Johannesburg in Gauteng Province. Established in 1912, Alexandra is one of Johannesburg's oldest townships, located adjacent to Sandton, Johannesburg's economic hub. *Alexandra typifies a majorly disenfranchised community in the context of South Africa, suffering the consequences of socio-economic marginalisation of black urban neighbourhoods during the apartheid era. Nearly 500 000 people live in approximately 100 000 households in formal and informal housing; unemployment is estimated to be at 60%, and most household incomes fall below the extreme poverty line of less than 1 USD per person per day.*
My intervention aims at mitigating the conditions of poor and inadequate housing and unemployment through an innovative approach of transforming plastic waste into building materials.

FACILITY STATEMENT

The project is a blend of three typologies: Infrastructure; Recycling/reusing waste materials. Industrial; Manufacturing Building materials from Plastic. Institutional; Training of labourers and reintegration into industry. The facility will house a process of collection and transformation of waste materials into building materials- through various participatory mechanical and artisanal systems, that would be tested and implemented on site and off site within the immediate context of Alexandra, improving the existing conditions of housing.

There will be a curation and incorporation of youth between ages 20 and 29 into the construction and operation of the project, creating a community that provides an opportunity for socio-economic interaction and exchange that would empower the youth of Alexandra.

THESIS STRUCTURE

01 OVERVIEW

1.1 INTRODUCTION

1.2 METHODOLOGY

1.3 LITERATURE REVIEW

02 ISSUE AND THEORY

2.1 SOLID WASTE

The crisis of solid waste

Economy of Recycling

Waste management initiatives

Rationality of Choice

Intention

2.2 RECYCLING

Focus

Precedent studies

Viability study

Systems & Input management

The recycling process

Output management & applications

Housing Issue

The shack problem

03 CONTEXT

3.1 A CASE OF ALEXANDRA

Demographics

Target group

3.2 SITE ANALYSIS

Location

Site context

Street activity

Amenities

Accessibility: Zoning & access

Possible Waste sources

Climate

04 ARCHITECTURAL RESPONSE

4.1 DESIGN REFLECTION

Charreette

Charrette translation

4.2 DESIGN DEVELOPMENT

Site and spatial planning/Organisation

Climate response

4.3 BUILDING SYSTEMS

Structural systems

Mechanical systems

Electrical systems

Sanitary and systems

4.3 ARCHITECTURAL DRAWINGS

05 SYNTHESIS AND REFLECTION

06 BIBLIOGRAPHY

01 OVERVIEW



Fig. 1: Graphical representation of a circular economy of waste recycling

Mpactrecycling.co.za. 2022. Home | Mpact Recycling. [online] Available at: <https://www.mpactrecycling.co.za> [Accessed 2 August 2022].

Introduction

The following is research around the existing realities of waste management in Johannesburg- more specifically, around the township of Alexandra. It is an investigation of the different sectors of waste management and how they contribute to mitigating poor waste management.

This investigations will in turn give a nuanced perspective on the matter of waste management and recycling that will come handy in the designing of a recycling centre, that aims at recycling plastic waste, transforming it into building materials and other useful products.

RESEARCH METHODOLOGY

Primary Data collection

-Mapping

-Site & context analysis

-Site visits

-Observation & study of context and exixting socio-economic fabric

-Contacting professionals in waste management industry

Secondary Data collection

-Case Studies- learning institutions & waste recycling facilities

-Literature reviews

-Journals

-Government statistics- Alexandra

-Government initiatives/interventions on waste management

-Contacting professionals in waste management industry

-Academic writings- Education and waste management

Literature Review

THE SOCIO-ECONOMIC IMPACT OF GOVERNMENT'S URBAN RENEWAL INITIATIVES: THE CASE OF ALEXANDRA TOWNSHIP- Phindile Mbanjwa, UCT January 2018

This is a research that was carried out *to investigate the impact of the implementation of the Alexandra Renewal Programme (ARP) on the lives of the inhabitants of the Johannesburg township of Alexandra, in South Africa*. The urban renewal project was spearheaded by the government in collaboration with the private sector and community-based organisations. The project aimed to mitigate the existing physical, social and economic conditions of the settlement.

The impact of township renewal programmes such as the ARP has not been evaluated comprehensively. Furthermore, concerns have recently been raised about the pace of government efforts to drive the change required. Qualitative research techniques were used to conduct this case study.

"Focus groups were made with 32 residents from formal and informal settlements in the township and the research data was analysed using thematic content analysis. The study recommends that the three spheres of government (national, provincial and local) should collaborate more to develop relevant policies which drive urgency and effectiveness into the implementation of the urban renewal programme (URP) in Alexandra, and in the Gauteng province in general."

This research was successful in highliting the current sorry state of townships in South Africa. Alexandra offers a theatrical contrast when looked at in comparison to Sandton, a suburb right next to it. It is rather disturbing that the country has two extremes of infrastructural and socio-economic development right next to each other. On one side, citizens being impoverished and dying from poor sanitation while on the other, citizens inebirating in wealth and good infrastructure with bright socio-economic prospects.

A renewal program is long overdue in our disenfranchised communities. There needs to be a collective effort to revamp the townships in the different provinces with urgency. My intervention will also play a part in this by offering an opportunity to the youth, primarily those who are informal waste collectors, to work and participate in waste management while improving their living standards.

*(**THE CASE OF ALEXANDRA TOWNSHIP-** Phindile Mbanjwa, UCT January 2018)*

UPGRADING INFORMAL SETTLEMENTS IN SOUTH AFRICA: A PARTNERSHIP-BASED APPROACH- Mr. Thomas Stewart, Lecturer, Urban Regional planning, UFS

This publication discusses some initiatives and revisits proven practices pertaining to upgrading of informal settlements- supported by case studies, experiences and appropriate examples.

"While many books and publications on the topic are available, this publication draws from the contributions of no less than 41 authors and co-authors, including academic authorities, technical professionals, and human settlement cum informal settlement practitioners. The 'compendium' of writings, primarily facilitated by the Isandla Institute and African Centre for Cities, supported financially by, among others, the Ford Foundation, the Swedish Foundation for Strategic Environmental Research (Mistra), and the Swedish International Development Cooperation Agency (Sida) makes for a comprehensive read and introduction to the South African and, to a lesser extent, the sub-Saharan human and informal settlement context."

Haywood LK;Kapwata T;Oelofse S;Breetzke G;Wright CY; (2021) Waste disposal practices in low-income settlements of South Africa, International journal of environmental research and public health. U.S. National Library of Medicine.

A partnership-based approach is a convincing avenue towards rebuilding our informal settlements. It is a plausible approach to development as it allows for an opportunity to create a pool of knowledge and skills from which projects and initiatives can emmerge. It increases the chances of real problem solving as it provides a platform that invites competent parties with specialisation and experience in different aspects of the problem of impoverished townships.

This approach is also plausible with regards to funding. Rather than relying only on government for funding, it allows for other benefactors to chip in, reducing the chances of stalling due to lack of adequate funding. This strategy shall be employed in my intervention mainly to source for skills and knowlegde in the field of recycling and waste management, as well as funding.

(Upgrading informal settlements in South Africa:** Liza Rose Cirolia, UCT Press 2016**)

WASTE DISPOSAL PRACTICES IN LOW-INCOME SETTLEMENTS OF SOUTH AFRICA

Domestic solid waste is increasing exponentially as a result of accelerated population growth especially in low income settlements and urbanization. Improper waste disposal poses risks to health and environment. Investigations were made aimed at waste disposal practices in relation to dwelling characteristics in South African low-income communities. Data was sourced from 2014 to 2019, from a community-orientated primary care program that was analysed using logistic regression- in simple terms, Logistic regression is a statistical analysis method used to predict a binary outcome, such as yes or no, based on prior observations of a data set. It was found that families that live in shacks, and used non-electric sources of fuel for cooking, those with poor sanitation, and those lacking access to piped water inside their dwellings were more likely to dump waste in the streets, in the yard or burying it. Families living in disenfranchised settlements are therefore at risk of exposure to solid waste and its negative side effects.

One of the main reasons as to why sustainable waste disposal practices are not popular in the townships is that the enterprises offering these services are not motivated to collect waste in these places as it is not as profitable for them. They would rather set up waste disposal systems in the suburbs where they are certain that they will make profit as the people in the suburbs are willing to pay for these services. This leaves the government no choice but to pull the weight by themselves in most instances. Unfortunately the people in the townships suffer in the end as the government is unable to solve the problem sufficiently, leaving the inhabitatnts exposed to the extremities that come as a result of poor waste disposal practices.

My intervention will accelerate the process of seting up formal chanels of waste disposal in said context. There will be a heavy reliance on waste collected from around the immediate and mediate context as raw materials. It will therefore be crucial to set up waste disposal and collection systems that will facilitate disposal so as to collect as much waste as possible in the shortest possible time for use as raw materials for recycling.

International journal of environmental research and public health, 2021 August. Lorren Kirsty Haywood, Thandi Kapwata, Suzan Oelofse, Gregory Breetkzke
***Keywords:** environmental health; pollution; poverty; service delivery; waste management*

PRACTICAL RECYCLING APPLICATIONS OF CRUSHED WASTE GLASS IN CONSTRUCTION MATERIALS. Construction and Building Materials, Vol. 156.- Prof. Michael C Forde, The University of Edinburgh, Institute for Infrastructure & Environment, School of Engineering, Edinburgh, Scotland, UK. (Review)

Abstract: *The disposal of waste glass in landfills is an important environmental challenge that many countries face around the world. The repurposing of waste glass into a construction material reduces the consumption of natural resources, minimizes greenhouse emissions and alleviates landfill scarcity. Over the last sixty-five years, numerous investigators have studied reusing crushed waste glass (CWG) as a construction material. However, CWG has not been widely used in concrete or asphalt construction applications across the globe. Additionally, barriers still exist that prevent CWG from being used as a fine aggregate in concrete, such as the severity of Alkali-silica reaction (ASR) expansions within concrete consisting of CWG, and the lack of understanding of these reactions. This paper presents an overview of previous studies carried out by researchers to reuse CWG as an aggregate in concrete and asphalt mixtures, an aggregate in unbound base and subbase applications, lightweight engineering material and a cementitious material. From the literature review conducted, it can be concluded that CWG has potential use as an aggregate in construction materials. More research is required to clarify contradictions regarding the properties of concrete containing CWG as fine aggregate, as well as further investigation of the properties of foamed waste glass concrete and ultra-lightweight fibre reinforced concrete containing expanded waste glass, and the use of glass powder as a filler in asphalt.*

Glass and plastic have a similar way of being recycled. The process can be simplified to 5 major steps. Collection, sortition, granulation, melting, moulding. One notable difference however, with glass is that, it can be recycled at the granuation stage, before being melted. Gass that is granulated can be used as aggegate in various mixtures such as concrete, terrazzo etc.

The simplicity of the process of reycling plastic, as with glass, makes it a very easy affair to implement. No specialised labour is required or spohisticated equipment for the process of recycling- more so with plastic. This makes plastic a perfect candidate to specialise in especiaally in the context of Alexandra where people suffer from shortage skills and knowledge due to high levels of illitracy.

(***Construction and Building Materials,*** *Volume 156, 15 December 2017, Pages 443-467)*

ARCHITECTURE AS A DEVICE: THE DESIGN OF WASTE RECYCLING COLLECTION CENTRES, Maria Luna Nobile, DiARC Department of Architecture, University of Napoli Federico II, via Toledo 402, 80123 Napoli, Italy, June 2018

This project approaches architecture as a more comprehensive process by reflecting on the role of architecture in urban transformation. It looks into the current conversation's main characters; the oreticians and architects, demonstrating that it is feasible to deliberate one's focus to a new way of developing architecture as a device for socio-economic transformation.

"The proposed topic is related to research conducted on the architecture and design of public spaces for waste recycling collection centres in the Department of Architecture of the University Federico II in Naples, Italy. The main idea is to conceive waste recycling collection centres not only for their service function but for public spaces in the city. The waste collection centres can have new associated functions, such as laboratories, markets, exhibition areas and rooms for educational activities. According to the guidelines of the Campania Region, a recycling collection centre is, "An area located in the city, and the number of centres is proportional to the number of citizens." According to these guidelines, the project wants to demonstrate that it is possible to avoid the NIMBY (Not In My Backyard) effect and to integrate this inconvenient function within the city centre, connecting these centres with other activities intended for community use that can be integrated with the size and the function of the recycling collection centre. This functional contamination does not mask an inconvenient function but increases the social value of these places. The case studies for designing waste recycling collection centres were developed according to the guidelines of this re- search and are described in this article."

This is a very useful approach to socio-ecomomic development and upgrading of the townships in South Africa. Poor waste dispsal is a crisis that is recurrent in all townships and disenfranchised communities. It is therefore appropriate to take on waste recycling in these places and use it as a catalyst for revamping the their current conditions. Recycling can be a great device for rehabilitation of the people living in these contexts through upskilling, reintegration.

My intervention will source labour primarily from within the context of Alexandra. This will give them a chance to benefit from the ntervention in ways mentioned above.

(***DiARC Department of Architecture****, University of Napoli Federico II, via Toledo 402, 80123 Napoli, Italy, June 2018).*

RECOGNISING THE INFORMAL WASTE SECTOR, Department of Department of Environmental Affairs, by Nanja Churr, from Kayamandi Development Services Ltd.

This report investigates the role of the informal waste collection sector in the bigger picture of solid waste management nationally, and contrasts it with the formal waste collection sector to acknowledge the different realities of the two and propose a solution for integration. From this report, it is evident that the informal waste sector is pulling most of the wait with regards to waste management in South Africa. Informal waste collectors might not have the formal academic training on how to deal withwaste, but they sure do have their non-formal yet very plausible ways to deal with waste. Their methodologies are very colloquial and inclusive.

Informal waste collectors face a lot of challanges during work such as extreme harsh weather conditions that they have to contend with as they are moving from one waste depot to another dropping off and collecting waste. They also have a crisis of housing, with most of them sleeping whenever night finds them or as close as possible to waste sources. This leads to other problems such as health complications and altercations with security guards and law enforcement.

Another challange they face is that of remuneration. Because of poor remuneration, most informal waste collectors live from hand to mouth with no capacity fo making savings or covering huge expenses on short call. As a result they live very hard lives. I personally have witnessed a scenario where a waste collector was walking by a street close to my residence and just dropped dead. This individual must have been suffering from a chronic illness but lacked enough funds to seek treatment for whatever he was suffering from. This is but one unfortunate instance of many that befall informal waste collectors as a result of poverty.

My facility aims at mitigating these crises by incorporating them beyond the stage of collection and dropping off of waste. To include them in the process of recycling, and in this way increase their value by upskilling them and offering them an opportunity to get exposed to bigger possibilities and opportunities within the recycling industry. My intervention will be a success if it will serve as a launchpad for informal waste collectors and other participants from the community of Alexandra to expand and seek greener pastures with new innovations and initiatives around the waste management sector.

https://www.dffe.gov.za/sites/default/files/docs/publications/recognisingtheinformalwastesector.pdf

02 ISSUE & THEORY



Fig 2: A heap of plastic waste at a dumpsite illustrating the crisis of plastic waste.
Striga, R., 2021. Will Chemical Recycling Solve Our Plastic Problems.

Crisis of Waste

According to the UN's estimates, the current world population of 7.3 billion is expected to reach 9.7 billion by 2050 and 11.2 billion by 2100- an additional 2.1 billion people. This will only add pressure immensely on the already fragile earth's eco-system. Consequently, waste generation is expected to increase. Landfills emit gases and water that has percolated through the fills, leach out some of the constituents from the waste and carries them along into waterways and streams. This has an adverse effect on the ecosystem.

It is estimated that landfills contribute up to about 20% of greenhouse gas emissions globally, and leaching of toxic chemicals such as lead, boron, beryllium, mercury, cadmium, arsenic, thallium and hydrocarbon compounds into the environment.

U.S. Environmental Protection Agency; Landfill Methane Outreach Program (LMOP)
Landfill Methane Outreach Program (LMOP); Basic Information about Landfill Gas (2022) EPA. Environmental Protection Agency. Available at: https://www.epa.gov/lmop/basic-information-about-landfill-gas (Accessed: February 13, 2023).

In South Africa, solid waste is increasing exponentially due to rapid urbanization, an accelerated population growth, and an increase in economic activities, while municipal service delivery is grappling to adapt to the new volumes of waste. This waste commonly consists of; business waste, building and demolition waste, domestic waste and garden refuse. Domestic waste constitutes a huge percentage of the total waste and is the one with the biggest impact on the health of people living in disenfranchised communities.

Municipalities have a responsibility to implement and oversee effective waste management services from removal, to storage, to the transportation, and final disposal of waste. The South Africa national standards for waste collection have, over time, come to a point of acknowledging the existence of different levels and modes of service delivery, dependant on practicality, frequency and cost-efficiency in a given context. Waste removal frequencies are prescribed to avoid health hazards, e.g. containers must be removed within 24 hours of being filled up, with worst case scenario being once a week to avoid piling up of waste. Furthermore, the National Policy of the Department of Environmental Affairs for the Provision of Basic Refuse Removal Services to indigent households, mostly found in low income settlements, compel municipalities to provide waste collection services at least on a weekly basis to households regardless of whether they can afford the service.

This initiative, however, has failed to take off and often municipalities do not respond to the needs of the disenfranchised communities- mostly as a result of poor accessibility from poor spatial planning. This is a huge crisis because such settlements often have high occupancy exceeding the maximum limit that existing infrastructures and space can sustain. As a result, vacant land near such unserviced areas in South Africa become misused by extensive littering and illegal dumping.

Uncollected and illegally dumped domestic, business, demolition waste etc. contribute to several negative environmental impacts. Often, drains get clogged with waste that is neglected, causing flooding during rainy seasons. Extreme temperatures and humid conditions increase the potential of generation of leach from dumped organic waste, which penetrates soil and contaminate ground water. The stagnation of water in waste dumps attracts mosquitoes and other insects which breed and end up spreading vector-borne diseases that affect the health of people living in these contexts.

In some cases, domestic waste is incinerated, which creates fumes and smoke that contains carbon monoxide, and other gases, which are harmful to human health. Burning produces greenhouse gases that contribute to global warming. According to UN-Habitat health data, acute respiratory infections and diarrhoea are significantly higher in children living in households that are in areas without regular waste removal services and where dumping or burning of waste materials in the yard occurs, compared to households that have regular waste collection service.

In South Africa, low-income communities comprise of settlements characterized by a mesh of formal (e.g., house, flat) and informal (e.g., shack) dwellings, as well as having socio-economic challenges such as poverty, overcrowding and insecurity. The existence of low income settlements is partly attributed to the ever shaky political and economic environment of the country, with poor governance, lack of access to land, lack of finance, relatively high cost of building materials, and poor urban planning.

Formal houses are typically made of bricks while informal dwellings include shacks or traditional huts (i.e., dwellings not compliant with current SANS building regulations). The most common features of these informal settlements include; overcrowding, small sizes of houses with poor building standards, lack of basic amenities and inadequate or absence of supply of municipal services including the supply of the basic utilities (water and electricity), Inadequate sewage collection systems and poor sanitation, and waste removal. UN-Habitat characterizes areas such as these as "slums." A 2011 study investigated the strain posed by the lack of municipal services on public health in dense, low-cost housing communities in Cape Town. Of the four communities living in low-cost housing who were surveyed, 68% said that they did not have waste bins inside their dwellings and 22% of the households disposed of their solid waste on the street. All the respondents in the survey complained of pests including rats, cockroaches, fleas, and flies carrying potential health risks within their immediate home environment.

(Govender, T.; Barnes, J.M.; Pieper, C.H.- Environ. Hous. Insight 2011)

Given the potential relations between household, dwelling characteristics and waste management, as well as the possible environmental health risks posed by uncollected waste on individuals living in low-income settlement, this study investigated waste disposal practices, e.g. formal waste collection, illegal dumping (e.g., in street, open land, etc.), burning or burying of waste, in relation to household and dwelling characteristics among individuals living in low-income communities in South Africa.

(Waste Disposal Practices in Low-Income Settlements of South Africa, Lorren Kirsty Haywood, Thandi Kapwata)

Having an understanding of the relationship between households and waste management, and the impact they have on each other in terms of health risks is needed to motivate local municipalities to address the lack of proper and reliable waste management service delivery systems to all settlement areas and for all households, regardless of location and dwelling typology. Such information will also help catalyse and inform development of awareness campaigns and initiatives for waste disposal.

Landfill Methane Outreach Program (LMOP); Basic Information about Landfill Gas (2022) EPA. Environmental Protection Agency. Available at: https://www.epa.gov/lmop/basic-information-about-landfill-gas (Accessed: February 13, 2023).

Hub, I.I.S.D.S.D.G.K. (no date) World population to reach 9.9 billion by 2050: News: SDG knowledge hub: IISD, SDG Knowledge Hub. Available at: https://sdg.iisd.org/news/world-population-to-reach-9-9-billion-by-2050/ (Accessed: February 3, 2023).

The Economy of Recycling

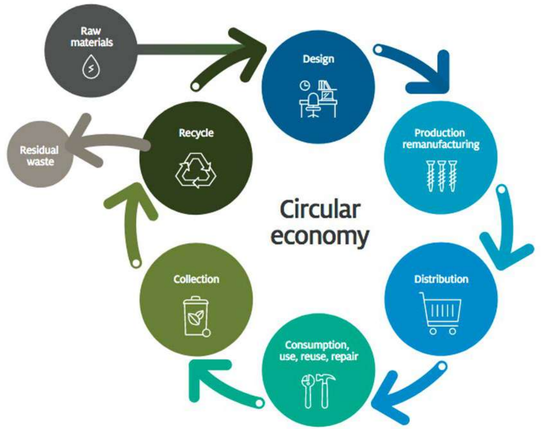


Fig 3: An illustration of a typical recycling economy
Source; Discover Magazine.

Non-profit organisation Green Cape's 'Waste 2020 Market Intelligence Report,' estimates that *the local waste economy of South Africa contributes about R24.3-billion to the country's GDP. This supports an estimated 36 000 formal jobs and a further 80 000 informal jobs.* Rajas Pillay, a waste management company Interwaste human resources and transformation director, explains, *"A paradigm shift needs to occur, whereby recycling is emphasised. By implementing the waste management hierarchy, we will embrace green economic empowerment (GEE)."*

Article by Darren Parker; Significant untapped potential in local waste economy, September 2021
Parker, D. (no date) Significant untapped potential in local waste economy, Engineering News. Available at: https://www.engineeringnews.co.za/article/significant-untapped-potential-in-local-waste-economy-2021-09-24/rep_id:4136 (Accessed: February 13, 2023).

Pillay argues that, *such a paradigm shift, if implemented effectively with adequate public-private sector support, could result in an increase in the GDP value of the local waste economy. This will in turn not only create many more jobs but also enhance participants' earning potential and bring numerous environmental benefits.*

Globally, *Waste management hierarchy is a best-practice framework*, which South Africa has failed to embrace and implement effectively. We are still widely faced with the crisis of landfill disposal which should be a last resort solution in dealing with solid waste.

According to Pillay, *one of the most significant barriers to implementing the waste hierarchy is inadequate sensitisation and education about waste recycling made available to the public*. As a result, there is a general indifference and complacency towards recycling amongst citizens. The rigorous and aggressive recent education and awareness campaign about Covid-19 vaccination is a perfect example on how South Africans can be educated on the importance of recycling and its critical relevance to the environment.

An indispensable part of transforming the way South Africa deals with waste is to embrace the GEE, the Green Economic Empowerment, as a way of integrating the informal waste recycling sector and repairing the negative connotations associated with it. The GEE concept's main objective seeks to address not only the environmental concerns but also the issue of unemployment by capitalizing on the significant untapped potential of the mostly informal waste recycling subsector. It seeks to focus on empowering and transforming workers in the waste economy.

The informal sector is a part of a huge economy that is, unfortunately, not sponsored or overseen by any form of government, nor included into the gross domestic product, nor taxed, as is the case with the formal economy. The bulk of the IWS consists of self-employed waste reclaimers working independently, as groups or as families.

"Waste reclaimers already make a significant contribution to recycling in South Africa, yet they are seldom acknowledged for their efforts," Pillay notes, adding that *their collective financial contribution, attributed to the savings made on landfill space, as well as municipal logistics and fuel costs, is significant. They are therefore not appreciated and are usually underpaid and exploited. In addition to this, they are not catered for in the existing transport infrastructures, with no designated pick up and drop off points, and are often seen as a nuisance. They end up spending hours travelling between points- usually on foot.*

The solution to these challenges faced by workers in the waste collection sector does not necessarily lie in formalisation of the informal waste collection sector, an idea which they vehemently oppose. It lies rather in collaboration. This can be achieved through adopting an integrated structure with invested stakeholders which will increase its chances of success- government and public-private sectors. This shall be expounded on further in the next sub-chapter.

Article by Darren Parker; Significant untapped potential in local waste economy, September 2021
Parker, D. (no date) Significant untapped potential in local waste economy, Engineering News. Available at: https://www.engineeringnews.co.za/article/significant-untapped-potential-in-local-waste-economy-2021-09-24/rep_id:4136 (Accessed: February 13, 2023).

Waste Management Initiatives

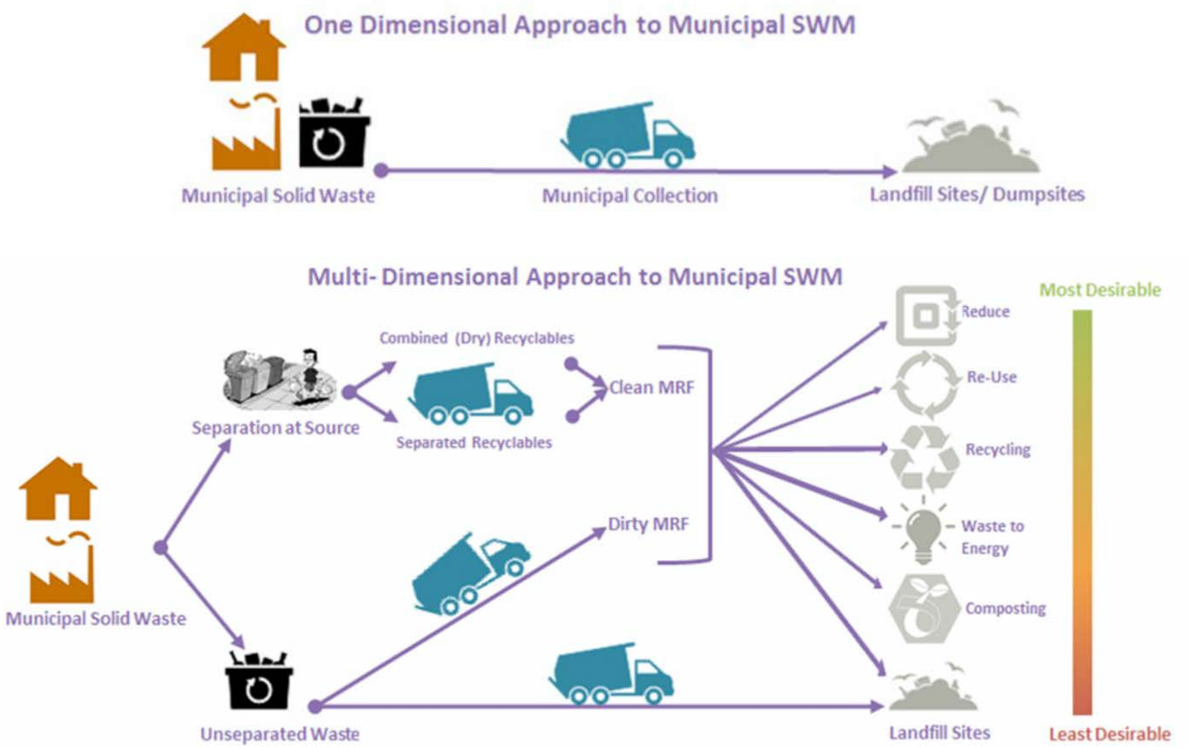


Fig 4 : A graphical representation of the two main waste management systems
RECOGNISING THE INFORMAL WASTE SECTOR, Department of Department of Environmental Affairs, by Nanja Churr, from Kayamandi Development Services Ltd.

Informal Waste Sector (IWS)

IWS can be defined as: 'individuals, families or (informal) small private sector entities whose activities are neither "organised", sponsored, financed, contracted, recognised, managed, taxed nor reported upon by the formal solid waste authorities'.

(Source: GIZ 2011:8 and Medina From GIZ 2011:8)

The IWS has played a critical role in Solid Waste Management for centuries. Informal recyclers have a keen eye for materials with a good market value from different niches of the waste management system, thus forming an integral part of the value chain for these waste materials. The indirect socio-economic contribution of IWS is for the most part contended with. Some consider the informal waste economy to be a system that perpetuates poverty and needs to be eliminated in a modern economy. Others maintain that informal waste management is a well-functioning sector that provides a solid accessible livelihood opportunity for the disenfranchised, which is necessary to enable people to earn a living.

The National Waste Management Strategy (NWMS) of 1999 attempted to eliminate informal reclamation at landfills, but with minimal success. Since then, there has been a recognition that the government has a growing social responsibility to support the IWS to sustain livelihoods of the poor.
Informal work in low income settlements continue to provide livelihood opportunities for the poor, which in turn mitigates poverty and functions as a buffer between employment and unemployment. Small farmers, street traders, micro-entrepreneurs, street waste reclaimers and artisans are among the workers who belong to the informal sector. The waste sector, like other commercial sectors in South Africa and other developing countries globally, has a very vibrant informal division that has been appreciating and reclaiming 'waste' as a resource with value for decades.

Over time, IWS has proven its relevance and function, at times, with a degree of logistics that competes with that of the formal sector. For example, in the landfills, division of access rights to materials is common, and will depend on the status of the reclaimer(s) within the social groups that have emmerged in the context, and the business relationships each one has made within the recycling value chain. On the streets, informal reclaimers concentrate on different waste materials based on their commercial relationships and domains within the supply chain networks they belong to.

Activities performed by the IWS can be categorised into these four types;

1. **Waste collection and transport:** Occurs in low-income areas that are usually not serviced by municipal waste collection services. In this activity, long distances and lack of transport are major obstacles that tend to prevent IWS from growing.
2. **Cleaning services:** Sometimes informal workers perform other waste-related services such as street sweeping and cleaning of public facilities that are usually hotspots for waste material disposed of by users of these spaces.
3. **Recovery of recyclables:** This is the most common activity in South Africa whereby roving waste buyers go from door to door, collecting, buying or exchanging for valuable materials, before formal collection pass by, or "curating" of materials (i.e extracting the most valuable materials) from landfills or the typical plastic bins and bags placed out on streets prior to collection by municipal waste collection services for recycling or reuse.
4. **Manufacturing activities:** Individual reclaimers or informal enterprises sometimes make use of raw and unprocessed recovered (e.g. aluminium and textile waste). This sometimes includes formal enterprises that have contracts with businesses, as they have the facilities for processing the unprocessed materials into products.

Activities Involved.

The first two activities are referred to as the informal service sector and are found mostly in unserved areas, including rural, urban and non-formal settlements. Locally, the recovery of recyclables (third activity) is the largest informal waste activity in the country.

Informal reclaimers extract solid waste with value for either personal or commercial re-use, re-use with repair, recycling or composting. By engaging in these activities, the IWS creates environmental and financial benefits for municipal authorities, helping them to reach recycling targets, minimise the need for waste collection and disposal and save valuable and expensive landfill space. No relevant data is available, but global research has shown that IWS can save up to 20% of a municipality's SWM budget.

(Cohen, P. 2013. Preparing Informal Recycler Inclusion Plans: An Operational Guide).

The informal sector generally constitutes a significant portion of the economy in South Africa, and employs approximately 2.5 million people (18% of the labour force according to Statistics South Africa, 2014). The full extent of the specific IWS activities is hard to quantify due to lack of proper data.

https://www.dffe.gov.za/sites/default/files/docs/publications/recognisingtheinformalwastesector.pdf

Where IWS operates

Recyclable materials in South Africa are recovered from four main sources: dumpsites, Landfill sites, kerbside (household or communal bins) and businesses. During recovery, cherry picking often occurs, whereby reclaimers selectively pick the most valuable materials. My site falls within a suburb that happens to have a strong informal reclaimer presence.

Factors driving the IWS

IWS in South Africa is driven solely by economic/financial incentives. For most reclaimers, it is the only income source, while for others it is a preferred choice given the low entry restrictions, low skill requirements and relative freedom. IWS collects recyclable waste materials and sells them to brokers or private recycling companies for a daily wage. Informal waste reclaimers typically consists of poor South Africans and illegal immigrants who are unable to find formal jobs due to lack of required documentation by immigration laws. Since in most municipalities in South Africa, solid waste is not being separated at its source, the market value for the extracted "filthy" recyclable materials from the mixed up waste streams reduces significantly.
After the primary waste generation point, there are three key players that regulate and define the intricacies of the solid waste management system: Municipalities, formal waste management operators and theinformal waste sector. The roles of these three entities are described below;

1. Municipalities

Despite the ratification of the National Environmental Management Waste Act, NEMWA, the solid waste management system in many parts of South Africa still remain similar to that of a typical developing country. This Act implores municipalities to implement hierarchy in waste management, however, in practice municipalities are only required, constitutionally, to ensure waste collection and disposal- an incomprehensive approach to municipal waste management that leaves out the aftermath of disposal. Currently, most of municipal waste still ends up on dumpsites and landfill sites, with few to no alternative formal systems for diverting and attending to waste materials, i.e. reduce/reuse/recycle.
Some municipalities, however, have small-scale recycling systems, but these are mostly still starting out with difficulty. Waste sorting and recycling are entrusted mostly to formal private recycling companies and the informal waste sector.

2. Formal recycling companies

Often, after waste materials are collected, recyclable materials are reclaimed by private facilities for further selection and processing. Once recyclable materials have been processed, they re-enter the production economy as input materials.

"In some cases, solid waste goes through a material recovery facility (MRF), which is a mechanical or manual separation plant, specialising in extracting recyclables. A distinction is made between a "clean MRF", which accepts waste streams that have already been separated at source (e.g. recyclables and non -recyclables), and a "dirty MRF", where mixed municipal waste arrives at the facility. MRFs are developed mostly by formal recycling companies, but selected municipalities in South Africa already have MRFs or are establishing them."

(Dept of Environmental Affairs, SA: Recognising the informal waste sector in advanced waste treatment)

3. Informal waste sector

Due to the large number of informal waste collectors in the sector, the quantity of materials collected by the IWS is substantial. The recyclables are either self-used by the reclaimers or sold to private recycling companies or to recycling brokers, dealers or wholesalers. These recyclables are then taken through the cycle of processing and production.

https://www.dffe.gov.za/sites/default/files/docs/publications/recognisingtheinformalwastesector.pdf (Pg 13-18)

Realities faced by Informal Waste Reclaimers

Perspectives on the socio-economic realities that informal waste reclaimers face differ. Table 1 below outlines some different socio-economic factors from the perspectives of IWS members, municipal leaders/managers and the general public. The responses are simplified and mostly stereotypical, but provide a useful basis for understanding the differing perceptions and positions of these key stakeholder groups towards the Informal Waste Sector.

FACTORS	IWS	MUNICIPALITIES	PUBLIC
LIVELIHOODS & EMPLOYMENT	• Desirable livelihood because of ease of entry into sector • Limited access to other jobs due to lack of marketable skills. • Work autonomy and freedom of movement. • Appetite for risk is low with low rate of job change often following lead of family.	• The IWS lacks recognition access to regulatory bodies due to its informal nature. taxpaying jobs and taxpaying businesses are unable to compete with the IWS.	• Perceive informal waste reclaimers as a nuisance because they often look shaggy and can leave a mess after reclamation. • Lack trust in IWS and often associate them to criminal activities such as housebreaking.
HEALTH & SAFETY	• Dangerous and unhygienic conditions, magnified by the public's habit of mixing dirty waste with valuable materials. • Health related problems from severe working conditions, which increases potential for lower life expectancy.	• Aware of unhealthy, dangerous and unhygienic working conditions but not doing much about it. • Waste reclaimers often take the blame for breaking down of fences and theft of infrastructure.	• See landfills and drop-offs as unsafe and treat these public areas as no-go zones. • Informal reclaimers are seen as a threat to health and safety due to the inconvenience caused from cherry picking.
WORKING CONDITIONS	• Hard physical labour under unfavourable conditions from the elements. • Long working hours (early mornings and into the night), with arduously long distances to walk to reclaim and sell recyclables.	• Cause disruption to operations for landfill managers. • Realise lack of regulation/ legislation on working conditions. • Would like to regulate activities at landfills, but it is difficult to control access as this will end up impeding on livelihoods.	• The public choose to turn a blind eye to the poor working conditions of IWS.
LIVING CONDITIONS	• Most reclaimers **temporarily** live on landfill sites, informal settlements or on the streets- as close as possible to hotspots of waste materials for convenience. • ***Shelters often constructed haphazardly from waste materials.* (This is one of the main motivations behind my intervention- providing alternative building materials from plastic waste that aim at aleviating the crisis of poor housing)** • No distinction between working and living environment.	• ***The government has a constitutional responsibility to provide access to decent housing and to improve living conditions of the disenfranchised.* (This allows for possibility of collaborating with government for funding and sourcing of personel to spearhead the project)** • Legislation does not recognise reclaimers and doesn't make provisions for them on landfills.	• The public are oblivious towards people living among waste at landfills and in makeshift houses.

https://www.dffe.gov.za/sites/default/files/docs/publications/recognisingtheinformalwastesector.pdf (Pg 19)

IWS Integration

The above comparisons clearly show how the day to day operation of the various waste collection sectors often trigger conversations around the concepts of integration or formalisation.

According to a report titled *Recognising the Informal waste sector*, by the Department of Environmental Affairs, SA, on recognising the informal waste sector in advanced waste treatment, the most widely adopted generic types of integration approaches, are:

- **Welfare-based interventions:** Aimed at improving day-to-day socio-economic conditions, such as focusing on daily needs of waste reclaimers and their children. The political and social forces that influence waste reclaimers' position are, however, not addressed.
- **Human rights interventions:** Aimed at addressing the most basic human rights, such as the right to work in a safe environment, or the right to have access to basic services.
- **Adaptation interventions:** Aimed at advancing and improving IWS activities in SWM systems and making the SWM system more efficient. One example is the municipal adaptation of by-laws/ regulations and incentivising of formal recyclers that partner with the IWS.
- **Business-to-business value chain interventions:** Supporting value-adding activities such as the production of final goods from recycled waste.
- **Professionalisation interventions:** Aimed at providing professional skills to the IWS and helping informal waste reclaimers to advance their position. An example is assistance with setting up contracts or partnerships between the formal and informal sector.
- **Formalisation interventions:** Aimed at legalising the IWS and ensuring compliance with business regulations, tax laws, etc., such as establishing a formal cooperative.

https://www.dffe.gov.za/sites/default/files/docs/publications/recognisingtheinformalwastesector.pdf (Pg 26)

Benefits of IWS integration

1. Social benefits

- Improved working conditions with increased productivity, decreased health and safety risks due to increased regulation. This would be due to the fact that there will be systems in place and necessary equipment that do not leave the labourers too exposed to accidents or hazards.
- Higher, and more stable income. Informal waste collectors will be able to receive the credit thats due fo them. With integration comes more recognition and acces to funds that would be used for proper remuneration.
- Improved standards of living for informal waste reclaimers and their families. As a resut of better and table income.
- Reduced exploitation and child labour. At the moment, children are being exploited as labour as there is no clear delegation for monitoring the collectors to ensure that labour laws are being adhered to.
- A good sense of identity and self-worth is promoted amongst workers. Professional success and reintegration into the work force economy goes a long way in improving the self esteem of the disenfranchised.
- Access to funding, enabling Small, Medium and Micro Enterprises (SMMEs) to grow. With more experienced and confident labourers s a result of integration, there will inevitably emmerge entrepreneurs who will see new opportunities in the waste recycling industry and will want to take action by setting up enterprises.
- Opens up career prospects for workers and encourages personal development.

2. Economic benefits

- *Saving on public and municipal budgets from avoided waste collection, recycling, treatment and disposal.*
- *Increased quality and value of recyclable waste materials.*
- *Huge contribution to the government's role of development of informal settlements, employment and economic growth.*

Recognising the Informal Waste Sector in Advanced Waste Treatment https://www.dffe.gov.za/sites/default/files/docs/publications/recognisingtheinformalwastesector.pdf (Pg 29)

3. Environmental benefits

- Reduced dependency on landfilling as a solution to the crisis of waste as most of the waste would be dealt with at the source
- Reduced carbon footprint- with reduced CO_2 emissions associated with presence of dumpsites and landfills.
- Recycling services brought closer to the public. This will sensitize the communities and thus increase environmental awareness.

Key Inferences

Integration initiatives have always been implemented through various involvements nationally and internationally. Projects with a long and successful history can be found in many parts of the world, especially south america, and are starting to become more common in South Africa.

The investigations above are crucial and very supportive to my study as they outline the status quo of the issue of waste in South Africa, and more specifically in the informal township contexts, where my site falls. The investigation was relevant as it offers an opportunity to identify and acknowledge the existing fabrics and initiatives for waste management and solutions that are working. This is also relevant as my intervention can learn from hindsight collected from the past and borrow from the existing systems of operations to manage waste in my context, while at the same time improving the mechanisms and methods that are inefficient and reinforcing those that work, thus creating a more habitable and clean environment.

https://www.dffe.gov.za/sites/default/files/docs/publications/recognisingtheinformalwastesector.pdf (pg 29)

INTENTION



Fig 5: A 3D visualisation of a Community Recycling Center | Architectural Graduation project 2021
Suboh, B., 2021. Behance.

My intervention aims at alleviating the current insufficiency in waste management within the context of Alexandra. It will provide a space that strives to improve the conditions of the township by implementing a creative approach to waste management- recycling/reusing of plastic waste into building materials.

What if we collected pastic waste and transformed it into building materials and other small useful equipment for the people of Alexandra?

Alexandra has been grappling with housing issues for years, with many residents resorting to land grabs due to limited space. The residents of Alexandra blame this crisis on poor leadership. According to a government report on the Institutional Arrangements of Current Housing Delivery, the government has repeatedly released funds of up to R1.3-billion to improve housing in Alexandra, but the funds are always embezzled and none of these initiatives have successfully taken place.

Government initiatives on housing in townships such as Alexandra, when intervening on the crisis of housing, usually go for conventional building materials such as brick, concrete and steel to create affordable housing. What if, instead of putting in a ton of money on these building materials that would only profit the multi-million companies that produce them, they invest rather in a local initiative that transforms various streams of solid waste into durable building materials. This will create inclusivity at a very high degree, whereby, members of the community get a chance to participate in the development of housing in the community. This creates a circular economy, with more job opportunities and positive environmental practices that will create a sustainable environment.

Furthermore, this intervention will create an inhouse design-research-implementation hub, where building materials are produced and used/reused in the same building and context. This phenomena is good for the socio-economic development of Alexandra.

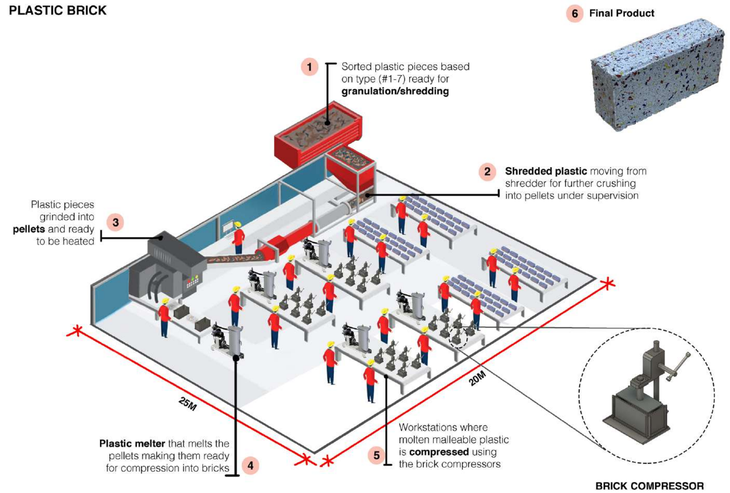


Fig 6 : A graphic illustrating the process of making of Plastic bricks- one of the products my facility shal focus on making from plastic waste
Graphic by Author with reference to PLASTIC BRICKS MADE FROM USED WATER BOTTLES
Written by Expert Skip Hire on 02 July 2018.

(no date) City of Joburg. Available at: https://www.joburg.org.za/work_/SpatialFrameworks/ (Accessed: February 3, 2023).

RATIONALITY OF CHOICE

Of all the types of wase, I decided to choose plastic and narrow down my focus on it. Compared to the other types of waste, plastic is the most workable for what my intervention is aiming to achieve. The process of trnsforming plastic is very straightforward with most of the work being sortation, granulation and generation of energy for melting of the plastics. This implies that there is no need for heavily skilled labour, which would have barred most of the community from participating as most of them lack skills and knowledge that would be needed otherwise. Also, when it comes to waste production, plastic is the biggest culprit; furthermore, it also accounts for around 90% of all the waste that is infesting our seas and oceans.

Plastic

Plastic can take up to hundreds of years to biodegrade plastic waste, making it a serious problem for future generations to deal with. Therefore, there is a dire need for new, innovative and ever progressing ideas and viable solutions to tackle the mounting problem of plastic waste. For example, researchers from the National Council of Scientific and Technological Research (CONICET) in Argentina have come up with a way of turning used plastic drinking bottles into eco-friendly building bricks. The PET (polyethylene terephthalate) material the bottles are made from has been tested and found to be as strong as a conventional house brick made from sand and cement.
Plastic bricks have several significant advantages over conventional bricks;

- They're thinner and lighter.
- They have incredible heat insulating properties (5 times that of standard bricks) and are just as strong as their counterparts.
- Relatively cheap to produce- it only takes 20 bottles on average to make one brick. Creating bricks out of plastic bottles is sustainable because it is less energy intensive than recycling the plastic into other forms.

(Plastic bricks made from used water bottles. Written by Expert Skip Hire on 02 July 2018)

Plastic is found in food packaging, clothing, and other domestic items. Poor disposal of these leads to having plastic waste in environments where they cannot be properly recycled or are discarded in landfills. Living organisms, particularly aquatic animals, can be at risk of exposure to these unattended plastic waste that end up in water streams/bodies. Entanglement and ingestion of plastics by aquatic animals leads to negative effects that vary from biological deformations and mutations, to death. Over time, primary plastics such as bottles, plastic bags, straws and plastic containers degrade and break down into smaller pieces- secondary plastic debris. These raise the biggest concerns.

Smaller pieces of plastic are much more difficult to collect and potentially cause the most harm to the environment as they are easily ingestible by almost all aquatic and terrestrial species. As a result, the dangerous chemicals contained in the plastics enter into the food chain- which includes humans. Humans are at the top of the food chain and eventually eat animals containing toxic plastic which can cause various health complications and disruption of normal physiological processes.



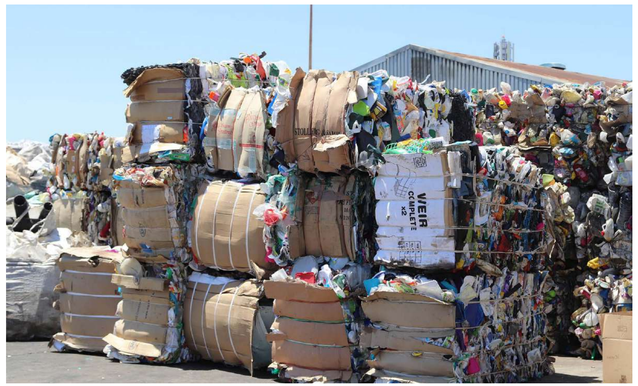


Fig 7 & 8: A dumpsite and recycling yard
The Mail & Guardian. 2021.

PLASTIC BRICKS MADE FROM USED WATER BOTTLES
Written by Expert Skip Hire on 02 July 2018. Hire, E.S. (no date) Plastic bricks made from used water bottles, Skip hire Sussex.

Ocean Plastic



Fig 9: An Image example illustrating the situation with Oceanic plastic
Feature.undp.org. 2022.

Plastics that travel over great distances and spreads, does so as a result of factors such as occurrence of water currents, winds and vast distribution of the human population.

A substantial amount of plastic waste eventually finds its way into waterways and ultimately into the ocean. There is a large amount of non- degradable plastic waste that is accumulating in our oceans and is threatening sea life, quality of oceans and consequently the environment.

A study conducted at Santa Barbara's National Centre for Ecological Analysis and Synthesis in 2015, analysed the input of plastic waste into the ocean from land. The conclusions indicated that every year approximately 25 million tons of plastic debris end up in the world's oceans.

(SBNCEAS, 2015)

In addition, according to a Greenpeace report, about 10% of plastic produced by the various industries annually will find its way into the ocean. *(Plastic Debris in the World's Oceans, 2006. Authors: Michelle Allsopp, Adam Walters, David Santillo, and Paul Johnston)*

The Greenpeace report also estimates that the typical plastic debris found on coasts have the following decomposition rates:

- Plastic cups: 400 years
- Plastic bottle: 450
- Foamed plastic cups: 50 years
- Fishing line: 600 years.
- Disposable diapers: 450 years

The Ocean Gyres

A gyre is a circular vortex in the ocean generated by the ocean currents passing close to each other. Gyres circulate clockwise in the southern hemisphere and anti-clockwise in the Northern hemisphere

Worldwide, there are five major oceanic gyres that cover over 40% of the global oceanic area. Specialists on this matter are certain that, these gyres behave in a very similar fashion, massive amounts of plastic debris found in the Great Pacific Garbage Patch located at the north pacific gyre also exist in each of the world's ocean gyres.

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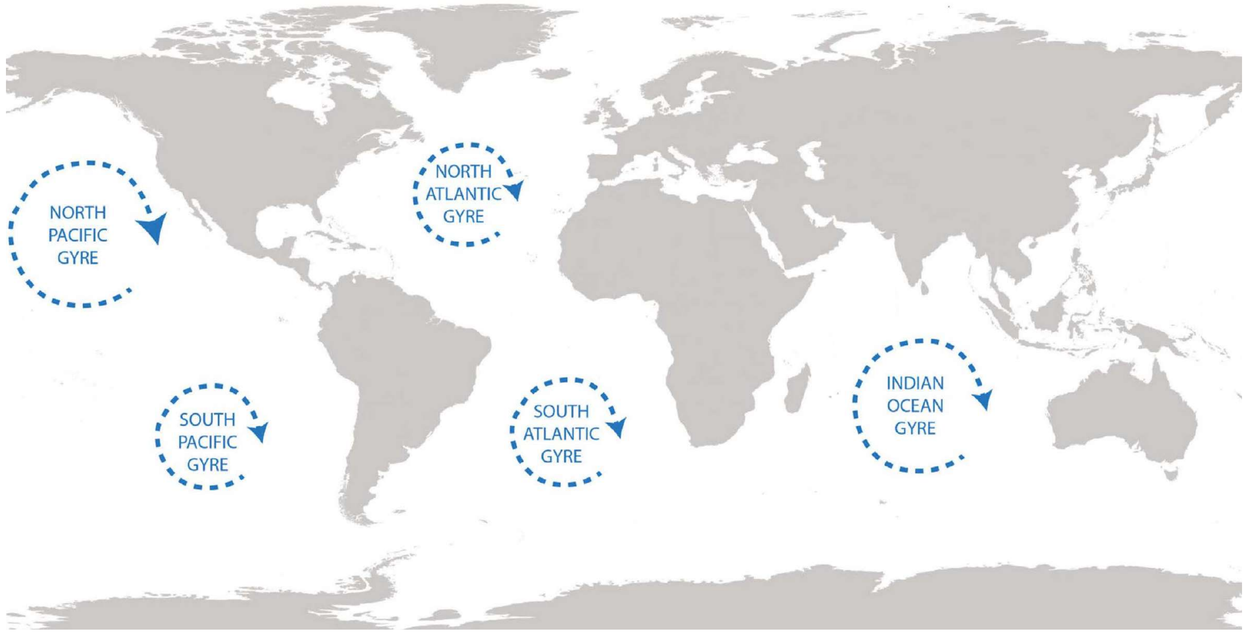

Fig 10: Map of the world showing the locations of Ocean gyres. The closest gyres to my context are the South Atlantic and Indian Ocean gyre.
Slat, B., 2021.

Plastic debris that finds their way into the ocean via streams, beaches or ships are gradually pulled towards these gyres due to ocean currents- forming a swirling soup of plastic pollution.

Gyres are situated in open ocean and usually do not fall in any jurisdiction of any country. This means that governments have no motivation whatsoever to take responsibility for cleaning up the plastic. As a result, this catastrophe is most likely to be attended to by independent initiatives.

Over time, due to UV from the sun, plastic degrades and with the continuous friction caused by ocean waves, it fragments into even smaller pieces. These smaller pieces are known as micro-plastics (pieces smaller than 5mm). Micro-plastics are considered to be among the most harmful types of plastic pollution because they are easily mistaken for food by marine life.

It is a common misconception that plastic pollution spreads itself between the surface and seabed or sinks to sit to the bottom of the seabed. But a study conducted by The Ocean Clean-up Foundation, indicates that plastic bigger than a sand grain (0.5mm), primarily stays on or near the surface.

"Our study revealed that conventional methods to study ocean plastic underestimate microplastic loads by up to 97% due to ocean mixing processes that push part of the debris just below these sampling devices. Understanding how plastic is distributed in the ocean is important to assess its impact, and allows us to adequately dimension our ocean clean-up systems."

(Boyan Slat, Founder of The Ocean Clean-up Foundation (2015))


Boyan Slat [Photograph]

The Ocean Clean-up project is a foundation started by a young aero-space engineering student, Boyan Slat. When he was 19 years old he developed a passive system to clean the ocean from plastic and debris. The Foundation started in 2013 and through crowd funding and investment from various corporations raised $2 million and as of October 2016 is in the process of testing a prototype of the system

The foundation was successful in developing the first feasible method of efficiently ridding the world ocean gyres of plastic and debris. The system collects plastic using the movement of the ocean currents, collecting the plastic as the current passes through. The debris caught will then be stored on a platform where they will be collected for transport to the mainland for recycling.

Slat, B., 2021. [online]

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In the Ocean Clean-up feasibility report, the foundation estimates that a system operating at the great pacific garbage patch for **10 years** could remove **42%** of the plastic pollution in the gyre. Once the plastic is collected it can be shipped to land for recycling. This is a positive estimation that can be replicated on all ocean bodies.

Beaches act as a natural net for catching plastic debris and many coastlines around the world are littered with plastic debri

When Boyan first founded The Ocean Clean-up, there was no feasible solution on how to clear the gyres of plastic, as each is several million square kilometres across. Coastlines act as an effective, natural way of trapping the plastic debris. However, there is no landmass in the middle of these gyres. Boyan, to cater for the enormous size of gyres, proposed to mimic the effective of coastlines by deploying a very long array of floating barriers anchored to the seabed.

Boyan's intervention seems rather futile- he has received a lot of criticism from various experts saying that he should rather have focused on preventing plastic waste from reaching the water bodies. Prevention is as important as mitigating the existing situation. Therefore, the best way to go about it is to tackle the problem from both sides, i.e. prevention and curing.

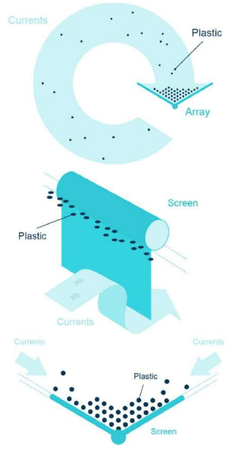


Fig 11: An oceanic plastic catchment system- Courtesy of Boyan Slat
Slat, B., 2021.

Inference

Borrowing from Boyan Slat's, Ocean clean-up foundation catchment methodology, a scaled down version of catchment shall be implemented to collect plastic waste in river streams and water bodies from around the context of Alexandra. Close to the site is **Jukskei River** that cuts across the township. This river is one of the many water bodies that have fallen victim of poor sanitation and poor waste management in the township of Alexandra.

Plastic waste collected shall be transprted to the facility for sorting and transformation into useful products.

PRECEDENT STUDIES

RURAL STUDIO

Newbern Alabama

EDUCATING CITIZEN ARCHITECTS

Rural studio is a design-build program in Hale County and part of the School of Architecture, Planning and Landscape Architecture of Auburn University, Albama. Their aim of thhe project was eduction students, coupled with research on sustainable rural living through both housing and the critical systems to enhance communitiy.

PROJECTS

1. CORRUGATED CARDBOARD POD



Newbern, AL
2001
5th Year Project
Campus
Fig 12a



Fig 12d



Fig 12b



Fig 12c

Fig 12 (a-f): Images of a corrugated carbon pod- an example of a building made using non-conventional building materials
Rural Studio. 2001. Corrugated Cardboard Pod.

MATERIAL COMPOSITION

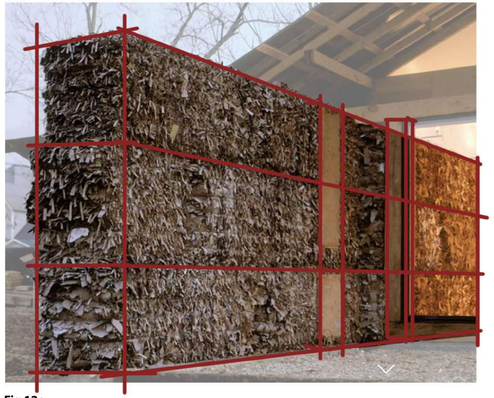


Fig 12e

WALL COMPONENTS



Corrugated cardboard shredded and impregnated with wax.

Composition bundled together in bales and stacked against each other to form a wall.



TYPICAL SECTION

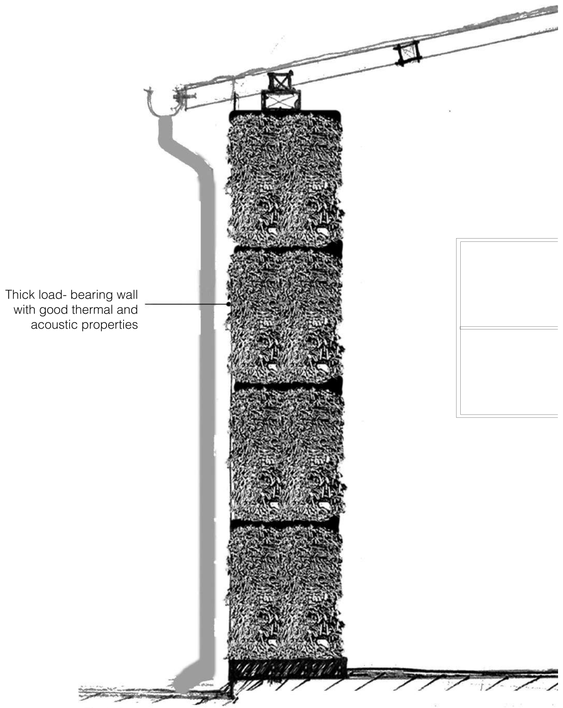


Fig 12f



Fig 14a



Fig 14b

Mason's Bend, AL
2002
Outreach Project
Residential



Fig 14c



Fig 14d

Fig 14a - 16c: Lucy Carpet House. Built from piling up waste carpet tiles from various carpet manufacturing factories
Rural Studio. 2002. Lucy Carpet House.

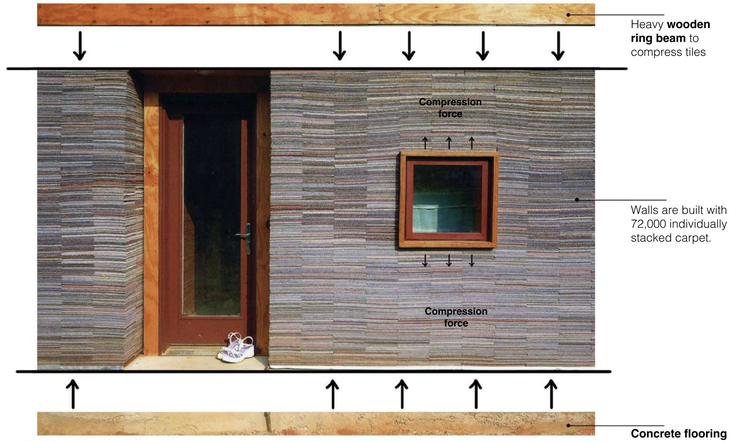


Fig 15



Fig 16

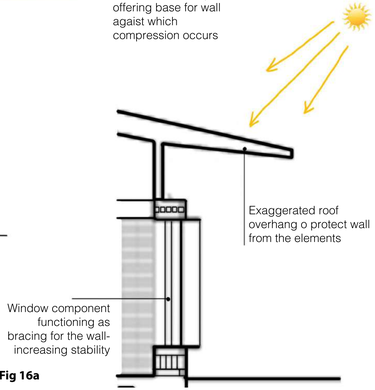
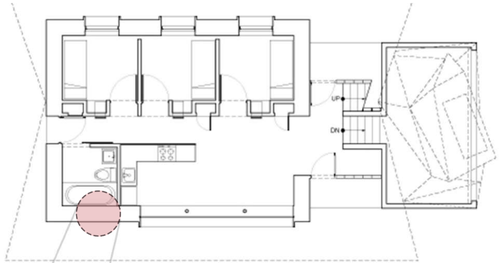
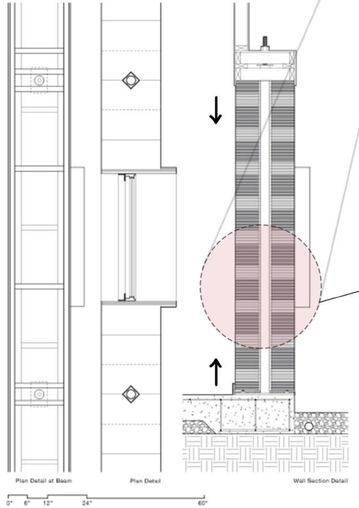


Fig 16a



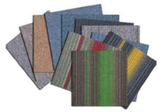


Carpet tiles manually stacked on top of each other to constitute the bulk of the wall

Construction Process



Fig 16c



72 000 redundant carpet tiles donated by a tile manufacturing company

+



Salvaged plywood panels for encasement

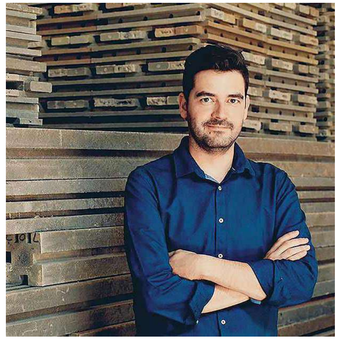
Fig 16b

CONCEPTOS PLASTICOS

Location: Guapi, Colombia
Material of Interest: plastic brick

Oscar Mendez founded **Conceptos Plasticos**, a company based in Columbia that recycles plastic and converts it into construction materials- brick & lumber. These materials are then used to provide high-quality, low-cost and safe housing for those in need.

The bricks are made from plastic that has been discarded by recyclers and factories. The plastic is melted and placed in a final mold that creates a 3kg brick. They have a design pattern whereby they are put together similar to Lego pieces.



Oscar Mendez (Founder) [Photograph]

Fig 16d



Fig 16e



Fig 16f



Fig 16d - 16f: Images of a prototype plastic brick units- courtesy of Oscar Mendez.

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GJENGE MAKERS



Nzambi Matee, Founder [Photograph]

Fig 17a

Gjenge is a community-oriented organisation whose aim is to address the need for affordabe and sustainable alternatives to conventional construction materials in Kenya and the continent at large. Their initial output is innovations derived from recycled plastics to produce paving blocks, paving tiles, and manhole covers.

The founder of the enterprise, Nzambii Matee was, for a long time, devastated about the state of affairs regarding plastic waste in her neighborhood. Before creating this enterprise, Nzambi majored in material science at Universit. She later worked as an engineer in Kenya's oil industry. In 2017 she quit her job to dedicate time to creating textured brick pavers through recycling plastic waste. With her background and experience, she understood which plastics would bind better together and created the machinery that would allow her to scale up production.

THE RECYCLING PROCESS



Fig 17b

1. Plastic is collected from various sources and brought on site for sorting. This stage of the process creates job opportunities for the people of the community and offers an entry into the practice of recycling and its industry. Nst of the collectors eventually end up taking more responsibilities as they learn more about recycling of plastic



Fig 17c

2. Selected plastics are thrown into the granulator to be crushed into small pellets. Selection is based on the 7 main types of recyclables. The distinction is mainly based on strenght and composition of the plastics collected



Fig 17d

3. Small plastic pellets are mixed with sand and subjected to high temperatures in a kiln for them to bond. The sand helps with bonding of the plastic and adds to the structural integrity and durability of the finished product.



Fig 17e

4. Resultant paste like mixture is poured into brick moulds. the moulds then compress the mixtures and the resultant blocks are left to cool and settle. The brick moulds are designed to standard dimensions that will ensure compatibility once the products are in the market.

5. Plastic bricks/pavers ready or distribution & use.

My intervention shall have a very similar approach to the process of recycling of plastic wate, but on a bigger scale. This will allow for employment of more personel, production of a wider range of products and a more inclusive program that would retain employees for purposes of skills training and socio-economic development



Fig 17f

Fig 17 (a-f): Gjenge makers- Images showing the process of making plastic bricks
Gjenge Makers. 2022.

VIABILITY STUDY

The Design Brief

The infrastructure is a facility that will house a process of collection and transformation of waste materials into building materials- through various participatory mechanical and artisanal systems, that would be tested and implemented on site and off site within the immediate context of Alexandra, and in the process, mitigating two major crises; poor housing conditions and unemployment among the youth of Alexandra.

The client is the municipality of Alexandra, that would represent the community. With the help of the municipality, a board committee shall be appointed by the community, to be their representative in the implementation of the infrastructure

The Site

The site being explored is erf 198/199, along 1st street, off 1st Avenue in Wynberg. It is located in Johannesburg, therefore, I shall consult the Johannesburg land use scheme to understand the parameters and constraints of land use In this location. The site is within close proximity to the M1 and N3 freeway. This means the site is easily accessible at a metropolitan scale.

Consolidation and Rezoning

Wynberg is an industrial zone which has predominantly manufacturing plants and warehouses for various kinds of commodities. My building is of an industrial typology and therefore fits into the zone. I intend to consolidate erfs 198 and 199 into one site of 800sqm. Consolidation is possible as the two sites are adjacent to each other and fall withing the same zoning parameters.

Building restrictions shall be observed as per clause 34 of the CoJ Land Use scheme.

Parking and Loading.

This is a major aspect of my design as the program has depot areas where waste materials are delivered. There is therefore need for loading and picking zones and parking spaces for trucks on standby. As per Zone A (JHB Inner City) and B (for areas as defined in the Spatial Development Framework, SDF, Sub-clause) parking guidelines in the CoJ land use scheme, parking requirements may be increased or reduced due to special conditions. My site falls under Parking zone B as it falls under "Deprivation areas, as defined in the Spatial Development Framework of the City of Johannesburg, sub clause 4, clause 36." In line with Clause 38 of CoJ Land Use Scheme, conditions for Loading and off-loading shall be included in the Site Development Plan that shall be submitted to the council along with a written application for consent.

Administration

Illegal land use contraventions- Half of my site has squatters in shacks. Some solutions to this are; Litigation, and/or engagement with squatters. Eviction can only be done when the matter is presented before a court and a court order is granted. An option of including squatters in intervention as staff to help uplift their situation could be considered by the developers- a town planner's opinion on these would be helpful.

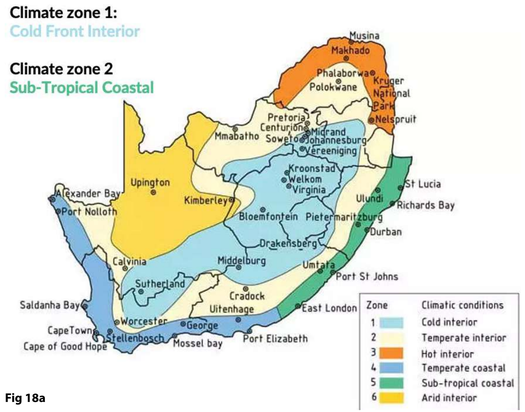


Fig 18a



Fig 18 a&b: Map showing climatic zone of site within the greater metropolitan context and Site aerial view **Fig 18b**

Google maps

Land Development

Local Character

The infrastructure aims at improving, the existing mechanisms and methods of waste collection and management that are inefficient and reinforcing those that work, thus creating a more habitable and clean environment. More specifically, it aims at collaborating intensively with the informal waste collectors who statistically speaking are the ones holding up the waste collection sector. By extension, this will improve the standards of living for the people of the context as a huge number of waste collectors happen to be bread winners for their families.

The infrastructure, being a place that transforms the various streams of waste into building materials (glass, paper and plastic), will also improve the housing conditions and varieties such that habitants live in more comfortable and presentable spaces.

The infrastructure will also function as a place of exposure and enticement for people to focus on becoming professionals in the sector of waste management and to start seeing the business opportunities around recycling of waste.

Connectivity.

There will be ease of access to local services and the living environment in the public and semi-public areas, such as recreational and open spaces within the site, which allow people to exercise, take part in competitive sports, socialise with others and a space for people far from the infrastructure to experience the natural environment. Street activities will be deliberately curated with the aim of articulating the porosity of the site to the neighbouring people of Alexandra across the street, who are the main benefactors of this intervention. Activities such as open markets, restaurants and retail spaces, sitting spaces, along with elaborate infrastructure for pedestrian access.

Design Implementation

Technical- Architectural

Building typology: Infrastructure; recycling/reusing waste materials. Industrial; manufacturing Building materials from Plastic waste. Institutional; training of labourers and reintegration into industry.
Operation: Manner of occupation by users; no accommodation, usage of facility shall be only during working hours. Maintenance schedules. There will be provision for ablutions for waste deliverers and workers on site.
Building Systems: The Architect in the designing of the building, shall employ various Structural systems, Mechanical systems, electrical systems, Landscapes, Sanitary systems, Fire-fighting systems, that will facilitate the process of transforming waste materials into building materials.

Program

The building program is a blend of three typologies: Infrastructure; Recycling/reusing waste materials. Industrial; Manufacturing Building materials from Plastic waste. Institutional; Training of labourers and reintegration into industry. The facility will have laboratories, pockets of exhibition spaces and markets, rooms for educational facilities, and shall house a process of collection and transformation of waste materials into building materials- through various participatory Mechanical and Artisanal systems, that would be tested and implemented on site and off site within the context of Alexandra.

Development Plan

Frameworks (Contracts): Client-Investor-Tenant.

The table below shows various contracts used to implement a building project (Bowmans, 2019). Establishment of how the project will be administered will make it possible to allocate responsibilities, risk, payment, and costing to plan the development. This will also enable the client to measure cost, control quality and value the upskilling of workers for future jobs in the industry of recycling.

Traditional Procurement	Design & Build	Management Contracting
	Allocation	
Design Separate from Construction	Design linked to Construction	Managed, Supervised and coordinated design by construction manager
	Risk	
Employer - design risk	Contractor - design risk & construction risk	Employer - performance of contractors CM - liable for bad management Level of risk driven by project specific factors (eg.)
	Usual Pricing Methods	
Lump Sum Re-Measurement Cost Reimbursement	Lump Sum	Reimbursement Management Fee

The risk associated with the whole project is on the client/developer, while smaller line item risks could be on the various members of the professional team depending on their role and responsibilities.

Phased Construction

The project shall be completed in two main phases- the first phase shall be for purposes of generating income for the next phase, and materials which shall be implemented on the second phase for purposes of illustration on the intention of producing the building materials.

Initiating: Definition and justification of phases. Appointment of suitable project manager

Planning: Duration of project, establishment of workflow, measurement of project materials. Contract value/cost and cash flow systems

Execution: Management of teams and observing timelines. Completion of defined work.

Monitoring and Controlling: Tracking, reviewing and regulating progress. Review contract value by factoring in inflation costs on materials and labour. Address any challenges arising.

Closing: Performance of due diligence, assess strengths and weaknesses of the project, re-assess budget and factor in losses, quality check and defects liability period

Systems and Management

Waste Collection: Technical aspects; the facility shall incorporate/collaborate with existing waste collection systems. This will save on cost of sourcing waste materials and the arduous logistic requirements of developing a system of waste collection from scratch.
Labour Management: Technical aspects; there shall be advertisement, selection (Ages 20-29) and employment of labourers from within the context of Alexandra. Financial aspects; Cost of training and remuneration of labourers shall be systematically assessed by the Quantity Surveyor in order to determine the initial operational costs of the facility.
Site Management: Accessibility to site shall be reserved for private and semi-private spaces. Amenities and utilities for labourers shall be provided.

Financial Sustainability

Reclamation of waste materials locally: Saves on transport cost of outsourcing materials
Recycling/reusing of materials: Transformation of glass, plastic and paper into building materials for use within context (Alexandra)
Testing and Implementation: Application of building materials to relevant phase of construction and off-site; financial implications of testing and application.
Environmental impact assessment: Impact of recycling on the environment vis à vis outsourcing building materials from various manufacturers financially and environmentally.

Financial Feasibility

Land Purchase: Holding costs. Consolidation of erfs. Cost of displacing squatters from site
Design Stages: Architectural professional fees
Assessment costs: Environmental assessments, structural analysis,
Construction: Material and labour costs
Final Building: Operational costs, Return on investments

Construction

Professional team; Since my project is relying heavily on government financial support, the government will want to appoint its own professional team for the project, as it is more effective logistically and cheaper for them. The following is an organogram which outlines the procurement process and the professionals involved at the various stages of the project;

Legal team

The legal team will consist of a qualified and well versed Attorney in the area of construction. He/she shall be tasked with dealing with the legalities involved in transferring of land/property and alteration of the title deed due to consolidation etc.

The legal team shall also be responsible for including a dispute resolution clause in the contract as a measure of prudence, should any significant disputes arise between the professionals involved and the client.

Planning team

Town Planner- A town planners advice is required to deal with the squatters who occupy one half of the proposed site. Being part of the professional team, he/she is expected to propose long- and short-term plans for land development and use, growth, maintenance and renewal. He/she shall also monitor relevant legislation, together with the legal team, and ensure that all projects comply with the regulations and rules- e.g. taking care of amendments of town planning scheme (rezoning).

Land Surveyor- His/her responsibility include identification of site boundary demarcations which will be used in the making of maps and site plans basic to all construction planning and development.

Design team

Architect- The Architect can also be referred to as principal consultant or principal agent. As a principal consultant, his/her role shall be to lead all the consultants in all matters concerning the project, including design, site development and technical co-ordination, on behalf of the client. As a principal agent, he/she also represents the client in managing and administering the building contract. He/she is the one in charge of preparing plans, designs and construction documentation.

Engineer(s)- For this intervention, besides a civil/structural engineer, there will be need for a materials engineer. He/she will be a consultant for the methodologies involved in transformation of plastic, paper and glass into building materials. The materials engineer will coordinate with the structural engineer on investigating the quality of the outputs and their viability for application within the context through prototyping, in accordance with SABS regulations.

There will also be a mechanical engineer required in the team. His role will be to liaise with the architect on the design and technical specifications of the mechanical equipment for processes of transforming the respective waste streams into building materials.

Quantity Surveyor- The QS is tasked with assessing the financials. He/she is brought onto the project as soon as the architect has the first initial concept drawings to measure from. The QS will be responsible for ensuring that the clients funds are being used in the most efficient and cost effective way- without compromising the construction quality of the building and minimizing wasted material.

His/her scope of work will be dependent on and respond to the architect's decisions on design, but not directly involved. The QS shall also act as an informant to the architect and give suggestions as they have a better grasp of current market prices.

The QS will work with rough rates per sqm based on structure and program in the initial design phases until details are finalised. Later on in the project, they work with more accurate data as the design will have been refined and resolved.

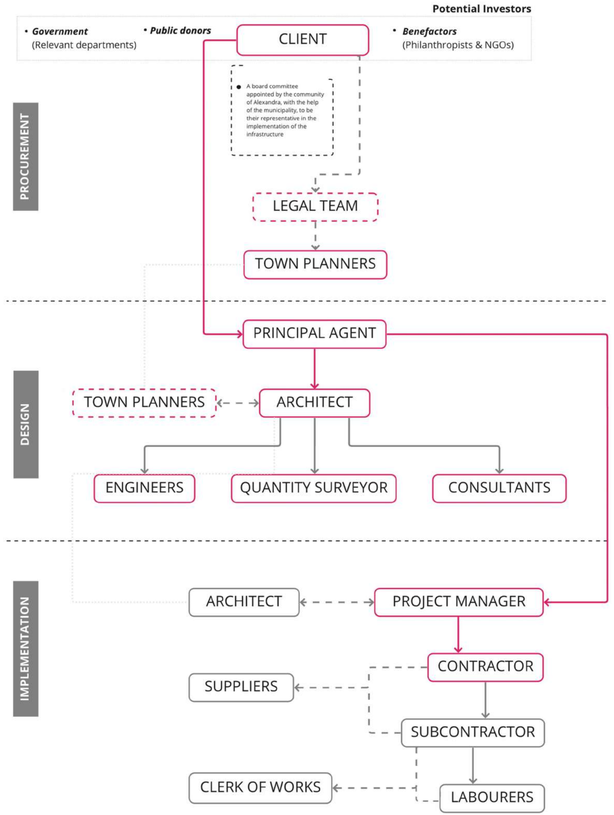
Project Manager

The main responsibility of the Project Manager shall be to coordinate the professionals participating in the project and the material resources throughout the project. He/she is expected to have adequate knowledge and understanding of the design and construction process. The project manager shall also assesses the project finance but more so through the lens of site efficiency and labour costs through a construction schedule with work breakdown structure and timetable. He/she shall define and allocate a clear and calculated budget that contributes to exploiting available opportunities and achieving the project goals within the estimated time frame.

Contractor

The contractor shall be responsible for planning, leading, executing, supervising and inspecting the building construction project. The responsibility for these extends from the beginning to the end of the project. The contractor is allowed to nominate subcontractors, with the consent of government authorities involved. However, he/she shall be responsible for ensuring that subcontractors are compliant with their requirements as outlined in the contract.

TRADITIONAL PROCUREMENT



The following is an organogram which outlines the procurement process and the professionals involved at the various stages of the project;
Fig 19: Graphic by Author

Financial Aspects

Funding
The total cost of building the infrastructure, training of staff, collection of waste and initial operational costs will rely heavily on various benefactors who have a keen interest in uplifting the townships of South Africa, as well as Government- which has a responsibility to intervene in the problem of housing in non-formal settlements. Supporting such an initiative would be a big leap towards solving the problem of housing and a huge benefit to the community of Alex. Once the project breaks even, it is expected to generate a certain amount of income that would then be used mainly for remuneration of the labour force in the infrastructure.

The project shall be done in phases. First phase shall include the primary systems and the private and semi-private spaces. The second phase shall include the public and semi-public spaces- the intention behind this is to use the generated materials to build up the communal spaces so they act as an illustration of how the materials can be applied in construction. This will have a cost implication on material costs, time and costs involved in training/preparing labourers for the process. Inflation due to phasing should be accounted for in all departments including the services provided by the QS and Architect.

Costing shall be worked out for the entire project rather than one phase at a time. As time goes on, prices and rates are expected to fluctuate. Thus, funds are to be carefully controlled and reassessed in order to not go over the total budget.

On Site Management
On-site management of funds shall be handled by the project manager. He/she will be in charge of defining and allocating funds to the various budgets and day to day expenditures. These costs will be re-evaluated on a regular basis (After each phase) to ensure the project is achievable within the timeframe and budget. This will also allow for making reasonable extensions and revisions to the completion of works.

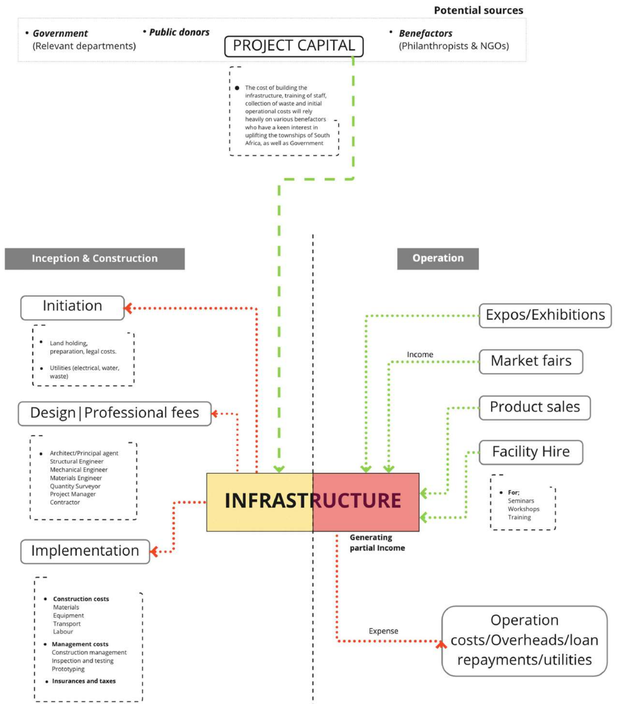
Site Materials
There shall be a site manager who reports to the project manager. This person is incharge of controlling material quantities by regular material checks and making sure that the labourers do not waste material. Part of this role entails protecting material on site from theft, the elements and damage. All materials shall be inside the site and not outside on the roadside. Should there be any leftover materials, the QS will quantify the cost of the materials and then the contractor will be responsible for reimbursement at the said rate. It is then their onus to sell or repurpose the materials.

Operation costs
Sustainable design choices during the design of the infrastructure are expected to facilitate economic savings over the operational lifetime of the building. The capital costs, additional maintenance, and insurance for the initialising/running of these systems should be evaluated against other comparable technologies and market products and prices by the QS.

CONCLUSION

The return on investment for this intervention is for the most part not financial. It has a very strong socio-economic return aspect, whereby the community will be empowered through job creation and mitigation of the current poor state of housing. Its existence will facilitate growth such as upskilling, better hygiene due to better waste management solutions which in the long run contributes significantly to the community's economy.

CASH FLOWS



The following is a diagram that summarises the major cash flows of the facility;
Fig 20: Graphic by Author

SYSTEMS & INPUT MANAGEMENT

Waste Collection



Illustration on waste collection sources
Fig 21a: Graphic by Author

Collection of plastic waste shall be mainly from two sources;

- Informal waste collectors (collaboration
- A well coordinated In-house waste collection system

Informal Waste Collectors

The following are extracts from interviews with street reclaimers about their feedback regarding government efforts to integrate the various sectors of waste management;

*"At first, before Jozi@Work existed, it was so simple, I was able to fill up my sac without any problems and **make R100** and something in one trip and know that I am fine for the day and it became optional to go and collect again for the second time but now that is not the case, we need to be met halfway because we are suffering, we are really suffering"*

(Street reclaimer, Zonde, 18/08/2016; cited in Ntuli, 2016: 32).

"I mean, they found us here doing this job, then the government comes and takes our jobs; people in households don't look out for us anymore, they look out for them. Basically we can't anymore; we are not being given a chance to eat"
(Street reclaimer, Zonde, 19/08/2016; cited in Ntuli, 2016: 32).

From various research reports that cover the involvement of informal waste sector in waste management, it is rather clear that its members face constant hostility from municipality and the public- nevermind the fact that it is arguably the most successful sector when it comes to waste management. Infact, some have eloquently argued that, since they had been collecting recyclables for decades before the municipalities and Pikitup became interested in waste as a resource, it was the municipality and Pikitup who were integrated into their system, and not the other way around.

(Waste Research Development and Innovation Roadmap Research Report Jan 2020)

Inspite their 'informality that would seem to be working against them, they are able to come up with systems and logistics that are deeply rooted in community and culture that prove to be very catalytic in creating a reliable system of waste collection and management.

It would therefore be futile to not include them in my intervention as stakeholders with regards to collection of plastic waste.

My facility shall have two sections for offloading and reception of plastic waste to be recycled. The one section shall be dedicated to the informal waste collectors. They shall offoad the materials theyve collected, afterwhich they shall be remunerated **based on amount, weight and quality.** It shal be seperated and sealed off from the second section that's dedicated for the in-house waste collection system, to avoid any feuds arising from their differences.

The cost estimation based on the current rates will be R 200 per person per trip.

The main sources for this sector shall be;
- Landfills
- Dumping sites
- River streams from around context.
- Households

In-house Waste Collection System

This serves as a supplementary source of plastic waste. it will aim at reaching out to places that informal waste collectors have difficulty reaching due to various reasons such as distance, time, hostility and stigmas etc.

Precedent: Pikitup Johannesburg (SOC) ltd.

Pikitup Johannesburg (SOC) Ltd is the official integrated waste management service provider to the City of Johannesburg. They provide integrated waste management services to the residents of Johannesburg. Pikitup has more than 4 500 people, using more than 200 trucks to provide waste collection services to Johannesburg's private, and business residents.

The following is an organogram showing the company's management structure;

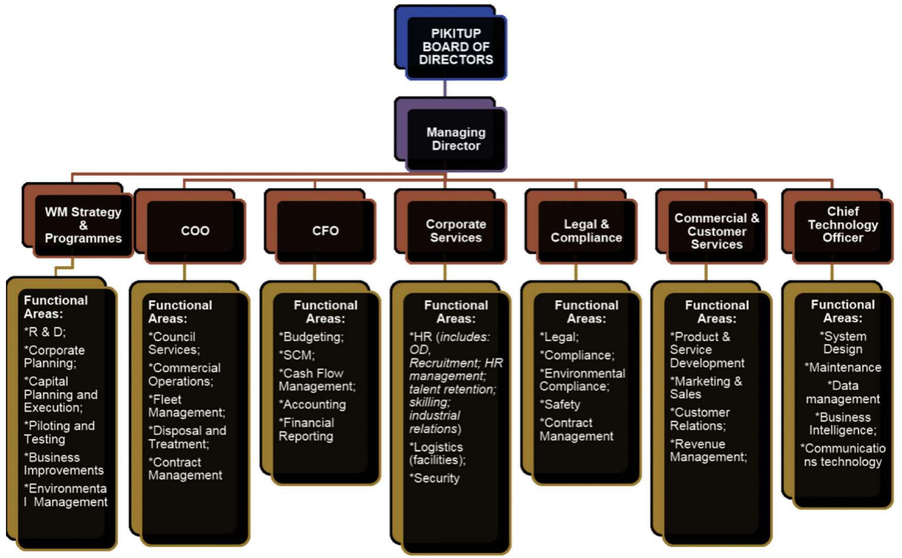


Fig 21b: Pikitup organisational structure
2022. Structure

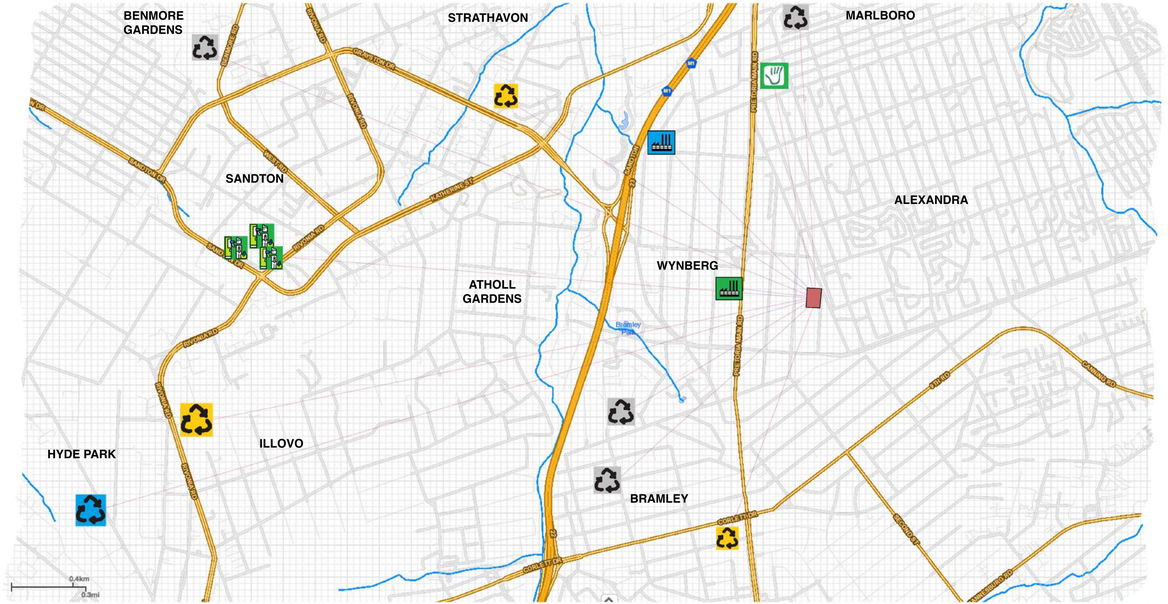
From this, I earned that private waste collection and management is a multi-faceted practice with aspects that go beyond the actual collection of waste.

Pikitup services the entire Johannesburg (1 625km^2), collecting around 6000 tons of waste every day. Their employees clean and sweep approximately 9 000km of streets across the seven regions.

Borrowing from the pikitup overal management system of waste collection, my facility shall have a similar scaled down organisational structure that is propotional for approximateley 100 people as opposed to 4 500 people.

Fig 21b: Pikitup organisational structure
2022. Structure -. [online] Available at: <http://www.pikitup.co.za/structure/> [Accessed 2 August 2022].

Map showing Recycling & Waste Locations in close proximity



LEGEND

- Glass Bank
- Paper Bank
- Glass & Paper Bank
- Collectors
- Reverse Vending Machine
- Recyclers
- Buy-back Centres

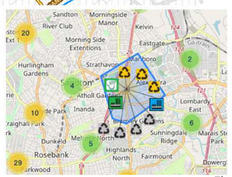


Fig 22a

Fig 22 (a-b): Maps showing various waste depots as potential sources ofplastic waste
Sstafrica.org.za. 2022. Recycling and Waste Locations.

The following are maps showing distribution and concentrations of points of waste colection and recycling around the city of Johannesburg and a 12km radius from the site respectively.

The main sources for my waste collection system shall be;

- Factories/industries
- Shopping centres/malls
- Households
- Waste depots

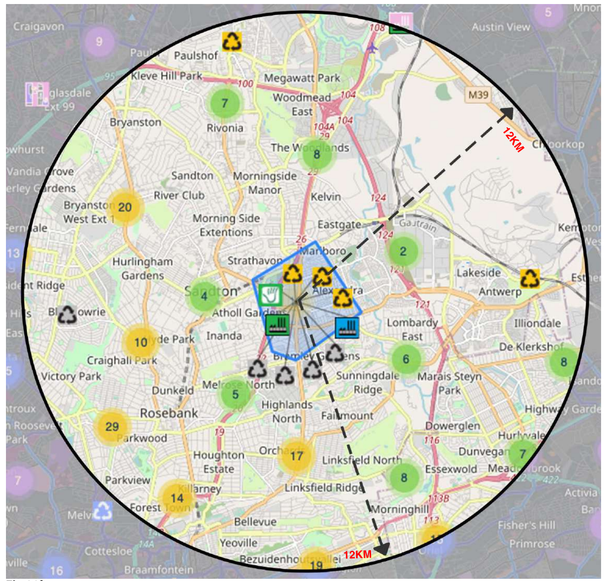


Fig 22b

Training & Reintegration

The facility has, as part of its program, a training and research section. This section, in tandem with the production spaces where transformation of plastic takes place, aims at equipping workers with knowledge and skills that they can carry outside of the centre and use to make a decent living.

Training and integration shall be implemented from 3 main dimensions; **Economic, social and psychosocial.**

Economic

This mainly entails providing opportunities for economic self-sufficiency to the target group. It is easier to draw the attention of invested parties (such as government, philanthropists, NGOs, private investors etc) concerning recycling of plasic as an institution/facility rather than as an individual. The facility will therefore act as an intermediary platform that shall pique the interest of invetors who subscribe to the mission of the facility- mitigating the crises of poor housing, poor waste management and unemployment in the township of Alexandra, through transformation of plastic into building materials and other useful products. Workers shall be encouraged, through the various programs and training, to take advantage of the opportunities that come with being in the centre.

Social

Along with economic integration is social integration. Activities in the facility will inevitably give rise to a social network- a community that emmerges as a result of having common interests and conditions. This social network will go a long way in giving support to those who decide to take strides to grow and try out new ideas in the industry of recycling.

Psychosocial

This is a dimension that is immplied in the first two. When people have work to do and people to meet and interract with, their mental health will usually be good and positive. This will also go a long way in reducing criminal activities- idleness and poverty are amongst the main causes of crime.

THE RECYCLING PROCESS

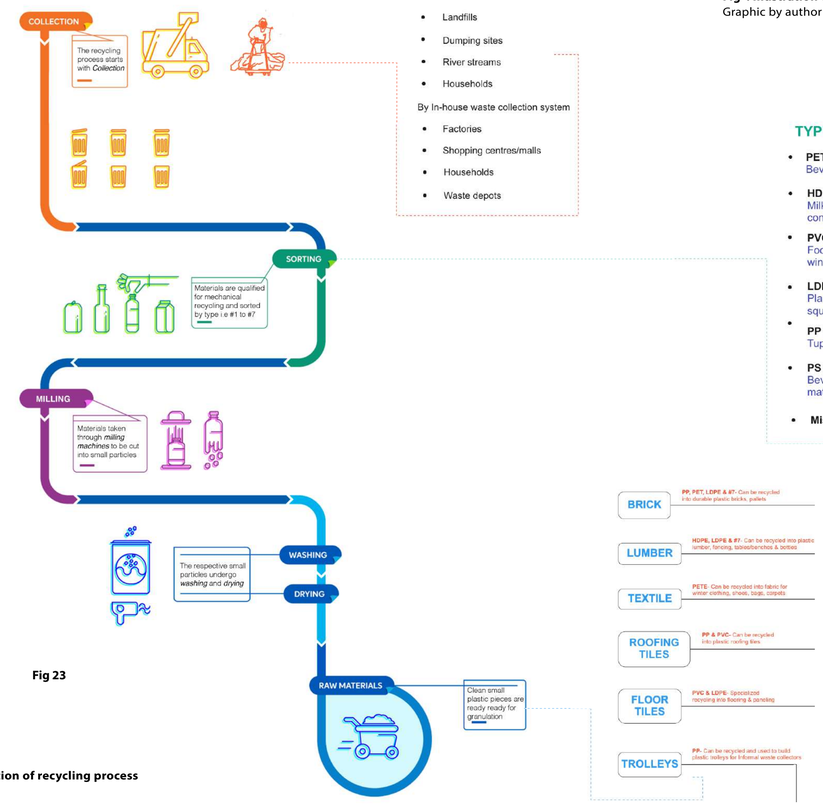


Fig 23



Fig 23 & 24: Illustration of recycling process
Graphic by author

Fig : Illustration of recycling process
Graphic by author

Recycling is the process of transforming waste materials into reusable objects or reusable raw materials in order to prevent accumulation of unwanted waste. It is a key strategy to reducing waste and is the only process which closes the life cycle of a product so that it can be continually reused over a long period of time.

Recycled materials do not always become the same product as they were before being recycled. Recycled materials are often mixed with new materials as this often produces a better quality product than using 100% of the recycled material.

With plastic, distinguishing the types of plastic is important as each type of plastic has certain characteristics that distinguish them from one another. The types are categorised between numbers 1 to 7. This number indicates the type of plastic that was used in the making of the product and makes it easier for sorting during recycling.

- **PETE (#1)** (Polyethylene Terephthalate) Bev. bottles, food containers
- **HDPE (#2)** (High Density Polyethylene) Milk Jugs, yogurt tubs, cleaning product containers, body wash bottles.
- **PVC (#3)** (Polyvinyl chloride) Food wrap, plumbing pipes, tiles, windows, medical equipment.
- **LDPE (#4)** (low Density Polyethylene) Plastic wrap, food containers, squeezable bottles.
- **PP (#5)** (Polypropylene) Tupperware, car parts, thermal vests.
- **PS (#6)** (Polystyrene) Bev. cups, insulation, packaging material, disposable utensils.
- **Miscellaneous Plastic (#7)** Plastic that is outside of the above categories.

A **recyclate** is a material that is in the process of being recycled. One of the biggest challenges when creating a successful recycling system is maintaining a high quality of recyclate. The quality of a recyclate is dependant on how much of the material is present without the presence of any other contaminants such as food waste. This can be ensured partly through a thorough sortition process.

Higher quality recyclates are worth more to manufacturers, so it is in the best interest of recyclers to maintain a high quality as this would mean more durable end products. It is crucial for a recycling program to have a steady source of recycling material in order for it to have a steady flow of operations and to be profitable. Material must constantly be processed otherwise the running costs will outweigh the profits.
High quality recyclates can be obtained through instruction of waste collectors of what specific plastic waste to collect.

The following are the 6 main products that the recycling facility shall focus on producing from the recycling of the various types of plastic.

Anthony stott Plastic recycling, Plastic Architecture- Wits M.Arch (Prof) 2017



Fig 24

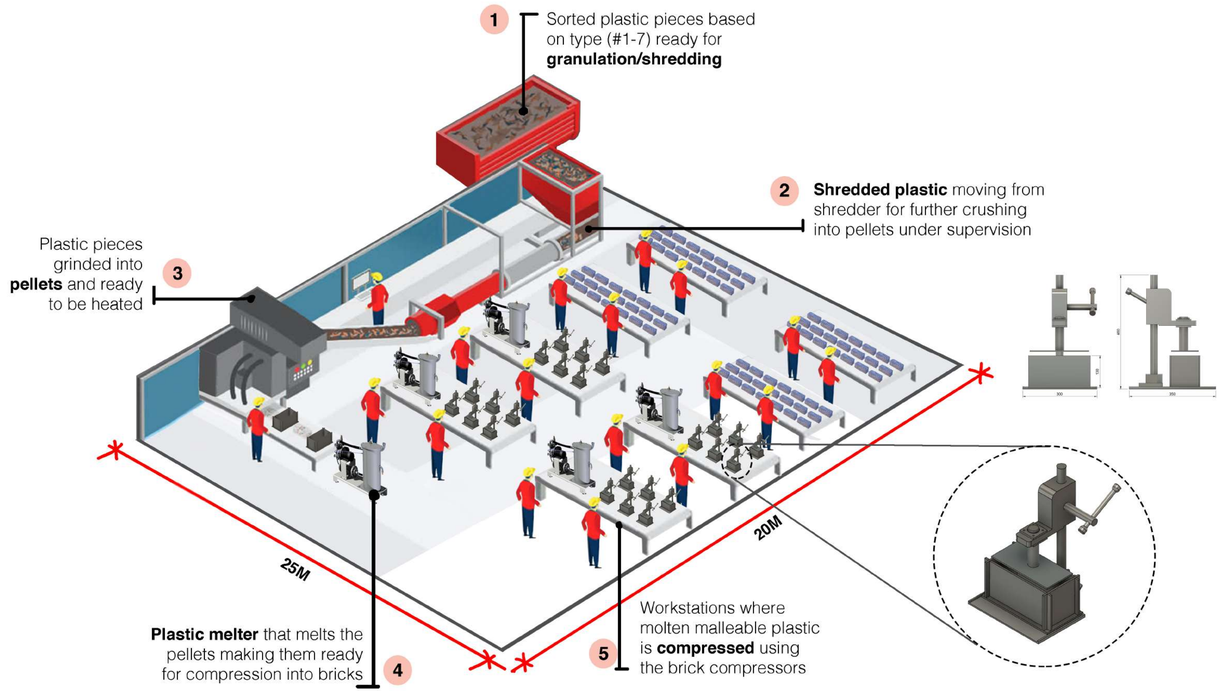
OUTPUT MANAGEMENT & APPLICATION

PET (polyethylene terephthalate) material from bottles have been tested and found to be as strong as a conventional house brick made from sand and cement.

Plastic bricks are thinner and lighter. They have incredible heat insulating properties and are just as strong as conventional bricks. They are relatively cheap to produce- it only takes 20 bottles on average to make one brick. Creating bricks out of plastic bottles is sustainable because it is less energy intensive than recycling the plastic into other forms.

In my facility, I intend to use plastic brick produced on site to build the second phase of the structure. The second phase will be made up of steel profiles for framing and bracing, and hollow core slabs. The steel profiles will be configured to allow for modular installation of the plastic bricks which will be locked in secondary lumber frames.

PLASTIC BRICK



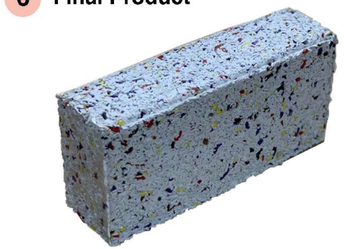


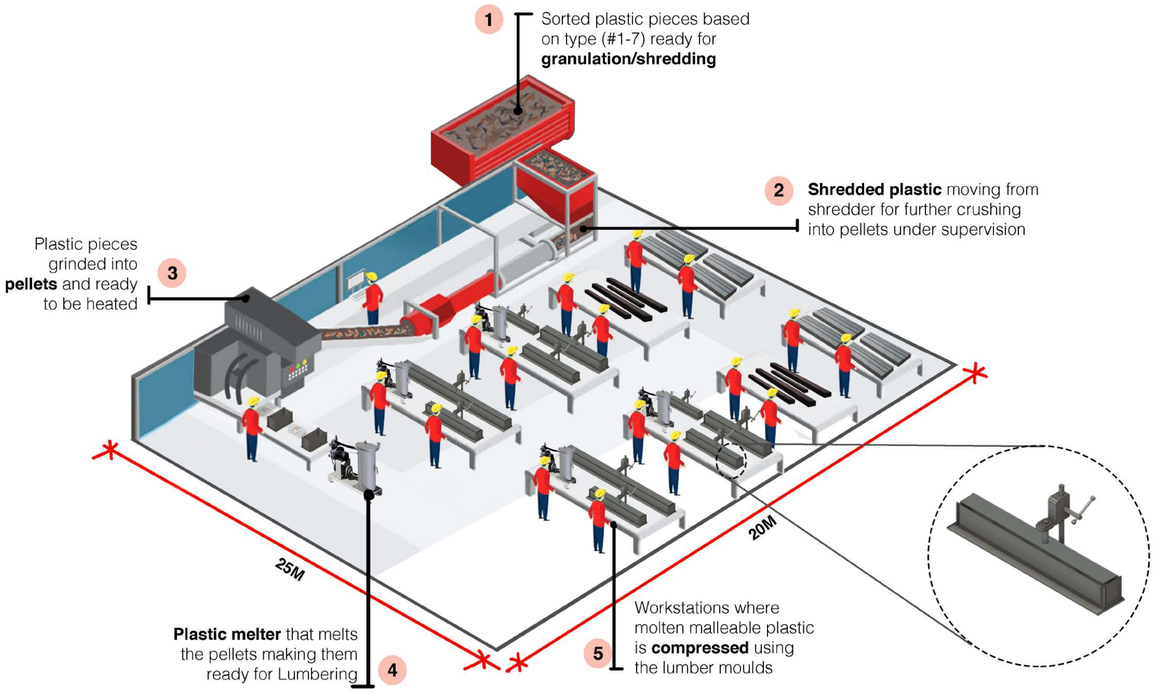
Fig 25: Making of Plastic bricks
Graphic by Author with reference to PLASTIC BRICKS MADE FROM USED WATER BOTTLES
Written by Expert Skip Hire on 02 July 2018.

The process of producing plastic lumbers is similar to that of plastic bricks. It takes a bit more energy and more plastic materials to produce lumbers as there are variations in length of the end product

Outdoor benches on site shall be made using these plastic lumbers as exhibition of the product to the public and to potential investors and buyers.

Plastic lumbers will also be used in the construction of the second phase of the facility. They will be used to make secondary frames onto which the plastic bricks shall lock. Thereafter, the frames shall be bolted onto the steel profiles that are fixed onto the main structural grid for support.

LUMBER



LUMBER MOULD

6 Final Product



Fig 26: Making of Plastic lumbers
Graphic by Author with reference to PLASTIC BRICKS MADE FROM USED WATER BOTTLES
Written by Expert Skip Hire on 02 July 2018.

PETE plastic can be transformed into fabric for winter clothing, alternative sewing thread, shoes, bags and carpets.

This is a great way to access and boost the local textile industry which at the moment is lagginng behind.

The finished products shall be used by personel working in the facility and also sold to the public- revenue from this will then be fed back into the facility to add onto the pool of funds that are used to cover for operational costs.

TEXTILE

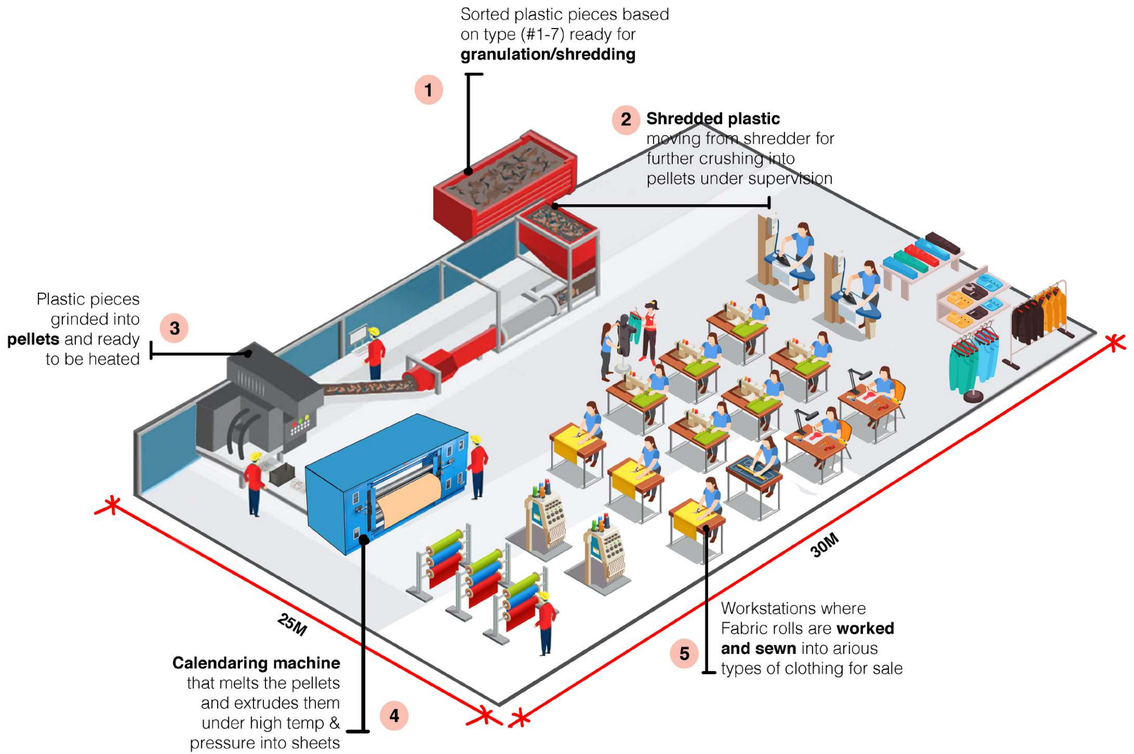


Fig 27: Making of Textile from recycled plastic
Graphic by Author with reference to PLASTIC BRICKS MADE FROM USED WATER BOTTLES
Written by Expert Skip Hire on 02 July 2018.

6 **Final Product**



ROOFING

Roofing is a well known output for plastic recycling. Plastic waste is recycled and pressed into rolls and corrugated sheets which are then used for roofing. It is a sustainable way of recycling plastic wate.

This is another material that will be used in the second phase for construction. PVC roofing has become a common roofing material that competes twith the other traditional materials such as clay tiles and gulvanised Iron sheets. They will also act as backdrops for solar panels that will be installed to harvest solar energy that would be converted into electricity to complement mainstream power from the municiplity.

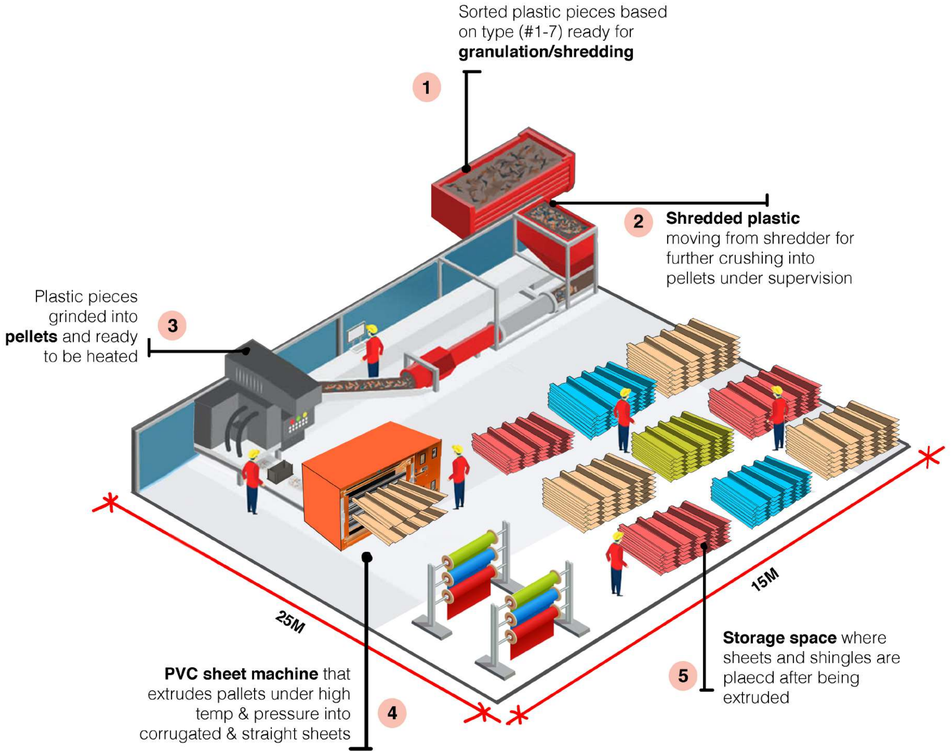


Fig 28: Making of roofing sheets from recycled plastic
Graphic by Author with reference to PLASTIC BRICKS MADE FROM USED WATER BOTTLES
Written by Expert Skip Hire on 02 July 2018.

6 **Final Product**



FLOORING

Similar to roofing, flooring is also a well known output of plastic recycling. Plastic waste is recycled and pressed into rolls and corrugated sheets which are then cut down to smaller pieces for flooring.

Different types of plastic produce different types of plastic tiles that will have different uses depending on the program of said spaces and the intensity of function.

Appropriate plastic tiles will be used for flooring of the productin spaces in the second phase of the facility- preferably vinyl flooring tiles, for their durability.

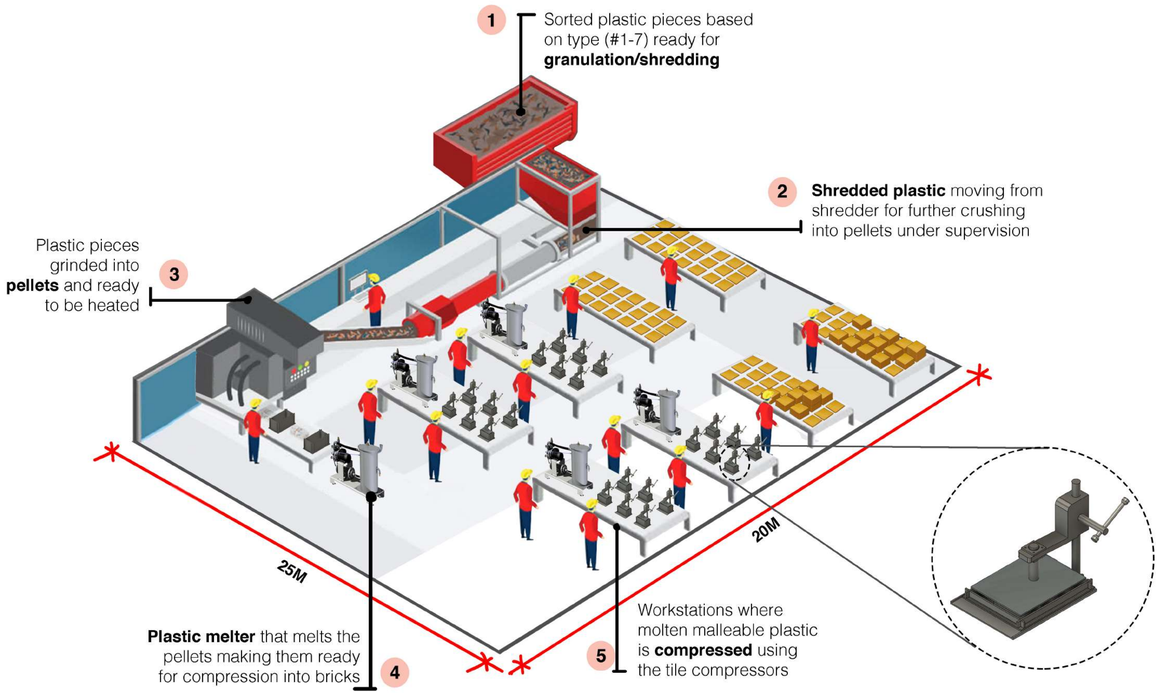




Fig 29: Making of floor tiles from recycled plastic
Graphic by Author with reference to PLASTIC BRICKS MADE FROM USED WATER BOTTLES
Written by Expert Skip Hire on 02 July 2018.

TROLLEYS

Building trolleys to sell them to malls and supermarkets can be a profitable way of generating income for the recycling facility.

Also, plastic waste can be transformed into better trolleys fo the informal waste collectors to make their work easier and more efficient.

Collaborations shall be sought with supermarkets and other enterprises that have a dire need for trolleys of various kinds. This product, along with textile products, shall be a source of revenue for the facility.

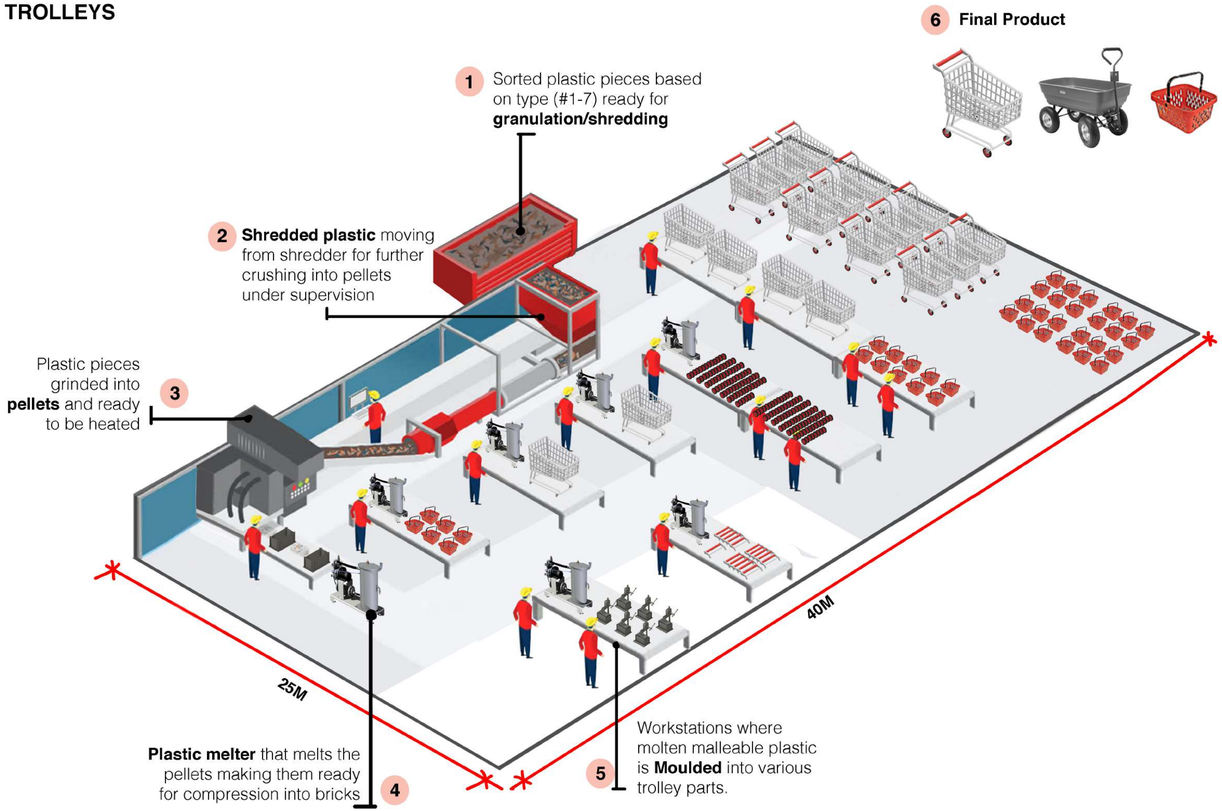


Fig 30: Making of trolleys from recycled plastic
Graphic by Author with reference to PLASTIC BRICKS MADE FROM USED WATER BOTTLES
Written by Expert Skip Hire on 02 July 2018.

Application

Testing, Quality Control and Assurance

Once these products have been manufactured, they are to be subjected to various testing procedures to ensure that they comply with the national stipulated standards- e.g the plastic brick has to comply with SANS regulations regarding building matreials. This phase shall be managed by material engineers and people with expertise in dealing wiht non-conventional building materials.

Phased Construction

The project shall be completed in two main phases- the first phase shall be for purposes of generating income for the next phase, and building materials which shall be used on the construction of the second phase for purposes of illustration.

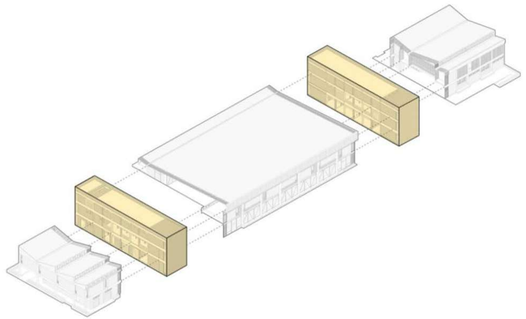


Fig 31: A project phasing diagram
Jordi, R., 2016. Behance.

Public spaces of the facility (e.g Exhibition spaces, reception, cafeteria) shall be built in the second phase of the design, using the various building materials produced from the recycling that occurs in the first phase. This way, the public shall be able to see a prototypical illustration of the materials and the intention of producing these materials.

Implementation

Aside from phased construction, the facility shall have a department that focuses on assisting the people of alexandra with using the products for constructing their own homes.
It will consist of artisans who already have experience with building shacks as we know them, and who have been recruited and trained to to use the non-conventional building materials to build.

HOUSING PROBLEM

Alexandra is a densely-populated township with a strong history of political resistance, poverty, high levels of crime and unemployment, and yet it is located adjacent to South Africa's successful commercial capitals i.e. Sandton, Morningside, Illovo, Hyde park and Rosebank.

This state of affairs is motivation enough to impllement my intervention, as it will miti

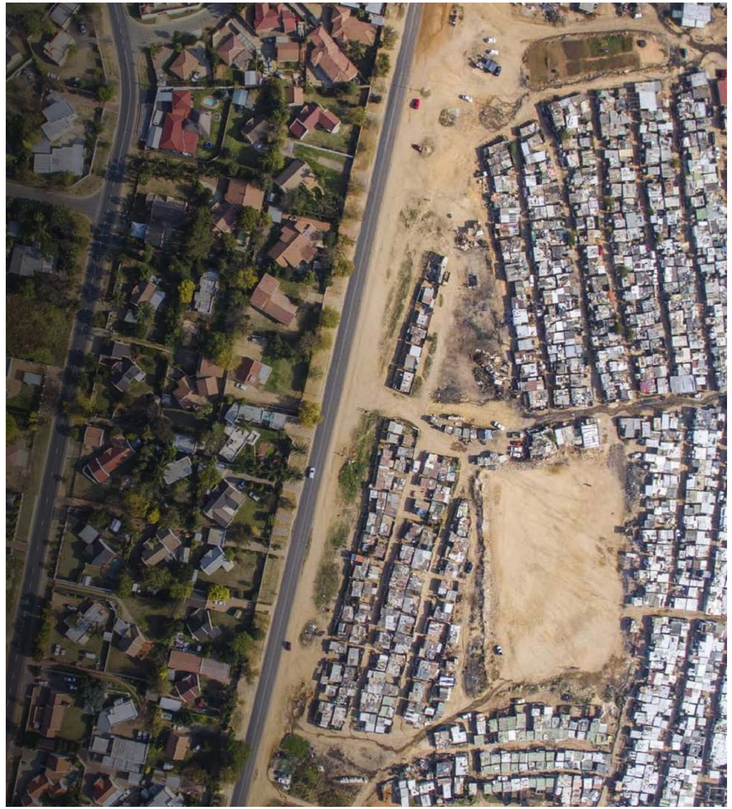
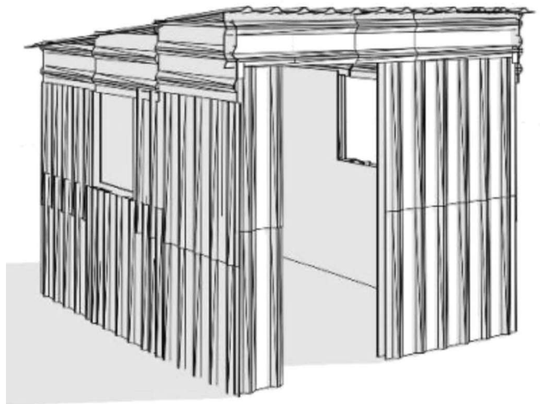


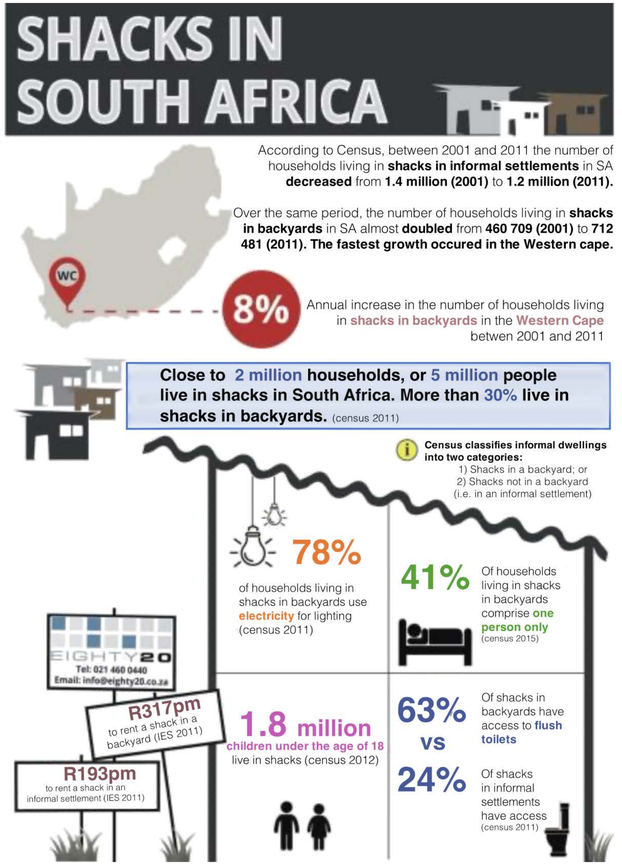
Fig 32: Aerial view of Sandton vs Alexandra
Source; The guardian



Millions of South Africans live in shacks, without adequate heating or food security.

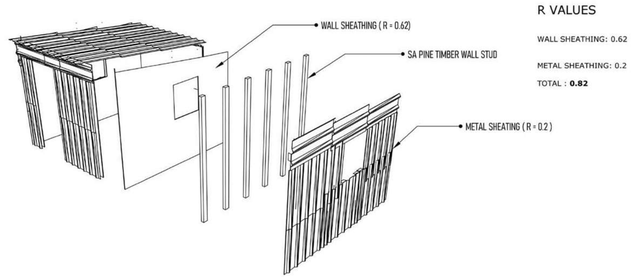
My intervention aims at mitigating this crisis by producing building materials that are accessible to these people such that they can use them to build better houses for themselves.

Fig 33: Existing Shacks statistics showing the delapidated state of housing in the disenfranchised communities e.g Alexandra
Source; https://www.eighty20.co.za/shacks-in-south-africa/



MATERIALS CONTRAST

EXISTING HOUSING

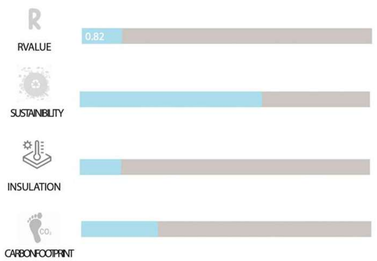


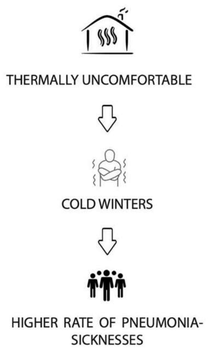
R VALUES

WALL SHEATHING: 0.62

METAL SHEATHING: 0.2

TOTAL : **0.82**





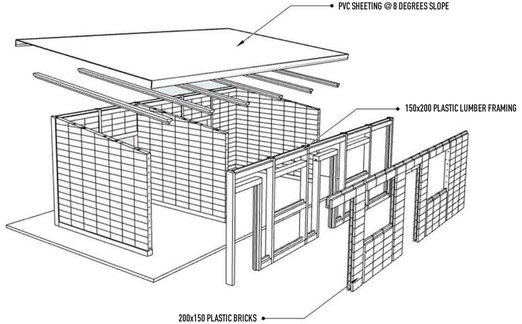
The following is a graphical analysis of a typical shack found in the townships in South Africa. Conventional materials have been used to build it up, i.e, Iron sheeting, timber for framing and plywood sheathing.

The materials used are cheap and readily available hence their preferece over other materials. However, during cold winters, these materials fail to keep the inside of the shacks temperate enough. The same applies during hot summers. This predisposes inhabitants of these shacks to illness related to cold weather e.g pneumonia.

These materials have also provd to be structurally unreliable. In the event of natural calamities, these houses collapse leaving many people homeless.

Fig 34a: Shacks statistics and analysis
Graphic by author

PROPOSED HOUSING



The following is an infographic of my alternative housing proposal to be implemented in the townships in South Africa. It consists of materials that will be generated from the recycling center after recycling of plastic waste e.g plastic brick, lumber and sheeting

These materials are more favourable as they posses better qualities in the various aspects that are critical to housing such as thermal comfort, affordability, durability and structural integrity.



Fig 34b: Analysis on alternative housing built from products made out of recycled plastic
Graphic by author

02 CONTEXT



Fig 35: Site locality map
Graphic by author basd on google maps.

A CASE OF ALEXANDRA

Demographics

Alexandra typifies a majorly disenfranchised community in the context of South Africa, suffering the consequences of socio-economic marginalization of black urban neighborhoods during the apartheid era. Nearly 500 000 people live in approximately 100 000 households in formal and informal housing; unemployment is estimated to sit at 60%, and most household incomes fall below the extreme poverty line of less than 1 USD per person per day.

My intervention aims at mitigating these conditions of poor and inadequate housing and unemployment through an innovative approach of transforming waste materials into building materials that are accessible to the people in need for better housing.

Target group

The data visualisation charts are a graphical representation that illustrates the different levels of unemployment based on age groups from 16 to 64 years old. The extent of the segments vary between men and women but are seen to have the same displacement approximately, indicating similarity. Based on the information gathered, the age groups experiencing the highest rate of unemployment are 20-24, 25-29 and 55-59, 60-64, with 60-64 being the highest.

Age group 50-65 has a high unemployment rate as this is an age bracket consisting of senior citizens, most of whom are not fully capable of working full-time jobs in the industry. Age bracket 20-29 however, raises concern as this is a group consisting of capable men and women and yet they exhibit the highest numbers of people not part of the labour force. Age group 30-54 consists of a majority of citizens who have jobs that are consistent on average. Age group 16-19 is understandably low as most of the people falling in this bracket are still in school.

It is therefore in order, to target the age group 20-29 as my source of labour force. There will be a curation and incorporation of youth between ages 20 and 29 into the construction and operation of the project, creating a community hub that provides an opportunity for socio-economic interaction and exchange that would empower the youth of Alexandra, mitigating the evident issue of unemployment in Alexandra.

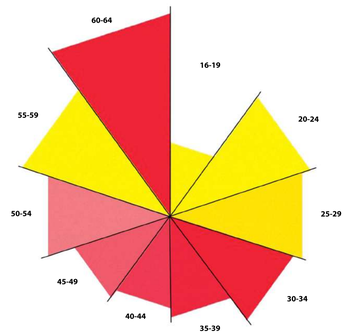
Fig 36: Employment statistics- Alexandra
Graphic by author using grasshoper and Rhinoceros Softwares

(https://open.uct.ac.za/bitstream/handle/11427/27819/thesis_ebe_2018_mbanjwa_phindile.pdf?sequence=1)

UNEMPLOYMENT RATES IN ALEXANDRA TOWNSHIP

A Graphical Representation of Unemployment per Age Group.

MEN- UNEMPLOYMENT



WOMEN- UNEMPLOYMENT

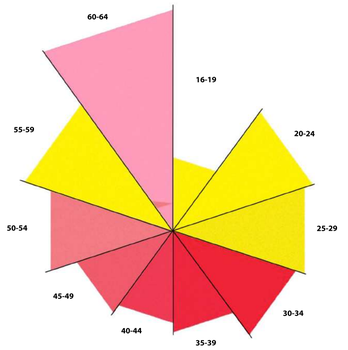
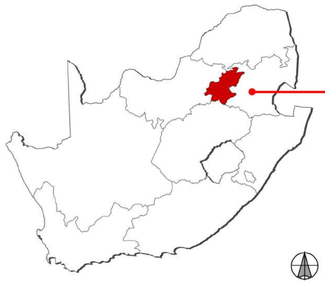


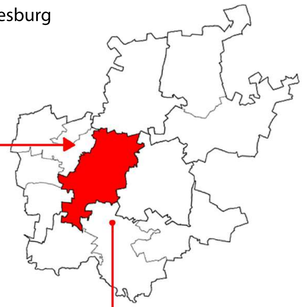
Fig 36

	Age	Population (Male)	Population (Female)	Reg. Unemployment (Male)	Reg. Unemployment (Female)
2	16-19	6694	6254	650	450
3	20-24	11807	11030	1765	1608
4	25-29	12764	11925	1860	1642
5	30-34	10241	9567	1041	1219
6	35-39	8009	7483	1007	783
7	40-44	6129	5728	1060	500
8	45-49	4883	4561	797	468
9	50-54	3506	3275	746	442
10	55-59	2867	2679	373	421
11	60-64	1757	1642	394	387

PROVINCE: Gauteng



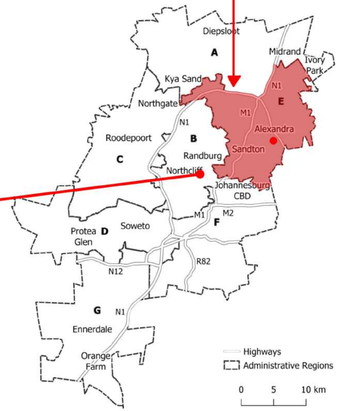
CITY: Johannesburg



SITE



REGION: E



The Project is located in Alexandra, Johannesburg in Gauteng Province. Established in 1912, Alexandra is one of Johannesburg's oldest townships, located adjacent to Sandton, Johannesburg's economic hub.

Fig 37: A composition showing the location of the site within the greater metropolitan context.
Graphic by author

Site Context



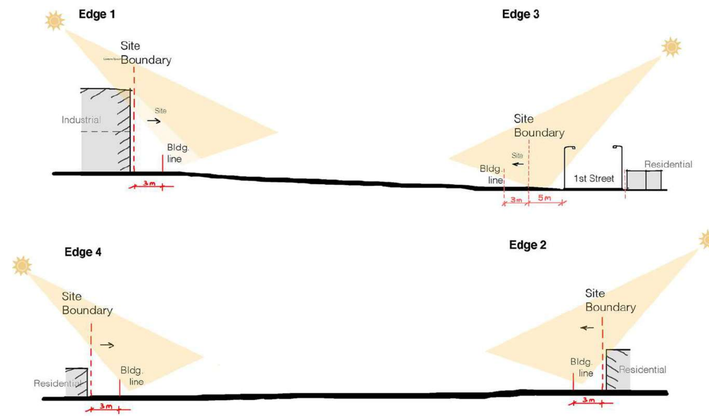


Fig 38: Site sections
Graphic by author (Source; google earth)

S-01 Section across first Street

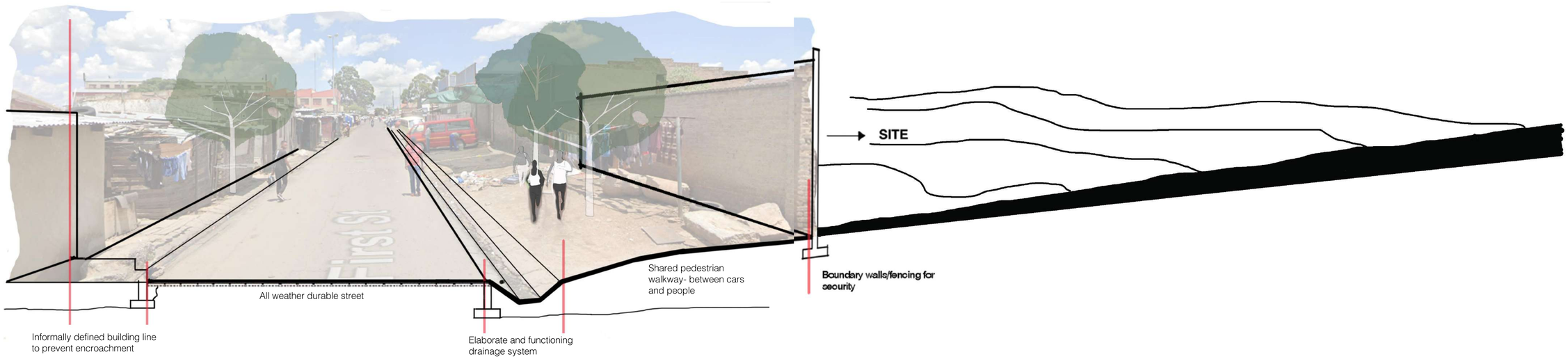
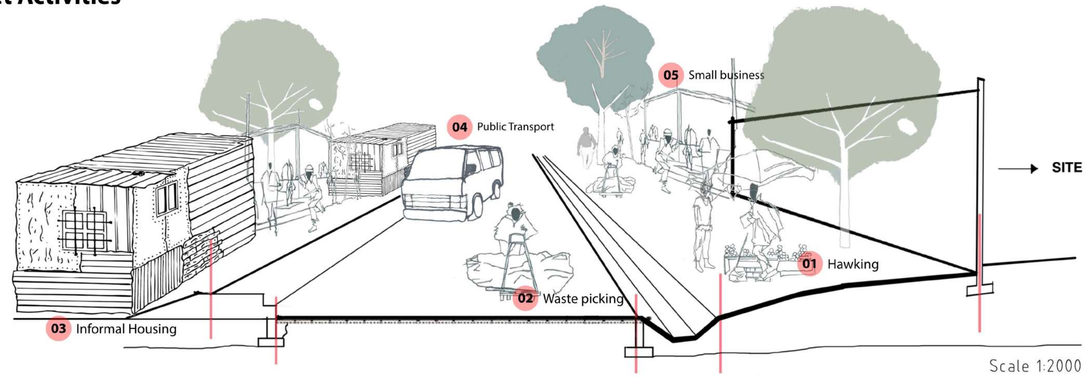


Fig 39: Site section- the street outside the site predominantly has minimum and domestic activity, with minimum small scale commercial activity
Graphic by author

Street Activities



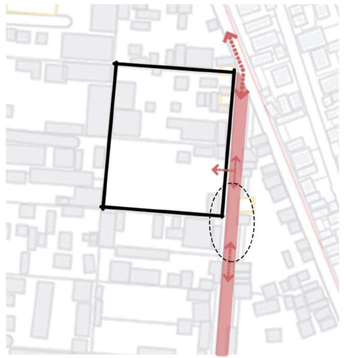


Fig 40: The various street activities
Graphic by author

01 Hawking

Majority of residents of Alexandra live from hand to mouth, hence the strong culture of hawking by the roadside.

02 Waste picking

Informal waste collectors scathe the streets of any valuable waste to collect and take to recyclers.

03 Informal Housing

This is the most predominant housing typology as it is cheap to build

04 Public Transport

Good road infrastructure allows for accessibility for cars throughout the context of the site by public transport- enabling movement to and from the city

05 Small business

Presence of small/medium scale entrepreneures who have identified demand for certain goods and services

Amenities



KEY

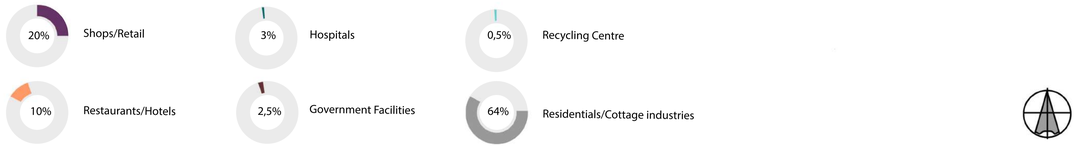
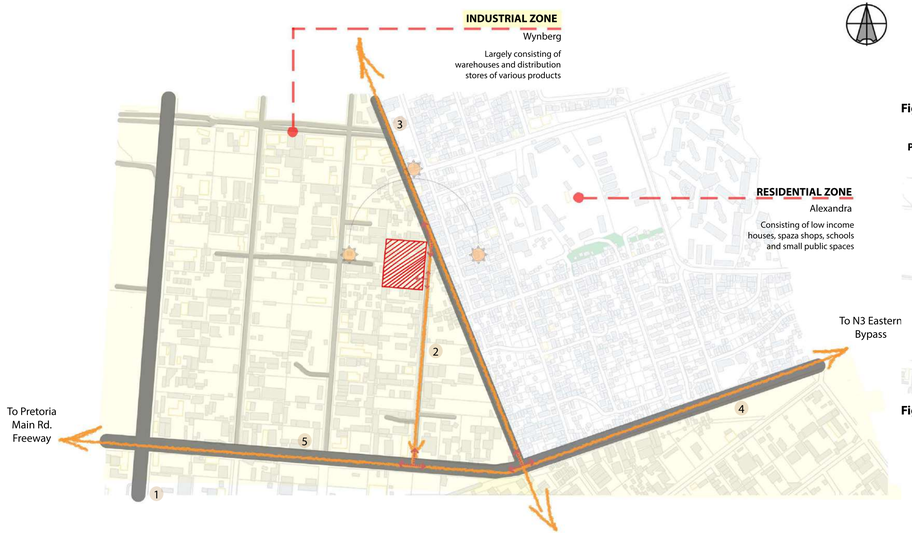


Fig 41: Amenities map
Graphic by author

Accessibility

The site is accessible both at a surbub scale and a metropolitan scale. The street passing outside the site connects to pretoria Rd on one end and the N3 eastern bypass on the other end. This is important as it allows for sourcing of plasic waste at a large scale beyond alexandra easily.



1 Pretoria Main Rd.
2 First Street
3 First Avenue
4 Wynberg Rd.
5 Arkwright Avenue
Access to site

Fig 42a

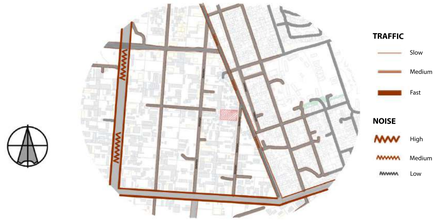


Fig 42b

Pedestrian access

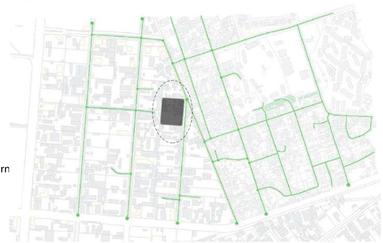


Fig 42c

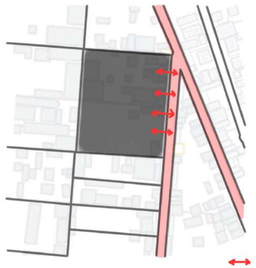


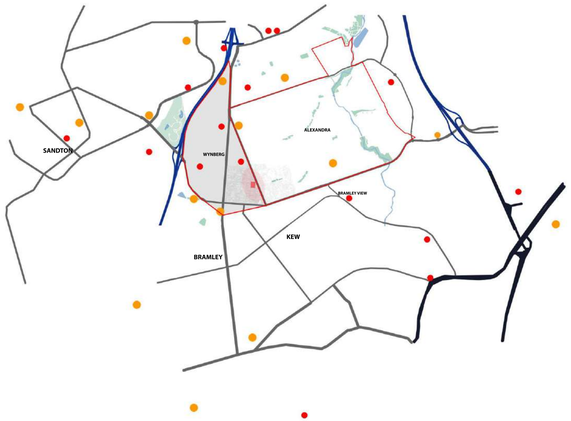
Fig 42d

Fig 42 (a-d): Zoning and access maps
Graphic by author

Possible waste sources

The main material of focus is plastic. The intention is to transform plastic into building materials that would be useful in mitigating the issue of poor housing in the context of Alexandra- along with unemployment through creation of job opportunities.

Plastic waste shall be sourced from around the context of Johannesburg- through an in-built independent collection system that collaborates with factories, shopping centres, donators and informal waste collectors. The map below shows possible spots where waste could be sourced around the context of my site.

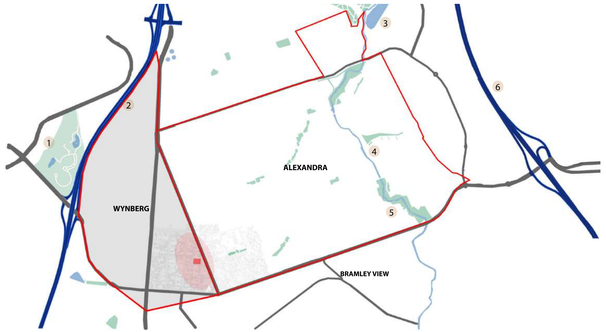


Large scale Shopping centres/ retail spaces
Industries/Factories

Fig 43 & 44: Map showing possiblle waste sources around Johannesburg metropolitan area
Graphic by author

Landmarks

Site is located in a well connected area, with sufficient accessibility on a metropolitan scale. This makes it possible to source waste from other places across the city and outside the immediate context of the site easily.



1 Innesfree Park
2 M1 Freeway
3 Linbro Park
4 Jukskei River
5 Alexandra Community Park
6 N3 freeway

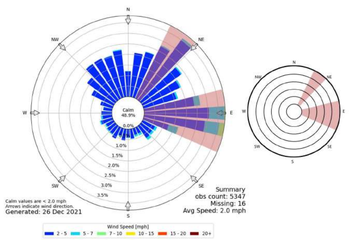
Fig 44

CLIMATE ANALYSIS

SUMMER

WIND

Johannesburg
01- 10 Jamuary



RAINFALL

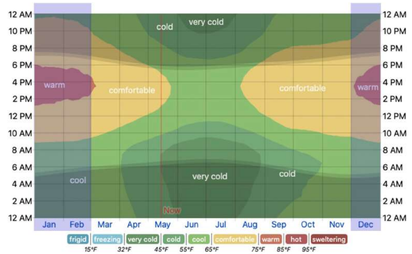
Johannesburg
Dec - Feb



	Dec	Jan	Feb
Rainfall	3.8"	3.9"	3.3"

TEMPERATURE/SUN INTENSITY

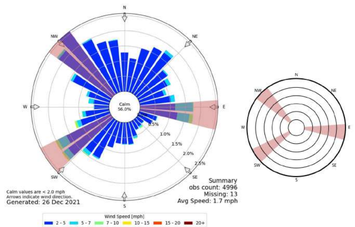
Johannesburg
Dec - Feb



ATUMN/FALL

WIND

Johannesburg
1 - 30 April



RAINFALL

Johannesburg
Mar - May



	Mar	Apr	May
Rainfall	2.5"	1.3"	0.5"

TEMPERATURE/SUN INTENSITY

Johannesburg
Mar - May

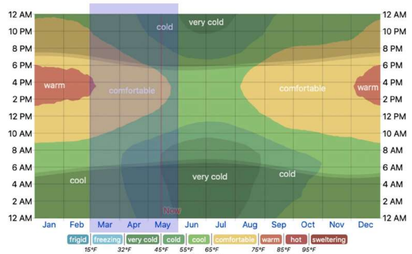
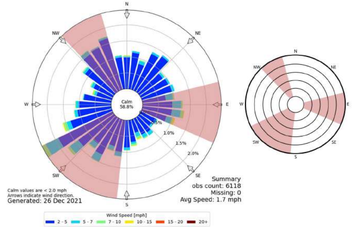


Fig 44: Climate analysis- Summer & atumn
Source; Mesonet.agron.iastate.edu.

WINTER

WIND

Johannesburg
01- 31 July



RAINFALL

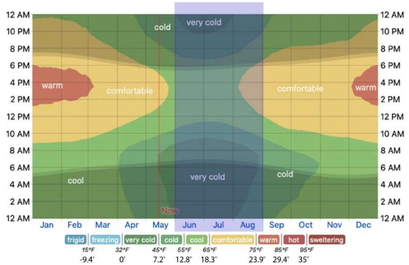
Johannesburg
Jun - Aug



	Jun	Jul	Aug
Rainfall	0.2"	0.1"	0.2"

TEMPERATURE/SUN INTENSITY

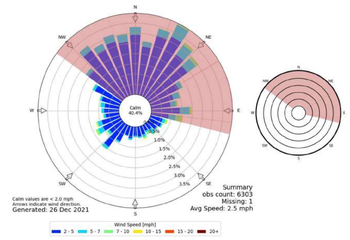
Johannesburg
Jun - Aug



SPRING

WIND

Johannesburg
01 - 31 October



RAINFALL

Johannesburg
Sep - Nov



	Sep	Oct	Nov
Rainfall	0.7"	2.1"	3.3"

TEMPERATURE/SUN INTENSITY

Johannesburg
Sep - Nov

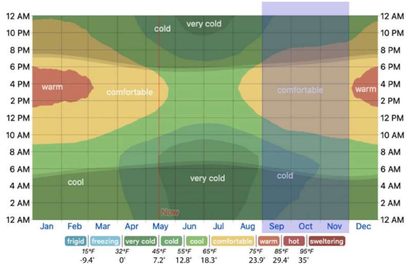


Fig 45: Climate analysis- Winter & spring
Source; Mesonet.agron.iastate.edu.

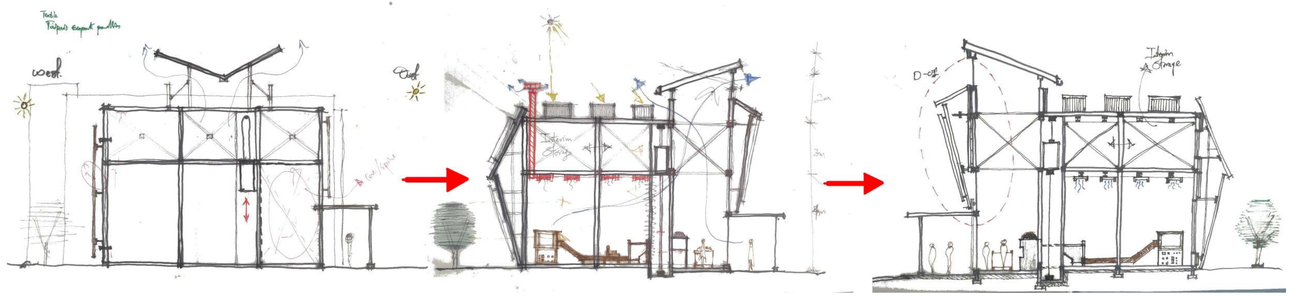


Fig 46: Section sketchesdeveloped during design development
Graphic by author

04 ARCHITECTURAL RESPONSE



Fig 47: 3D visualisation of facility from above
Graphic by Author

DESIGN REFLECTION

CHARRETTE

Possible planning of processes

The following are some sketches depicting my initial thinking around the concepts of process and connectivity- relating the inputs and outputs of recycling and how they can mesh spatially.

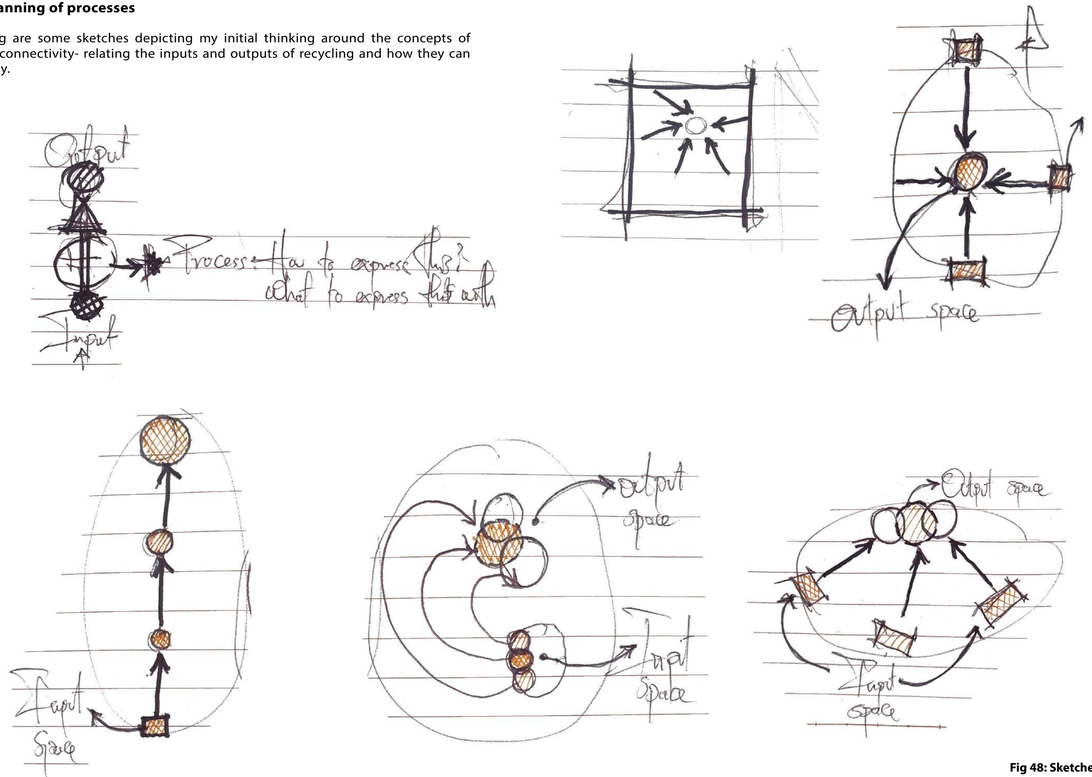
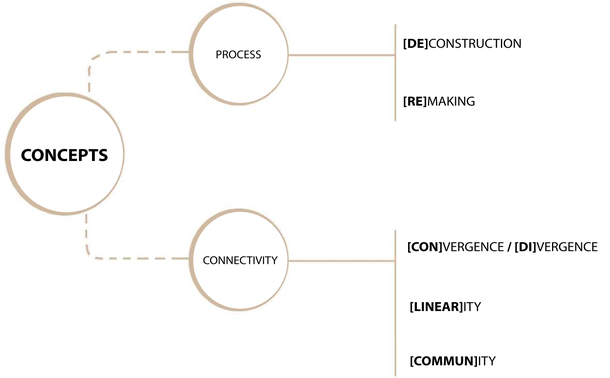


Fig 48: Sketches by author





MATERIALS -Paper- (cartridge paper- receipts & notes

ELEMENT -Water

Fig 49a

Fig 49 (a-c): Images of the charrette process
Graphics by author



MATERIALS
-Timber strips
-Banana leaves
-Thread
-Graph paper
-Cork material

Fig 49b



MATERIALS
-Carton (Polystyrene & pulped paper)
-Timber strips
-Matches

ELEMENT
-Fire

Fig 49c

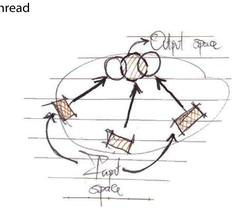
EXERCISE 1



Fig 50a

MATERIALS

-Timber strips
-Banana leaves
-Thread
-Graph paper
-Cork material



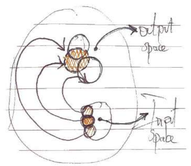
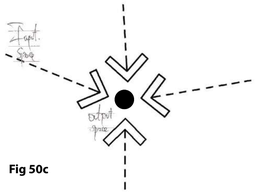


Fig 50b



[LINEAR]ITY | **[CON]**VERGENCE



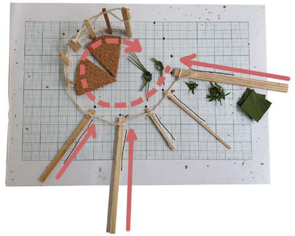
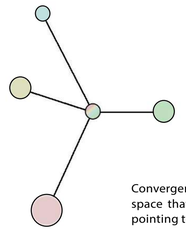


Fig 50c

The unidiretional aspect of the process of deconstruction and remaking creates a strong sense of linearity and hierarchy from which I could possibly derive my planning principles.

This will be relevant in designing my building in terms of deciding on access points- drop off and collection points.

[COMMUN]ITY | **[RE]**MAKING



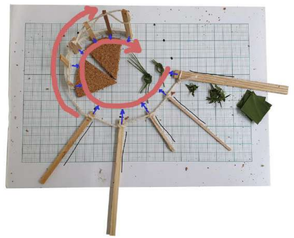


Fig 50d

Convergence of the different linear processes of remaking creates a common space that offers opportunity of interraction amongst the different outputs, pointing towards the concept of community- A community that emmerges as a result of cross programming, spatially and materially.

This has relevance in terms of appropriation of public space, and collection points of finished products.

Fig 50 (a-h): Images of the charrette process
Graphics by author

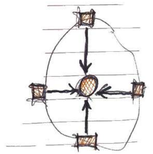
EXERCISE 2



Fig 50e



[DE]CONSTRUCTION | **[DI]**VERGENCE



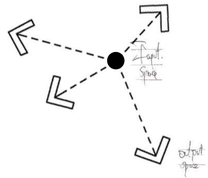


Fig 50f

In this exercise, I observed the divergence due to the element of fire acting on the materials- the fire started from the centre and consumed the materials as it grew bigger in an outward direction. The result is a composition that is rather detatched.

In designing my building, this could inform my decision of appropriation of access and public space relating to materials that would transform in this manner.

EXERCISE 3



Fig 50g



[LINEAR]ITY

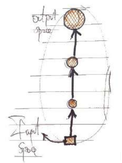


Fig 50h

The step by step process of altering the form and state of paper using water and fire, when observed in plan, is a linear process. The end result is seen to be of a lesser volume and occupying less space.
In building, this could possibly translate into variations of volume and square metrage for units dealing with the process of remaking.

DESIGN DEVELOPMENT

INITIAL DEVELOPMENT

RESOLUTION 1

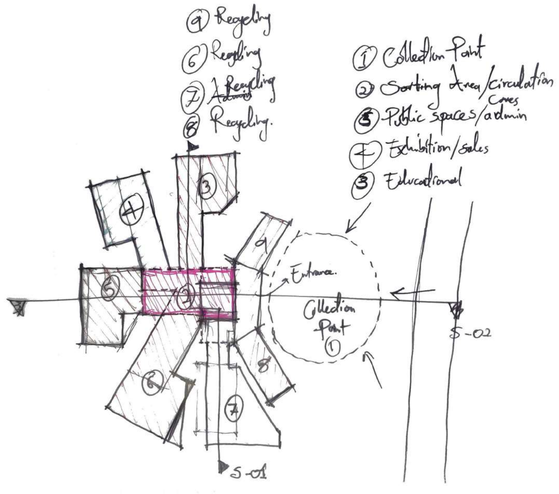


Fig 51: REsolution1 Plan

In this resolution, spaces are arranged about a main blocknthat serves as the main entrance and point of circulation into the other blocks and around the site.

This type of layout saves on space and makes movement from on point to another easier and quicker.

RESOLUTION 2

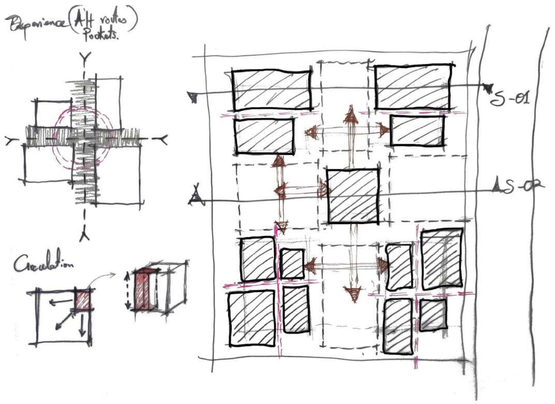


Fig 52: Resolution 2 Plan

This design resolution is fragmented. The spatial layout consists of a play between built up space and outdoor space. The outdoor spaces act as breakout areas and connect the various blocks, facilitating movement through and around the site

ALTERNATIVE 1 DEVELOPMENT

This spatial layout is derived from the concept of convergence from my design charrete. The unidirectional and linear aspect of the process of deconstruction and remaking is used as a principle upon which spaces are arranged

This is a useful approach as it simplifies accessibility for entry and exit of people and materials to be transformed

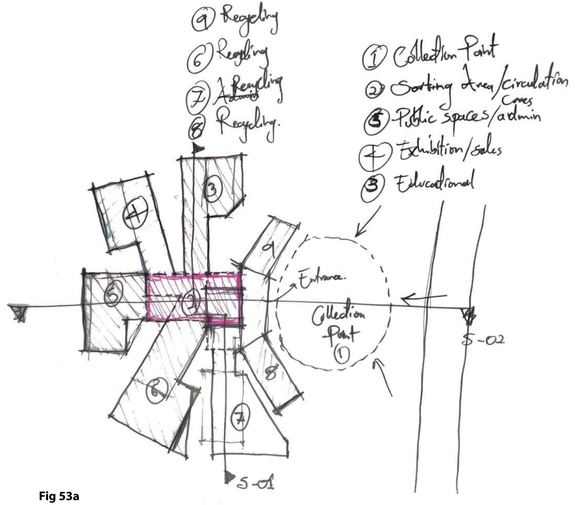


Fig 53a

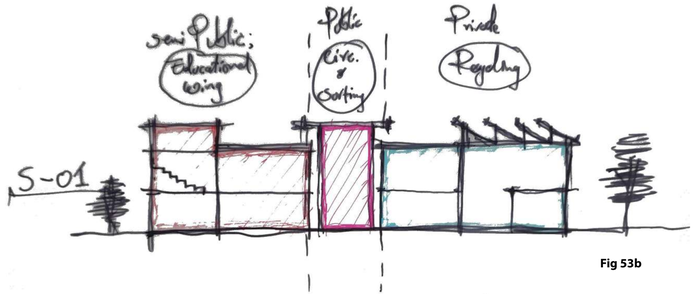


Fig 53b

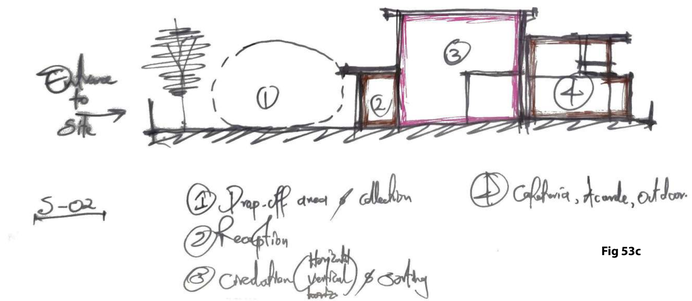


Fig 53c

Fig 53 (a-c): Resolution 1 Plan & Sections
Graphics by author

RESOLUTION 2 DEVELOPMENT

Spaces in this resolution are arranged in a manner that creates pockets of space that act as breakout spaces and connection spaces between the various blocks.

The pockets of space for circulation aim to create an experience with their slightly narrow and tall alleyways.

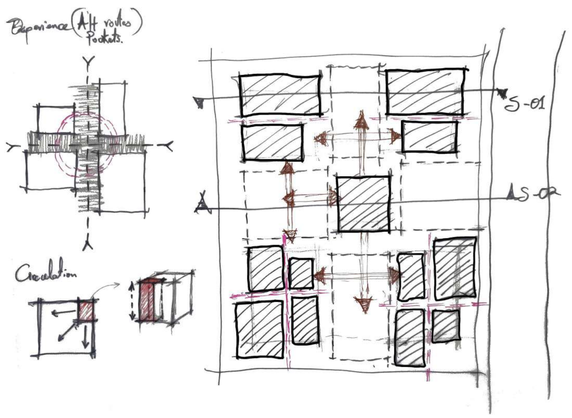


Fig 54a

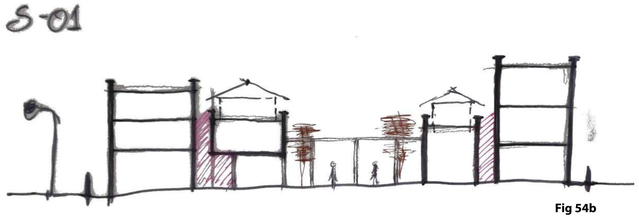


Fig 54b

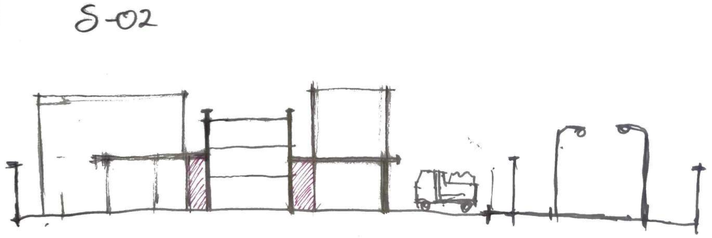


Fig 54c

Fig 54 (a-c): Resolution 2 Plan & Sections
Graphics by author

This kind of planning has one critical flaw- Poor access control.
It is nearly impossible to establish a hierarchy for access and pedestrians can basically access the site from any point. This could potentially cause security issues.

Another flaw is access to daylight. Most of the blocks will not receive adequate ambient light as they are being blocked by the other blocks. This is unfavourable in terms of lighting and utilisation of heat energy in the interior.



Fig 55a

Fig 55 (a-c): Resolution 2 Plan & Sections
Graphics by author

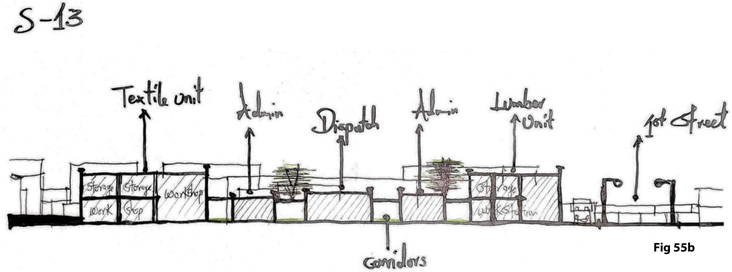


Fig 55b



Fig 55c

MASSING

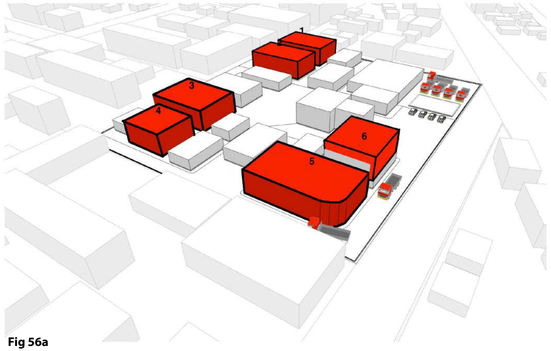


Fig 56a

1. Brick Making Space
2. Tile Making Space
3. Textile Making Space
4. Roof Making Space
5. Trolley Making Space
6. Lumber Making Space

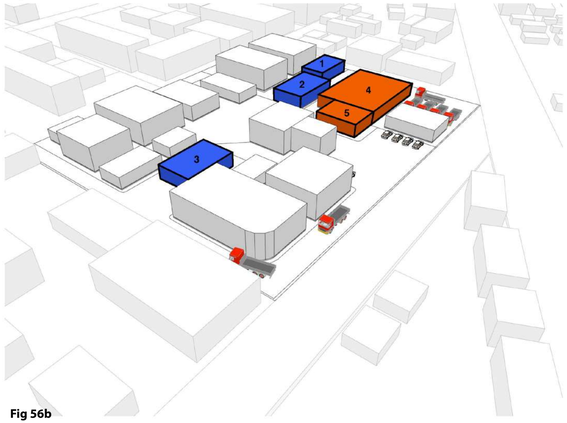


Fig 56b

1. Dispatch (Bricks & floor tiles)
2. Cleaning & Sorting
3. Dispatch (Textile, Lumber, trolleys & Roofing)
4. Collection point (formal)
5. Collection Point (Informal)

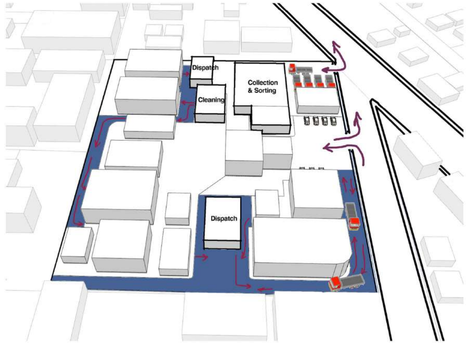


Fig 56c

Fig 56 (a-c): Alternative 2 Massing diagrams
Graphics by author

PHASE DESIGN

The teethed roof on the manufacturing phase of the facility slants facing the North for ample exposure to the sun for most of the day. This ensures that the panels on the grooves receive solar energy that is then converted into electric energy to be used in the facility.

Mechanical ventilation is used to compement passive ventilation systems that have been incorporated in the design. The same applies to solar energy- it acts as a complimentary source of power to the municipality power.

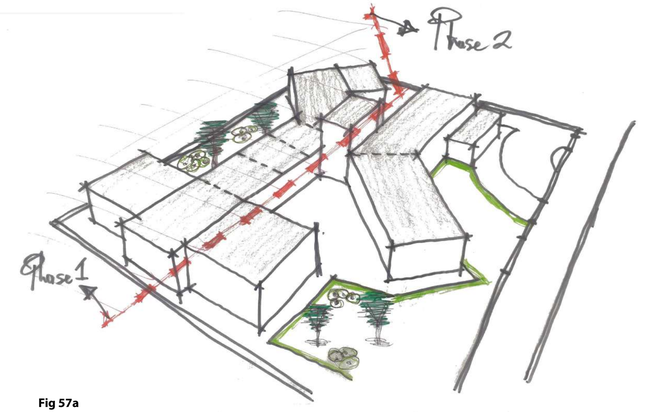


Fig 57a

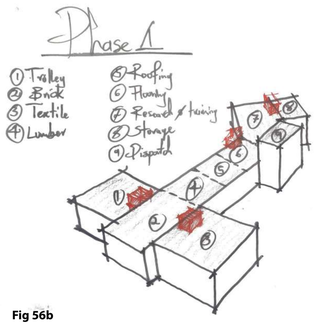
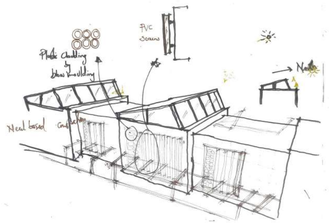
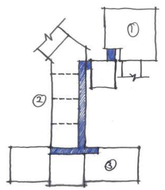


Fig 56b





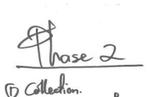
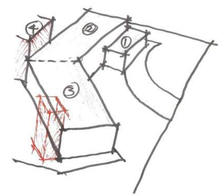


Fig 56c



Brick and lumber takes priority as they are essential building materials in the design.

Phase 2, which mainly consists of public spaces will also include the building materials produced in phase 1 for illustration purposes

Fig 57 (a-c): Alternative 2 Massing diagrams
Graphics by author

SECTION DEVELOPMENT

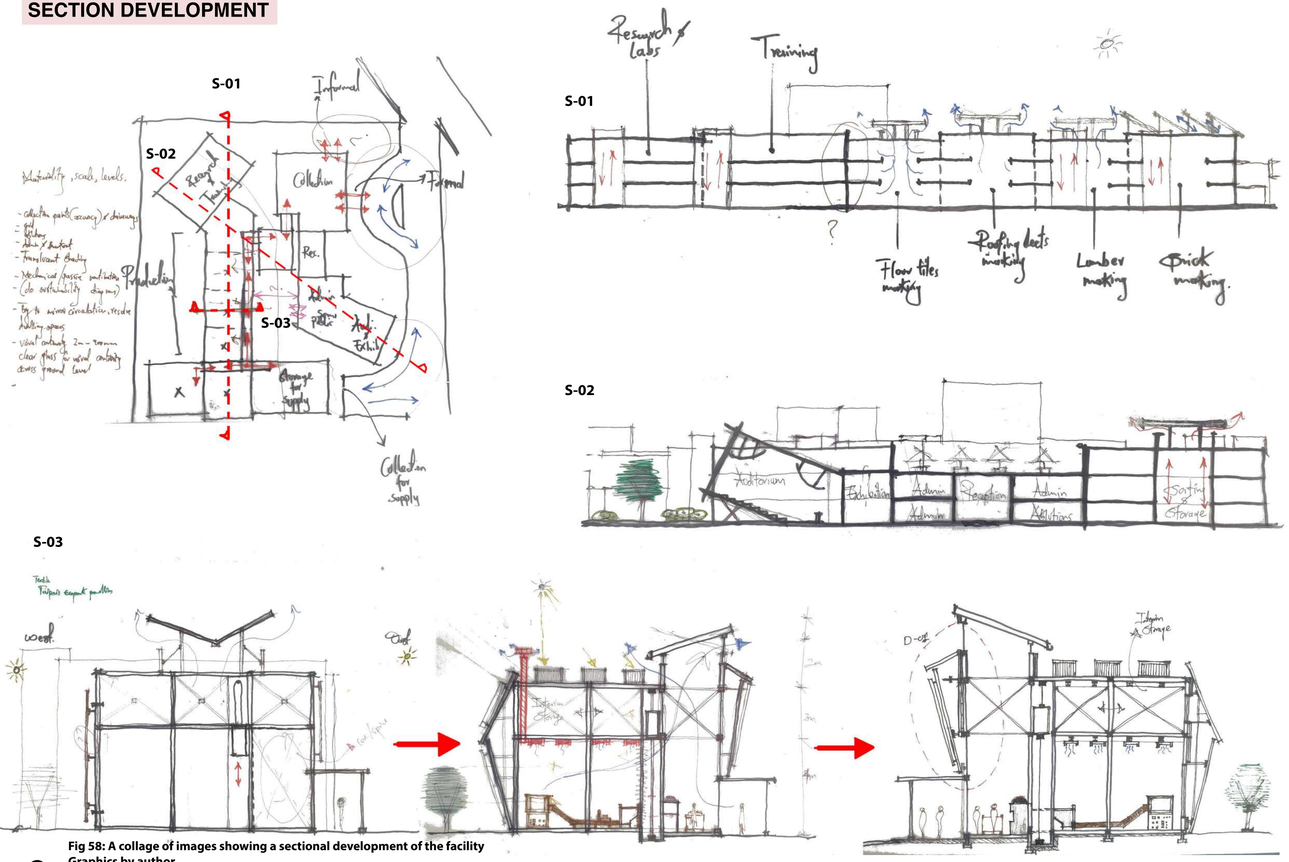


Fig 58: A collage of images showing a sectional development of the facility
Graphics by author

FURTHER DEVELOPMENT

CONCEPTUAL EXPRESSION

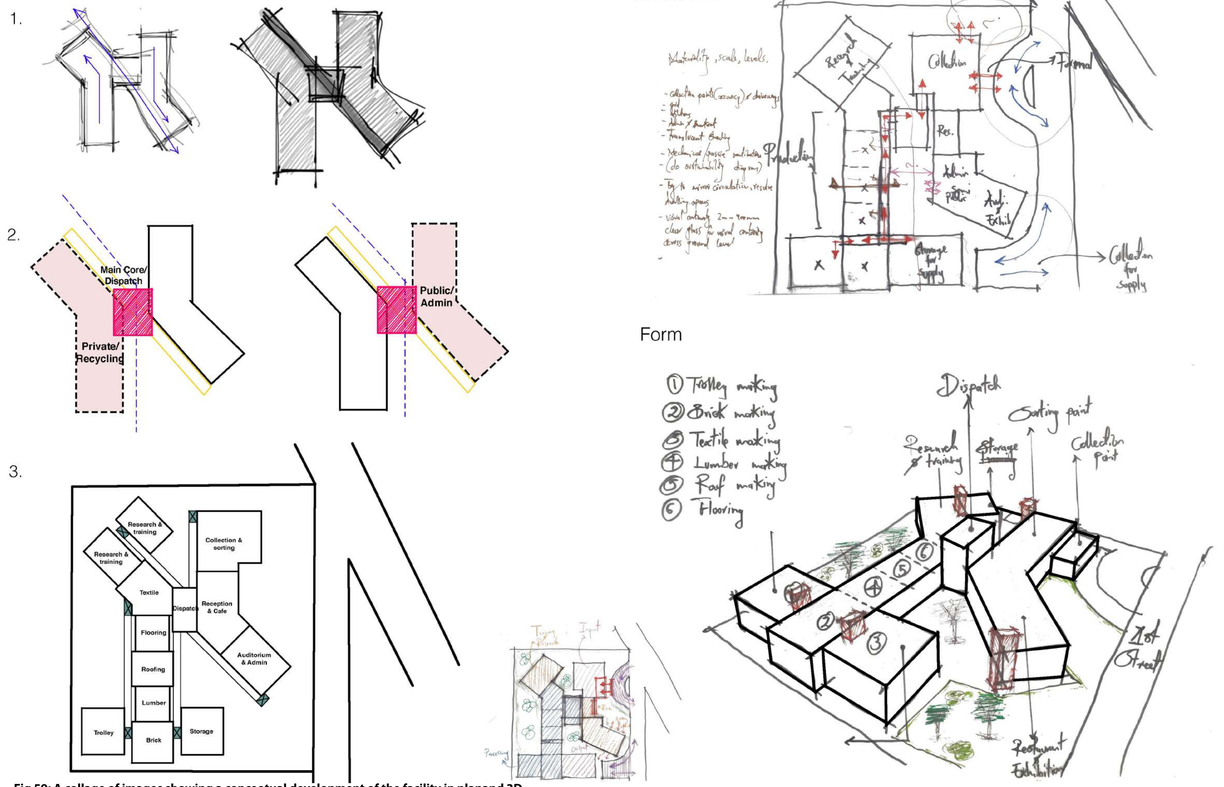
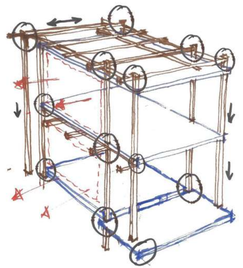


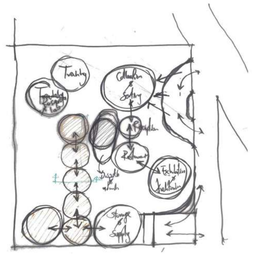
Fig 59: A collage of images showing a conceotual development of the facility in planand 3D
Graphics by author



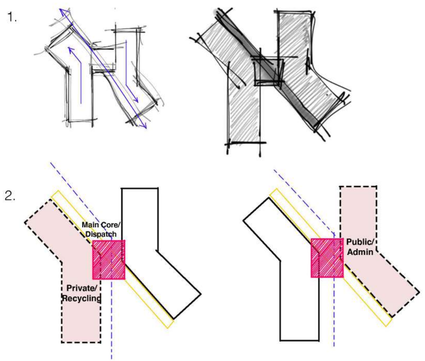
CONNECTION

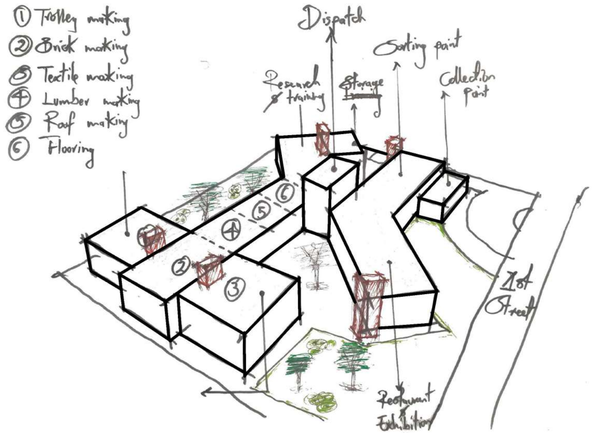
Connection is expressed structurally and spatially;

Structurally through how materials interact and support each other
Spatially through spatial flow and transitions based on program

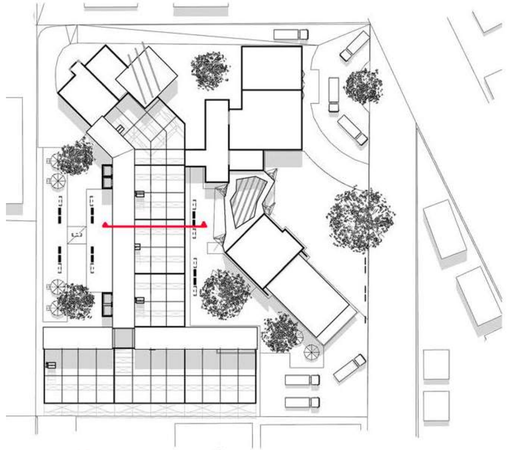


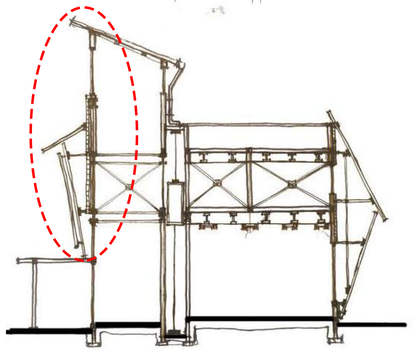


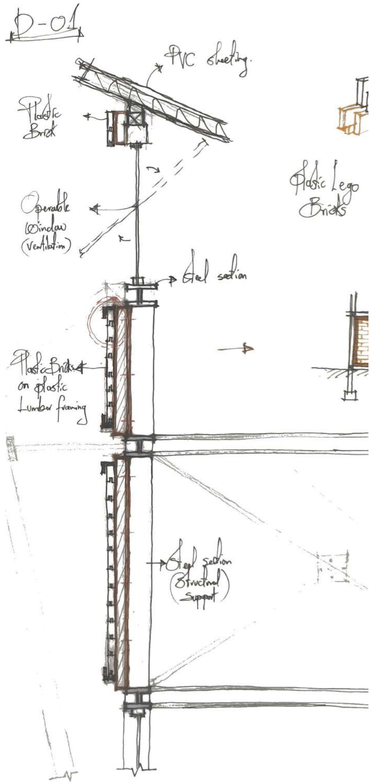




STRUCTURE & MATERIAL







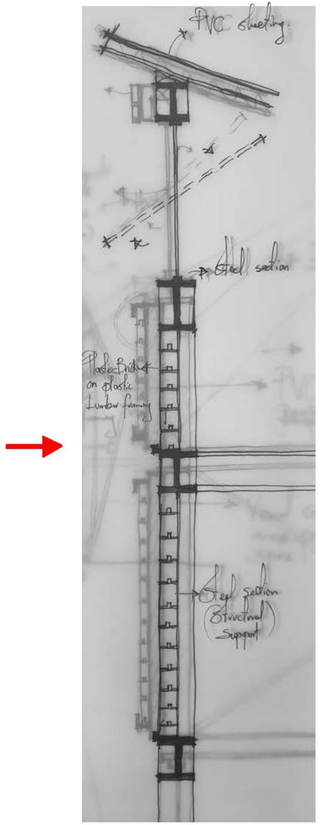


Fig 61: A collection of sections showing a detail of the perimeter of the building
Graphics by author

Fig 60: A collage of images showing a concept o connection as the key word of the project
Graphics by author

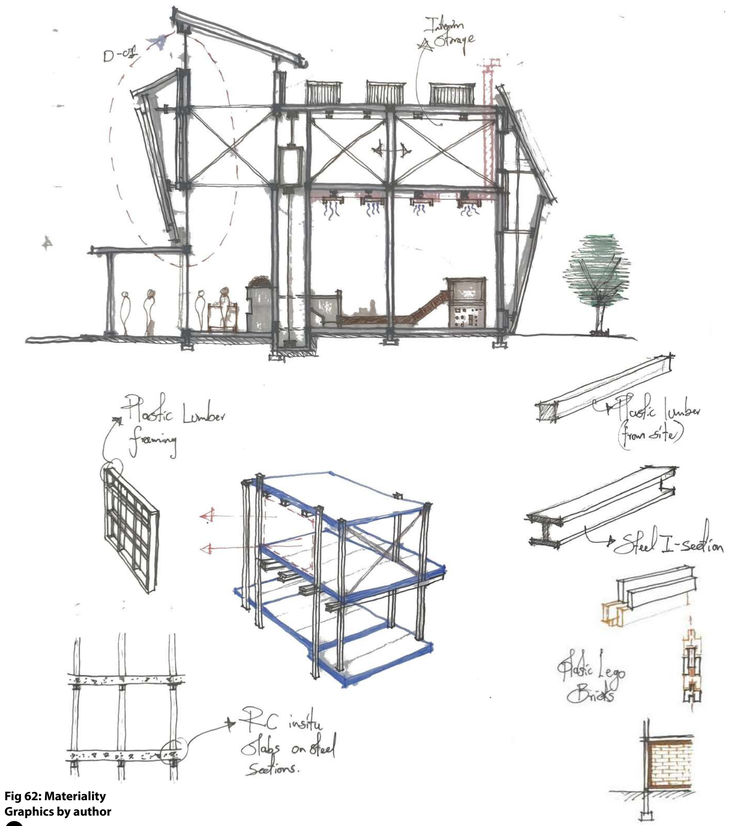
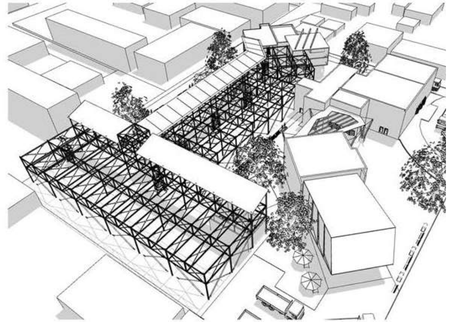


Fig 62: Materiality
Graphics by author



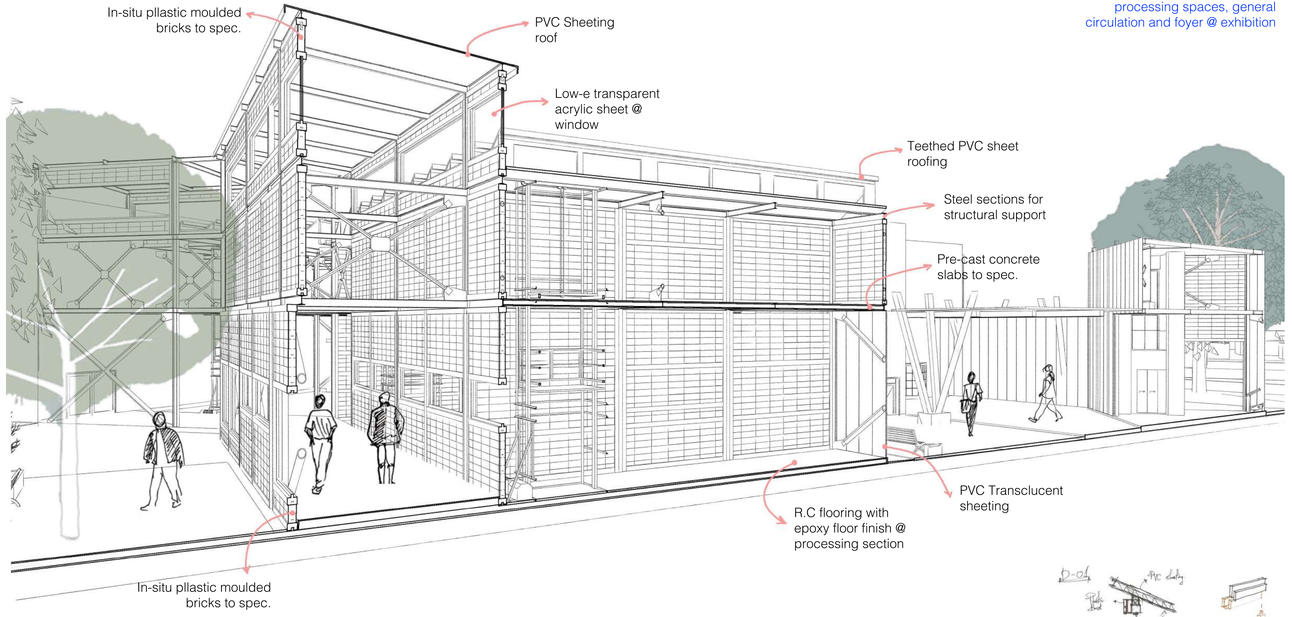
STRUCTURE

The structural configuration of the facility was insired mainly by the idea of creating frames on which modules of plastic bricks can fit. The structure is primarily a balloon framed structure, with steel profiles for columns and beams. Slabs are made from hollow core slabs that tie in to the spans, to structural engineer's specifications.

The steel framing gives the facility the industrial look that is very appropriate to its typology, and as well offers the compatibility for installation of removable modules of plastic bricks- the idea is that, as the recycling of plastic brick into building materials progresses, there will come other alternatives to plastic bricks that would then replae them in the frames for the public to see.

The first phase of the building is constructed using the conventional building materials i.e brick and concrete.

ISO SECTION
A 3D cutaway across one of the processing spaces, general circulation and foyer @ exhibition



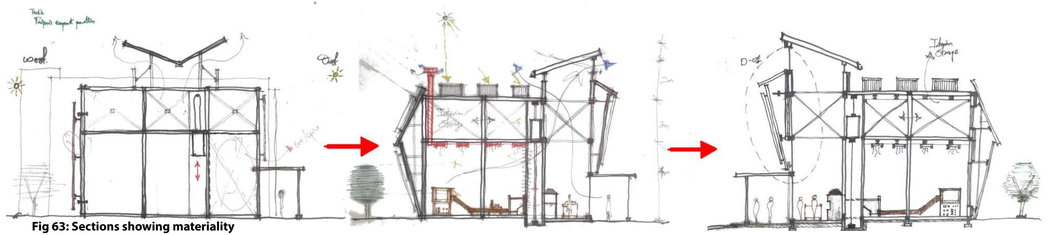
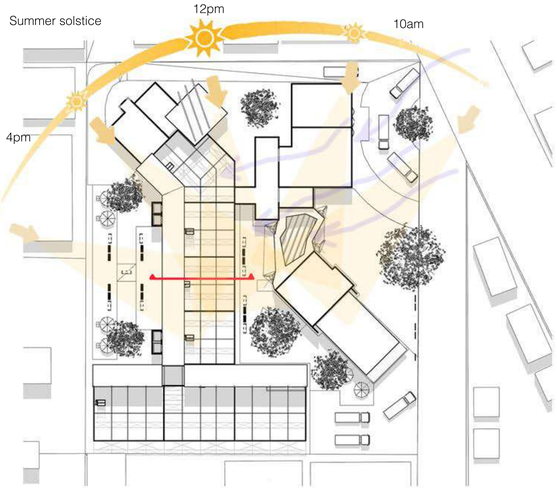
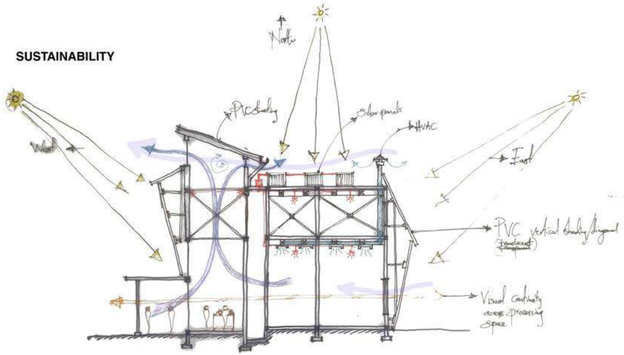


Fig 63: Sections showing materiality
Graphics by author

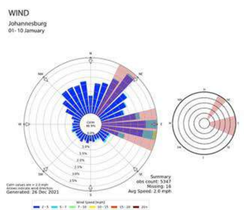
CLIMATE RESPONSE

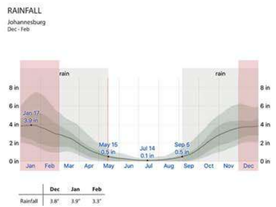


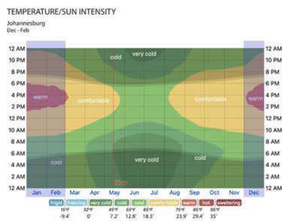


CLIMATE ANALYSIS

SUMMER



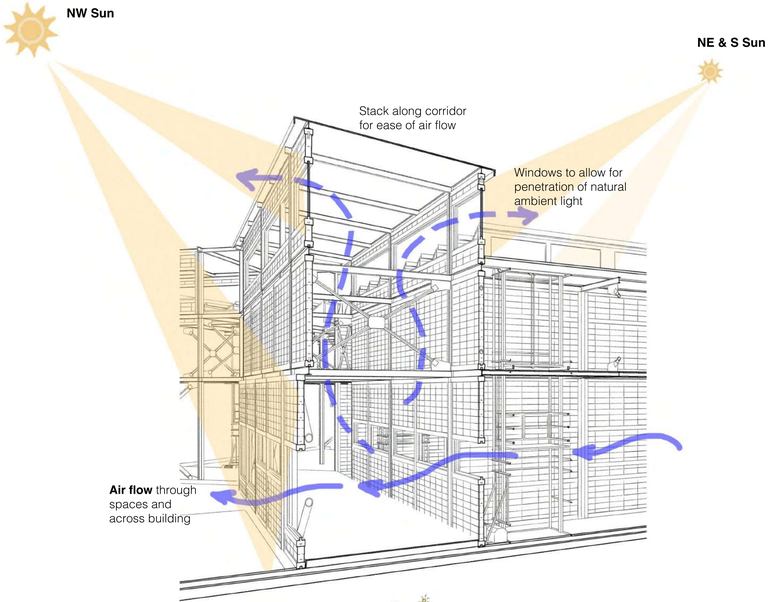




The production section of the building generates a lot of heat from melting and transformation o plastic waste. It is therefore essential to have a building design that is well ventilated to facilitate constant flow of air for cooling during summer (As shown in section)

From the following analyses, it is important to consider passive stack ventilation to compliment active ventilation, as well as solar harverstring using solar panels- to catch the northern sun that is available for most of the year.

Fig 64: Climate analyses



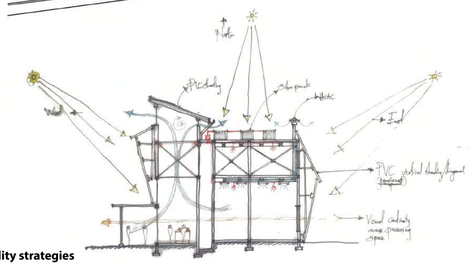
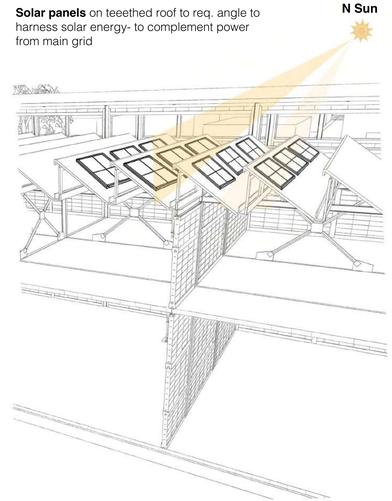


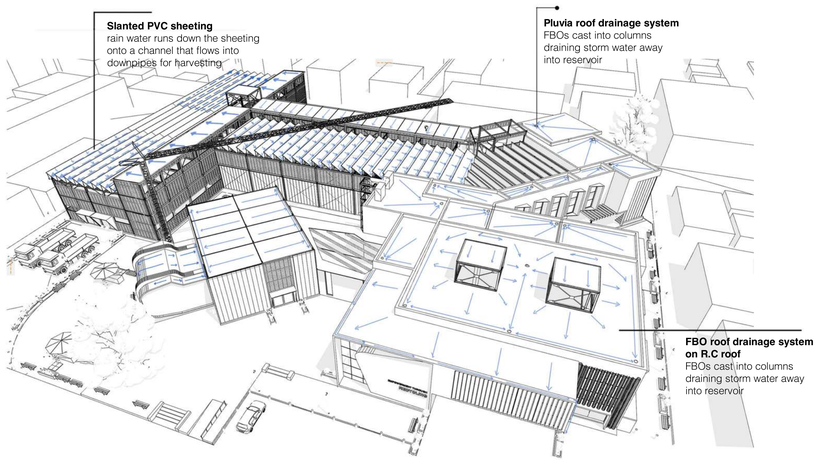
Fig 65: Illustration of sustainability strategies



SUSTAINABILITY
Passive ventilation through stack
along corridor
Natural light is harnessed
through windows

WATER HARVESTING

Different roofs have different methods of water harvesting. The main methods are the pluvia system which uses FBOs and use of gutters and downpipes to chanel storm water into reservoirs for treatment and reuse. Appropriate roof angles have been implemented to facilitate water run off.



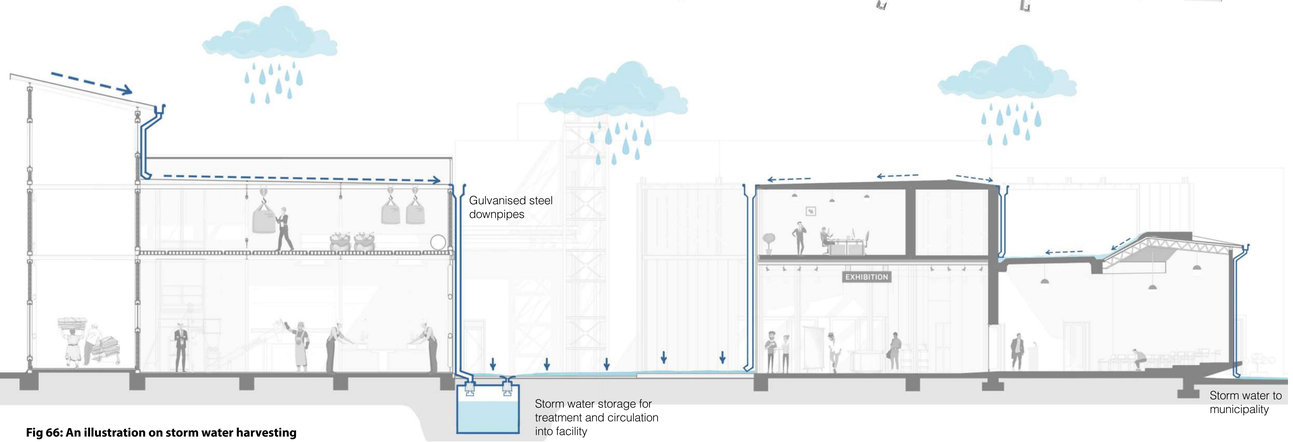
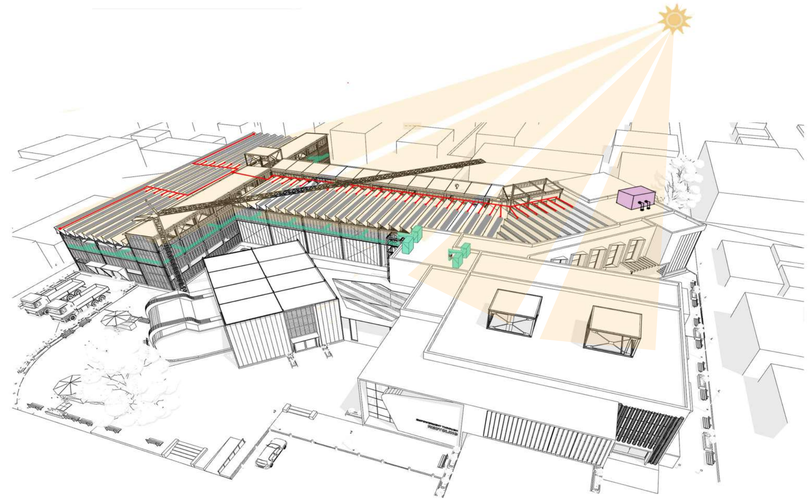


Fig 66: An illustration on storm water harvesting

SOLAR & HVAC

The teethed roof on the manufacturing phase of the facility slants facing the North for ample exposure to the sun for most of the day. This ensures that the panels on the grooves receive solar energy that is then converted into electric energy to be used in the facility.

Mechanical ventilation is used to compement passive ventilation systems that have been incorporated in the design. The same applies to solar energy- it acts as a complimentary source of power to the municipality power.



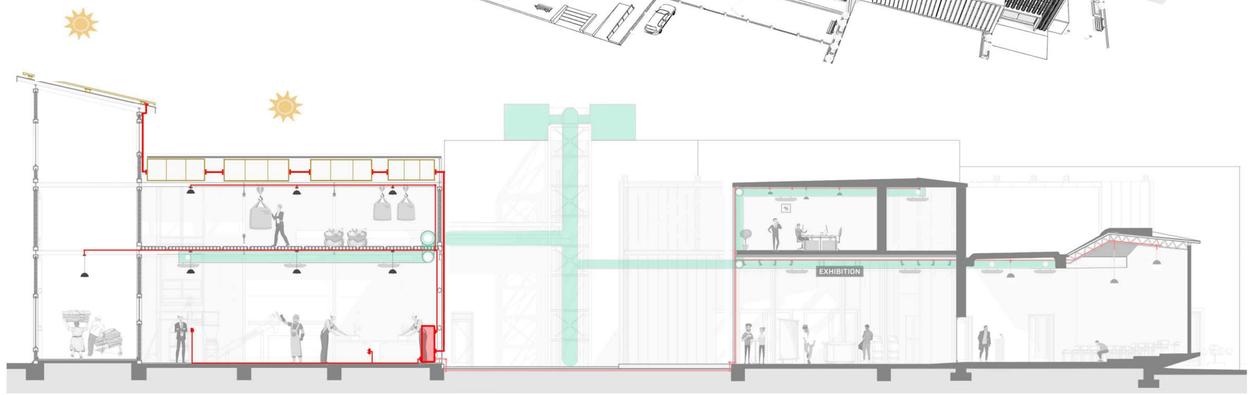


Fig 67: An illustration on solar harvesting and HVAC systems

CORE PROGRAM

The following are the 6 main products that my facility shall focus on producing from the recycling of the various types of plastic waste.

Once these products have been manufactured, they are to be subjected to various testing procedures to ensure that they comply with the national stipulated standards- e.g the plastic brick has to comply with SANS regulations regarding building matreials. This phase shall be managed by material engineers and people with expertise in dealing wiht non-conventional building materials.

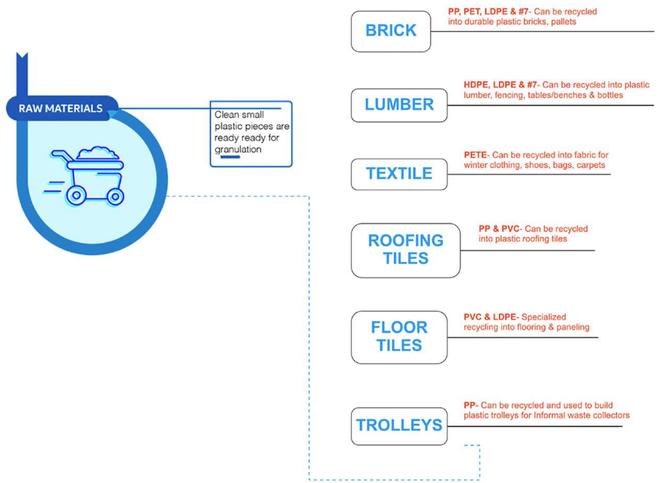


Fig 24: An illustration of the recycling process

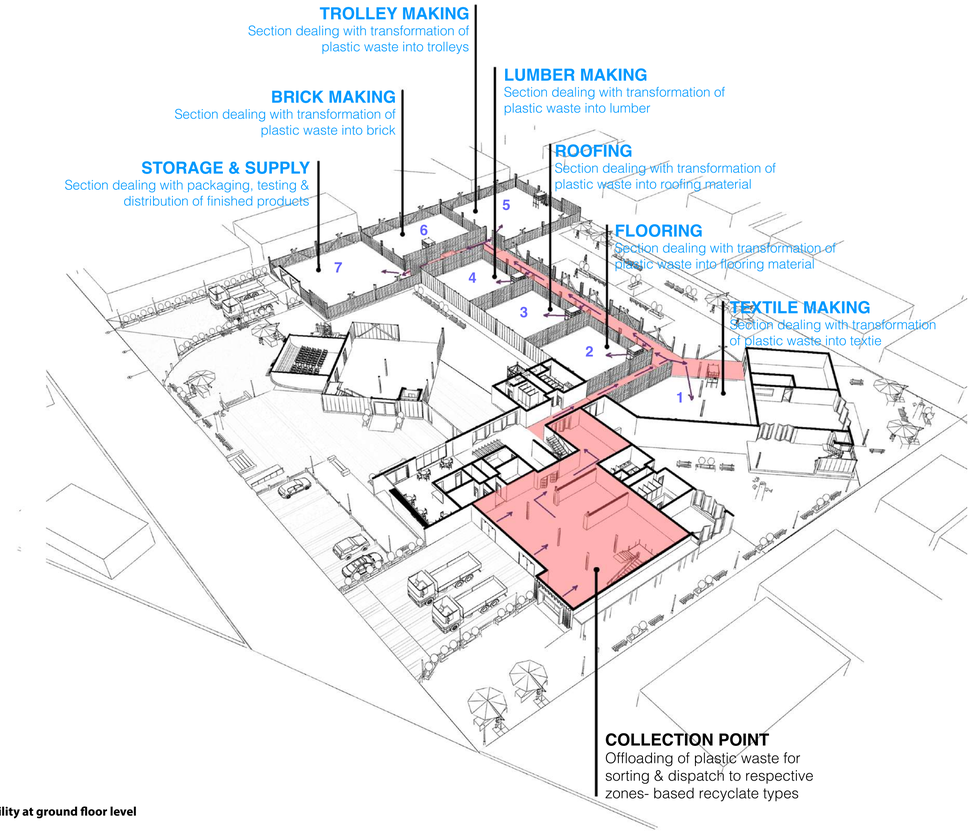


Fig 68: Program of facility at ground floor level

PHASE 1

The project shall be completed in two main phases- the first phase shall be for purposes of generating income for the next phase, and materials which shall be implemented on the second phase for purposes of illustration.

The 1st phase of the design houses 3 of the 6 recycling processes- These are the main products that will be used to construct the second phase of the centre



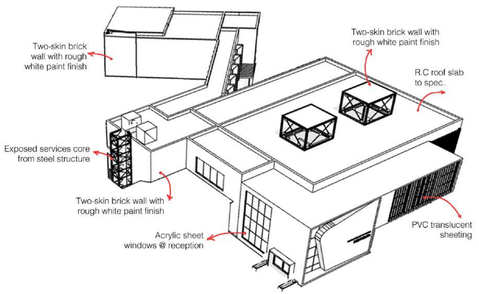


Fig 69: A collage showing phase 1 development



FINAL PROGRAM

1. COLLECTION & SORTING SPACE
2. RECEPTION & CAFE
3. ABLUTIONS
4. DISPATCH
5. ABLUTIONS (Collectors)
6. MAMA'S KITCHEN
7. ENTRANCE LOBBY
8. COLLECTOR'S CAFE
9. TRAINING WORKSHOP

MAIN MATERIALS

BRICK-

CONCRETE-

STEEL-

PVC SCREENING-

ACRYLIC SHEET WINDOW

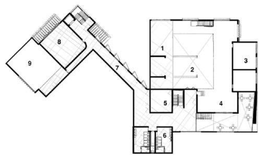
INTIAL PROGRAM & FUNCTION

GROUND FLOOR

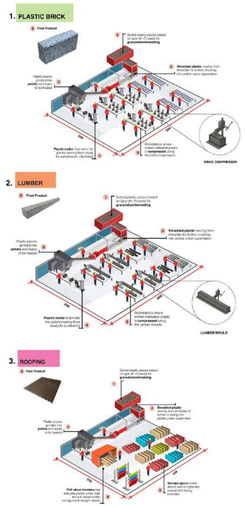


4. COLLECTION & SORTING SPACE
5. RECEPTION & CAFE
6. ABLUTIONS
7. DISPATCH
8. ABLUTIONS (Collectors)
9. MAMA'S KITCHEN
10. ENTRANCE LOBBY

1ST FLOOR

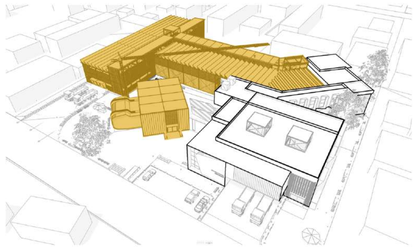


1. SORTING SPACE
2. VOID OVER COLLECTION POINT
3. ADMINISTRATION
4. INTERIM STORAGE/ DISPLAY
5. STORAGE
6. ABLUTIONS
7. CORRIDOR
8. SEMINAR ROOM
9. TRAINING WORKSHOP



PHASE 2

Processing space shall be built in the second phase of the design, using the various building materials produced from the recycling that occurs in the first phase. This way, the public shall be able to see a prototypical illustration of the materials and the intention of producing these materials.



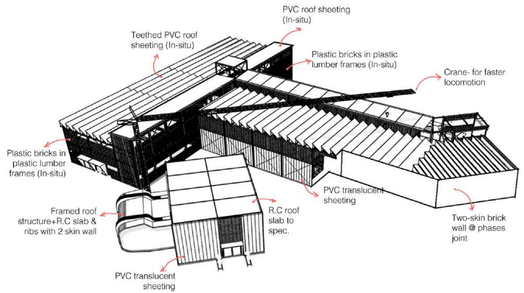


Fig 70: A collage showing phase 2 development

GROUND FLOOR



FINAL PROGRAM

1. TEXTILE MAKING
2. FLOORING
3. ROOFING
4. LUMBER MAKING
5. TROLLEY MAKING
6. BRICK MAKING
7. STORAGE & SUPPLY
8. AUDITORIUM
9. EXHIBITION SPACE

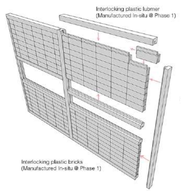
1ST FLOOR

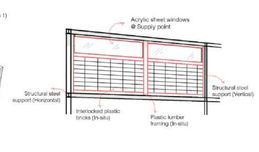


FINAL PROGRAM

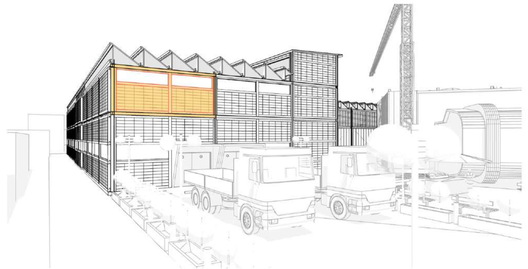
1. TEXTILE MAKING (Storage)
2. FLOORING (Storage)
3. ROOFING (Storage)
4. LUMBER MAKING (Storage)
5. TROLLEY MAKING (Storage)
6. BRICK MAKING (Storage)
7. STORAGE & SUPPLY
8. AUDITORIUM
9. ADMIN & OFFICES

CONSTRUCTION TECHNOLOGY









OFF-SITE APPLICATION OF MATERIALS

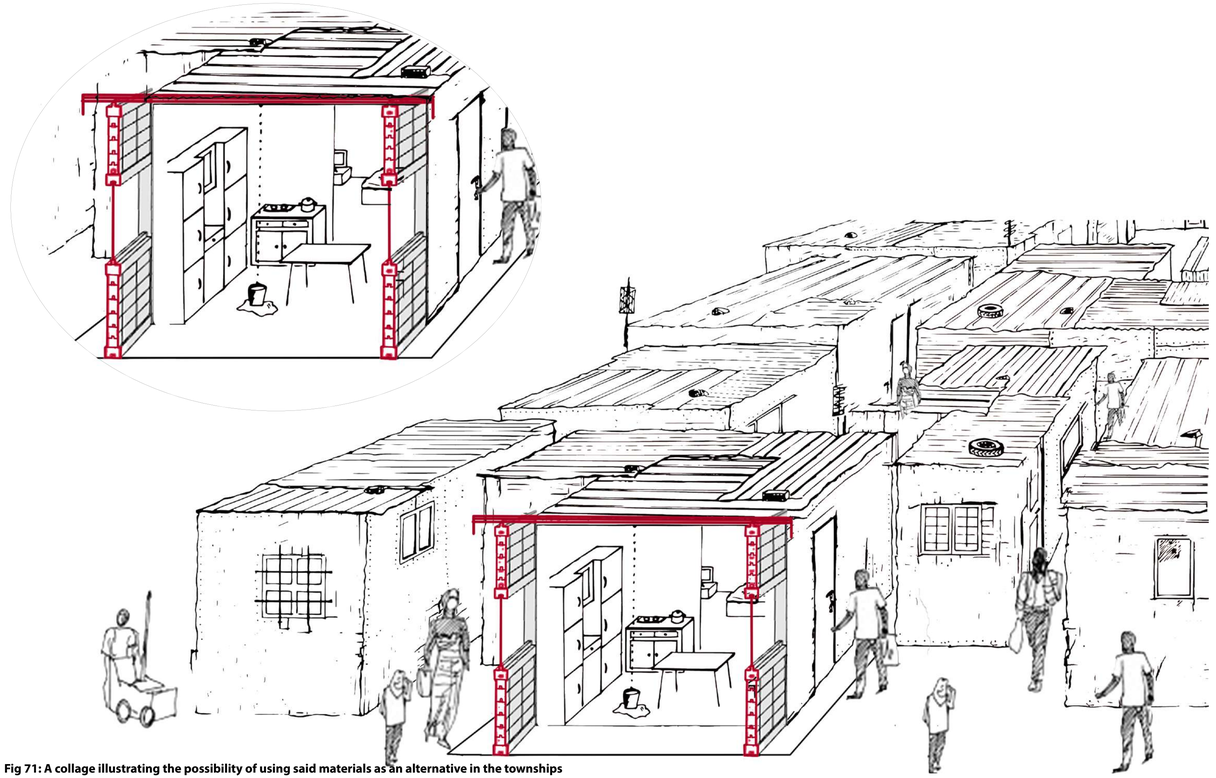
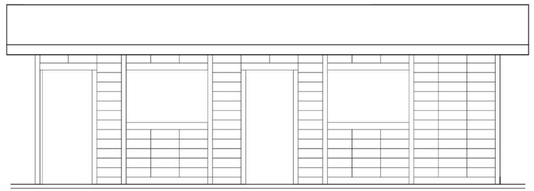
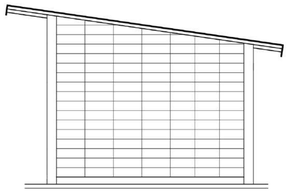
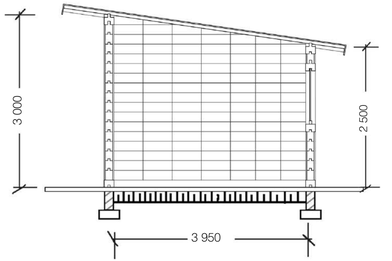


Fig 71: A collage illustrating the possibility of using said materials as an alternative in the townships

STANDARD CORE- HOUSE TYPE A





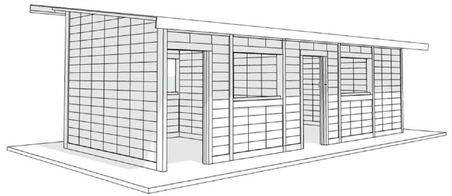


BUILDING COMPONENTS

Roof: 15mm PVC sheeting @ 8 degrees fixed on plastic lumber purlins & joists manufactured from recycling centre

Walls: Plastic bricks made at recycling centrejoining with plastic lumber frame in T&G method

Floor: 15mm thick 200x600 PVC flooring from recycling centre



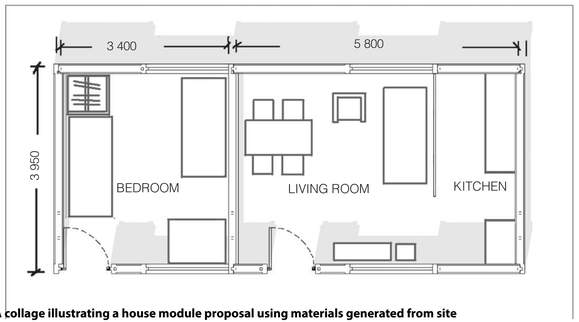
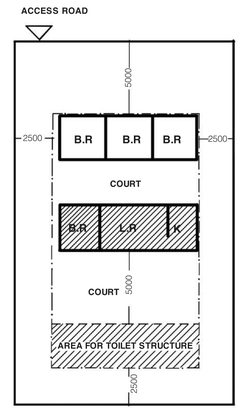


Fig 72: A collage illustrating a house module proposal using materials generated from site

PROPOSED SITE LAYOUT

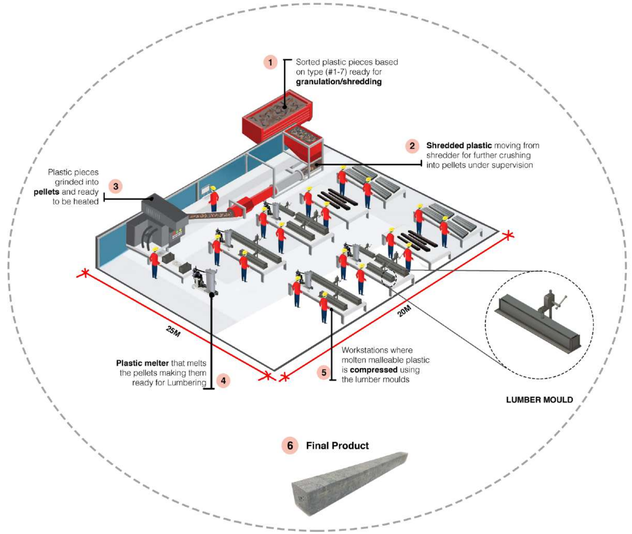


Basic plot (15x25)sqm= 375sqm
Core House= 36sqm

LUMBER PRODUCTION STATION

The process of producing plastic lumbers is similar to that of producing the other five products- more specifically, plastic bricks. It takes a bit more energy and more plastic materials to produce lumbers as there are variations in length of the end product.

Outdoor benches on site shall be made using these plastic lumbers as exhibition of the product to the public and to potential investors and buyers



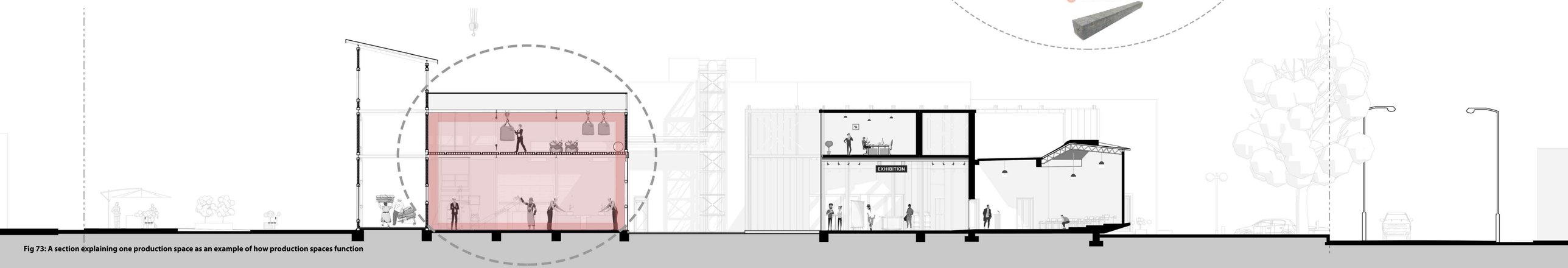


Fig 73: A section explaining one production space as an example of how production spaces function

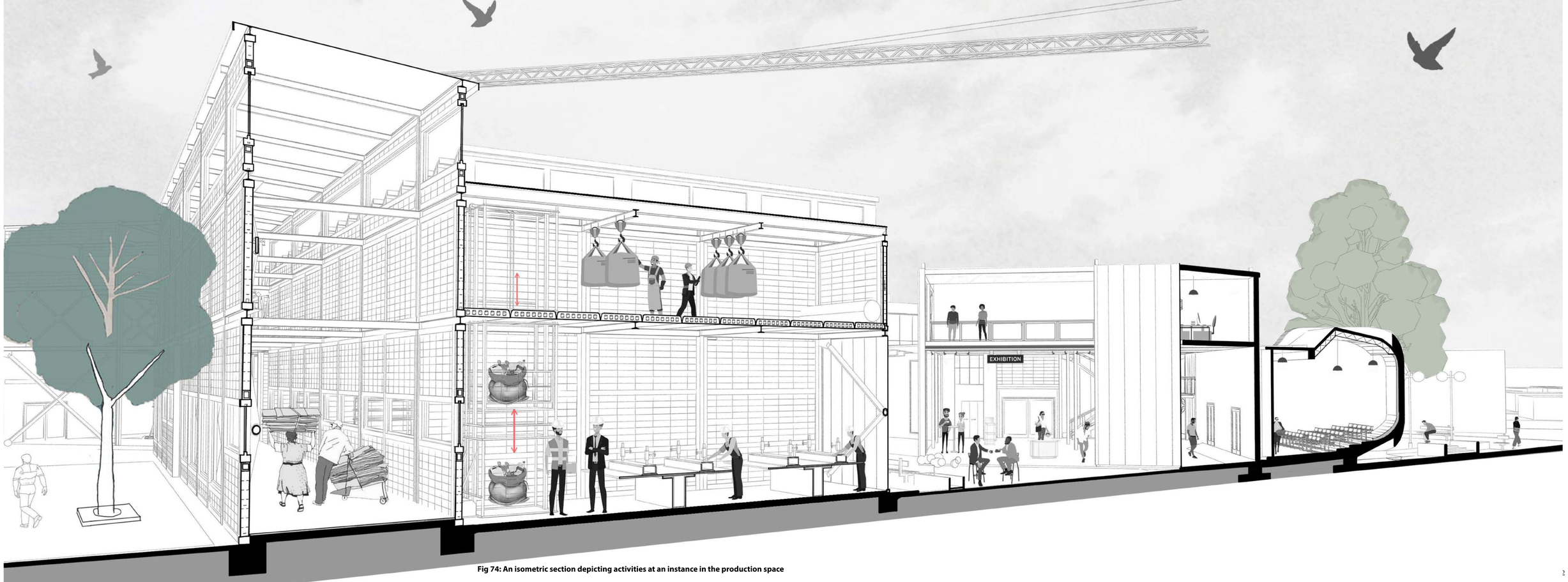
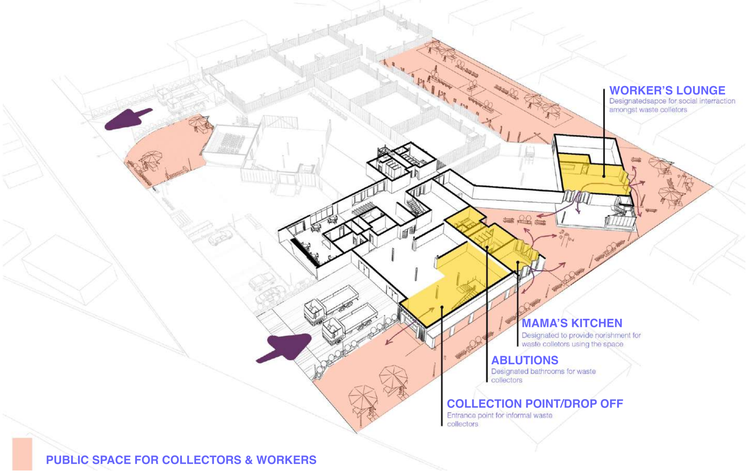


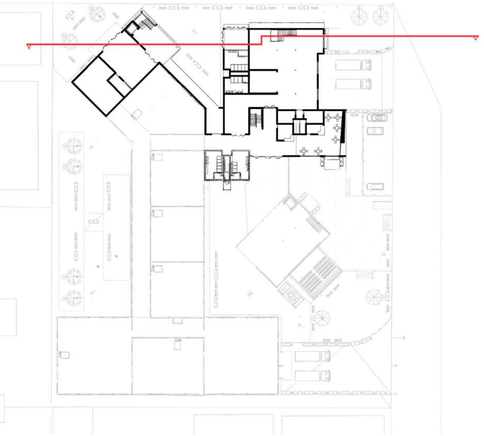
Fig 74: An isometric section depicting activities at an instance in the production space

COLLECTOR'S SPACE

External spaces invite and ephemerally accomodate waste collectors in the site for nourishment and rest. Kitchen space gives the women who cook for the waste collectors an opportunity to take part and contribute to the intervention

This enhances an over-all socio-economic growth amongst the people of Alexandra





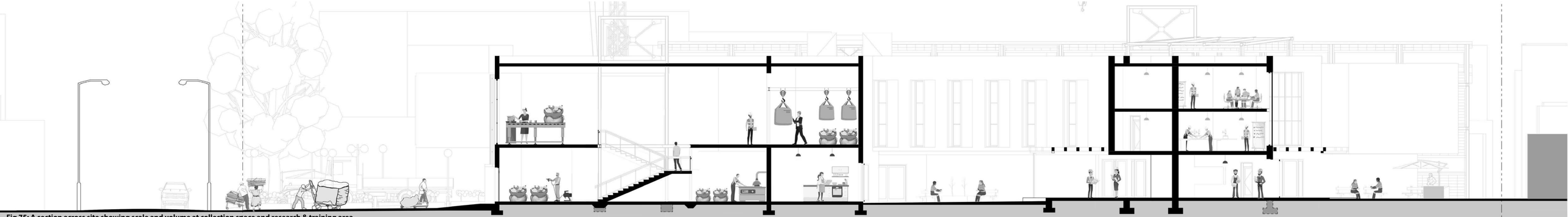


Fig 75: A section across site showing scale and volume at collection space and research & training area

EAST ELEVATION

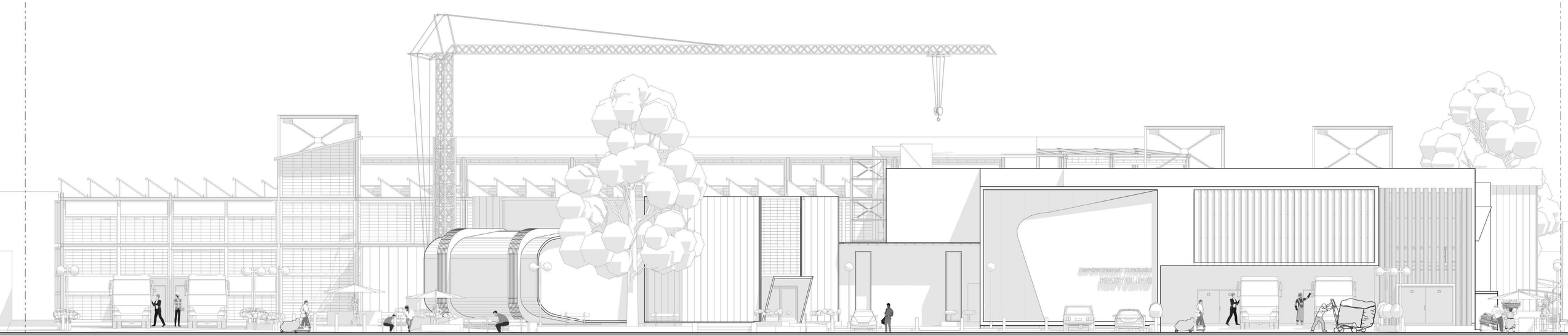


Fig 76: East elevation

NORTH ELEVATION

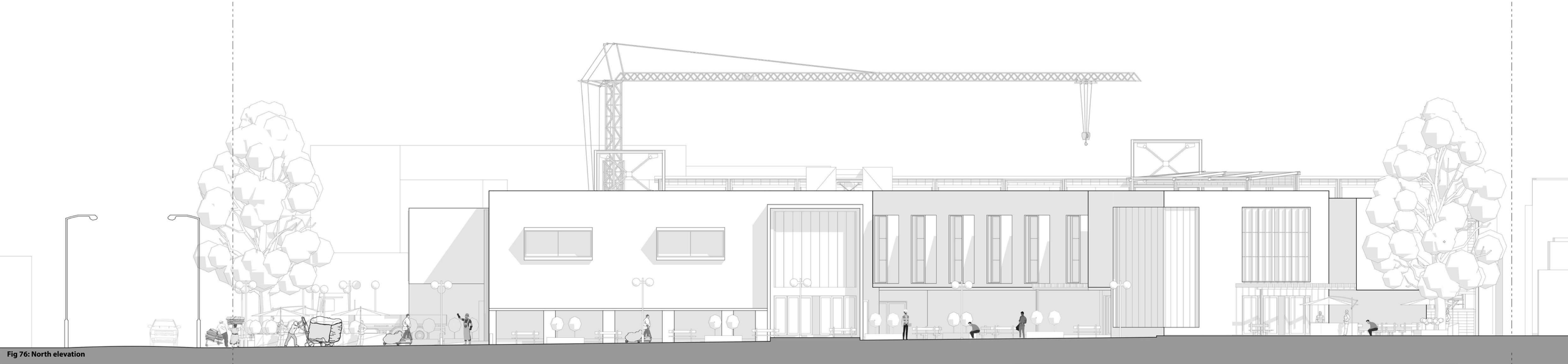
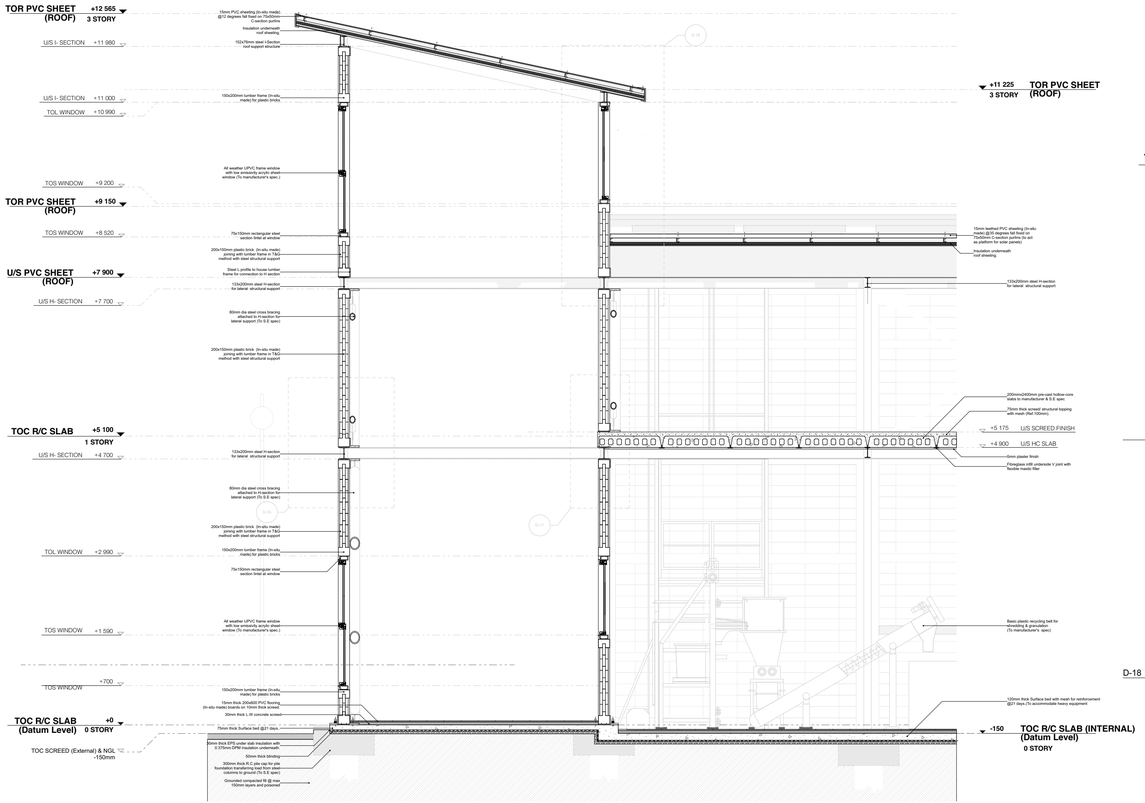
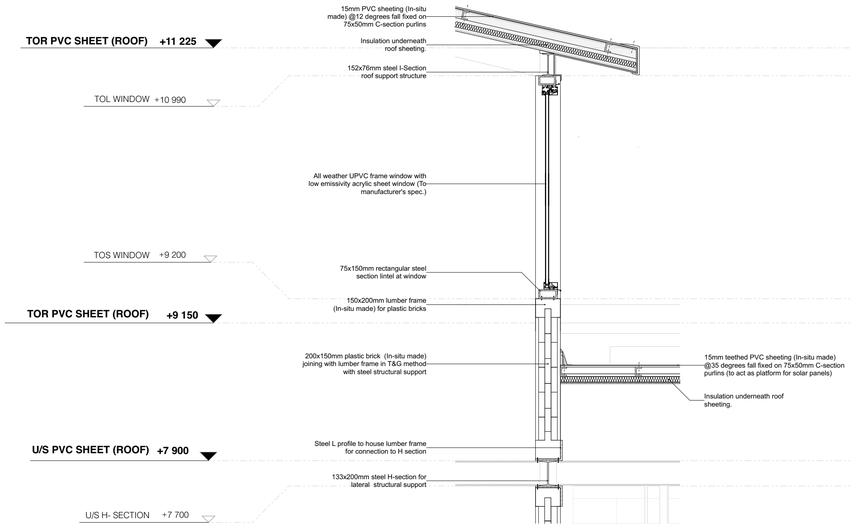


Fig 76: North elevation

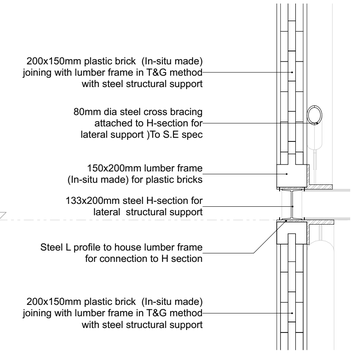


PERIMETER SECTION

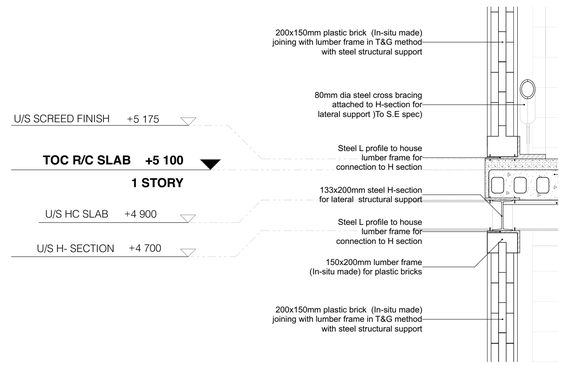
Fig 77: Perimeter section



D-18 DETAIL **Fig 78a**



D-16 DETAIL **Fig 78b**



D-17 DETAIL **Fig 78c**

Fig 78 a-c): Detail drawings

Fig 78 a-c): Detail drawings

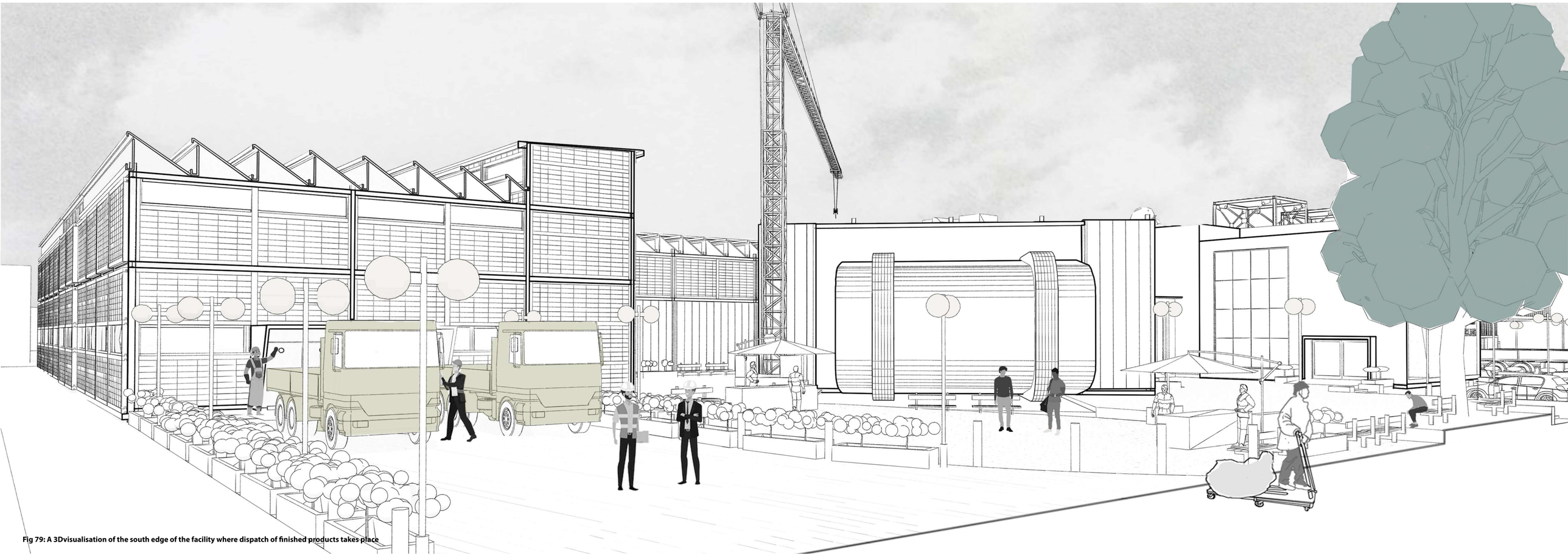


Fig 79: A 3Dvisualisation of the south edge of the facility where dispatch of finished products takes place

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Fig 4 : A graphical representation of the two main waste management systems
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Fig 12 (a-f): Images of a corrugated carbon pod- an example of a building made using non-conventional building materials
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Fig 18 a&b: Map showing climatic zone of site within the greater metropolitan context and Site aerial view
Google maps

The following is an organogram which outlines the procurement process and the professionals involved at the various stages of the project;
Fig 19: Graphic by Author

The following is a diagram that summarises the major cash flows of the facility;
Fig 20: Graphic by Author

Illustration on waste collection sources
Fig 21a: Graphic by Author

Fig 21b: Pikitup organisational structure
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Fig 22 (a-b): Maps showing various waste depots as potential sources ofplastic waste
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Fig 23 & 24: Illustration of recycling process
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Fig 25: Making of Plastic bricks
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Fig 27: Making of Textile from recycled plastic
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Fig 28: Making of roofing sheets from recycled plastic
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Fig 29: Making of floor tiles from recycled plastic
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Fig 30: Making of trolleys from recycled plastic
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Fig 31: A project phasing diagram
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Fig 32: Aerial view of Sandton vs Alexandra
Source; The Guardian. https://www.theguardian.com/cities/gallery/2016/jun/23/south-africa-divided-cities-apartheid-photographed-drone

Fig 33: Existing Shacks statistics showing the delapidated state of housing in the disenfranchised communities e.g Alexandra
https://www.eighty20.co.za/shacks-in-south-africa/

Fig 34a: Shacks statistics and analysis
Graphic by author

Fig 34b: Analysis on alternative housing built from products made out of recycled plastic
Graphic by author

Fig 35: Site locality map
Graphic by author basd on google maps.

Fig 36: Employment statistics- Alexandra
Graphic by author using grasshoper and Rhinoceros Softwares

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Fig 37: A composition showing the location of the site within the greater metropolitan context.
Graphic by author

Fig 38: Site sections
Graphic by author (Source; google earth)

Fig 39: Site section- the street outside the site predominantly has minimum and domestic activity, with minimum small scale commercial activity
Graphic by author

Fig 40: The various street activities
Graphic by author

Fig 41: Amenities map
Graphic by author

Fig 42 (a-d): Zoning and access maps
Graphic by author

Fig 43 & 44: Map showing possiblle waste sources around Johannesburg metropolitan area
Graphic by author

Fig 44: Climate analysis- Summer & atumn
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Fig 45: Climate analysis- Winter & spring
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Fig 46: Section sketchesdeveloped during design development
Graphic by author

Fig 47: 3D visualisation of facility from above
Graphic by Author

Fig 48: Sketches by author

Fig 49 (a-c): Images of the charrette process
Graphics by author

Fig 50 (a-h): Images of the charrette process
Graphics by author

Fig 51: REsolution1 Plan

Fig 52: Resolution 2 Plan

Fig 53 (a-c): Resolution 1 Plan & Sections
Graphics by author

Fig 54 (a-c): Resolution 2 Plan & Sections
Graphics by author

Fig 55 (a-c): Resolution 2 Plan & Sections
Graphics by author

Fig 56 (a-c): Alternative 2 Massing diagrams
Graphics by author

Fig 57 (a-c): Alternative 2 Massing diagrams
Graphics by author

Fig 58: A collage of images showing a sectional development of the facility
Graphics by author

Fig 59: A collage of images showing a conceotual development of the facility in planand 3D
Graphics by author

Fig 60: A collage of images showing a concept o connection as the key word of the project
Graphics by author

Fig 61: A collection of sections showing a detail of the perimeter of the building
Graphics by author

Fig 62: Materiality
Graphics by author

Fig 63: Sections showing materiality
Graphics by author

Fig 64: Climate analyses

Fig 65: Illustration of sustainability strategies

Fig 66: An illustration on storm water harvesting

Fig 67: An illustration on solar harvesting and HVAC systems

Fig 68: Program of facility at ground floor level

Fig 69: A collage showing phase 1 development

Fig 70: A collage showing phase 2 development

Fig 71: A collage illustrating the possibility of using said materials as an alternative in the townships

Fig 72: A collage illustrating a house module proposal using materials generated from site

Fig 73: A section explaining one production space as an example of how production spaces function

Fig 74: An isometric section depicting activities at an instance in the production space

Fig 75: A section across site showing scale and volume at collection space and research & training area

Fig 76: East elevation

Fig 77: Perimeter section

Fig 78 a-c): Detail drawings

Fig 79: A 3Dvisualisation of the south edge of the facility where dispatch of finished products takes place

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Bukasa, E. Interview with a Project Manager. By Benedictte Kabongo. M.Arch Prof, 2022.
Bukasa, P. Interview with a Contractor. By Benedictte Kabongo, M.Arch Prof, 2022.
Sacks, G. (2022) Interview with a Property Developer. By Reuben Visser & Caitlin Ho. M.Arch Prof, 2022.
Guest, I. (2022) Interview with Town Planner, Ilan Guest. By Merlin Love & Caitlin Ho. M.Arch Prof, 2022.
Yung Fah, C. (2022) Interview with a Quantity Surveyor. By Tanitha Yan. M.Arch Prof, 2022.

Lecture presentations- ARPL7002A, 2022:

- The Professional team- 2022-01
- Viability report 2022- 02b
- Development costs 2022-04
- Technical aspects 2022-06